PODIUM PRESENTATIONS 01

International Variations in the Clinical Presentation and Management of Cervical Spondylotic Myelopathy. One Year Outcomes of the Aospine Multi-Center Prospective Study

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Introduction: Little information is available with respect to differences in global approaches to treatment of cervical spondylotic myelopathy (CSM).

Methods: To date, 318 patients with clinically symptomatic CSM have been enrolled in a prospective multi-center controlled, cohort study involving 13 sites in Europe, Asia, South America and North America. Data were analyzed using multivariate techniques adjusting for baseline differences (age, gender, surgical approach, number of spinal levels and baseline outcome parameter value) in patient populations (SAS 9.2 PROC MIXED).

Results: There were 39% females with an average age of 56.5 yrs (SD 13). Patients underwent anterior (60%), posterior (37%) or circumferential (3%) decompressive/reconstructive surgery with the surgical techniques chosen by the treating team. There were significant differences in presentation and surgical approaches among the regions. To date, 142 patients have completed 1 year follow-up. There has been a statistically (P <.01) and clinically significant improvement from baseline values to 12 months in all outcome parameters. The MJOA improved from 12.70 ± 2.95 at baseline to 15.24 ± 2.64 at 12 months. The NDI improved from 37.53 ± 20.72 at baseline to 28.46 ± 18.80 at 12 months. The Nurick improved from 4.03 ± 1.17 at baseline to 2.82 ± 1.51 at 12 months. The PCS improved from 35.02 ± 8.82 at baseline to 43.19 ± 10.51 at 12 months. The MCS improved from 38.51 ± 9.91 at baseline to 45.36 ± 11.12 at 12 months. Of note, the amount of improvement varied across the regions. Asia & Pacific and Latin America had better outcomes than North America and Europe. The reasons for these differences are under investigation and will be clearer as the follow-up progresses.

Conclusion: This large prospective global clinical study shows that surgical treatment for CSM is associated with significant improvements in generic and patientspecific outcome measures at one year. There are however significant variations in extent of improvement that needs to be further investigated.

PODIUM PRESENTATIONS 02

Validity and responsiveness of the Core Outcome Measures Index (COMI) in patients with neck pain undergoing cervical disc arthroplasty

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Introduction: The Core Outcome Measures Index (COMI) was originally proposed as a parsimonious set of items for monitoring multidimensional outcome in patients with back pain (1). Further COMI validation studies have subsequently been carried out, mainly on patients with problems of the lumbar spine. A version for use in patients with mechanical neck pain undergoing conservative management was introduced in 2004 (2). The present study sought to validate the COMI-neck in patients with more severe neck symptoms undergoing cervical disc arthroplasty.

Methods: Patients were participants in the nationwide SWISSspine registry of disc arthroplasty, for whom various established patient-rated outcomes (the EQ-5D Quality of Life instrument and the NASS Cervical Outcomes Questionnaire (NASS-C)) were being collected on an obligatory basis, to assist with decisionmaking regarding future reimbursement policies. The patients were also participating in the standard quality management process of the authors’ hospital, in which outcome was documented using the COMI-neck instrument. The questionnaires were administered by different authorities (Nationwide registry and own hospital) at similar time-points (pre-op, and at various time-points up to 2y after surgery). The data of 67 patients (36 F, 31 M; age 45 ± 8y) were available for analysis at the first follow-up (3mo).

Results: The baseline scores for the pain items in the COMI showed significant correlations with those of the NASS-C (neck pain, r=0.56;
arm pain, r=0.70; each p<0.0001). The COMI scores showed a significant correlation with the EQSD scores (r=0.58, p<0.0001) and the NASS-C pain/disability scores (r=0.70, p<0.0001).

The responsiveness to change (standardised response mean) at the first follow-up was greater for the COMI (1.75) than for the EQSD (0.95) or any of the NASS-C sub-scales (0.99-1.65). 88% patients reported a good global outcome and 12%, poor. Of all the scales/sub-scales, the COMI showed the best ability to discriminate between good and poor outcomes (area under ROC curve, 0.95;CI,0.86-0.99).

Conclusion: The study provides evidence to support the use of the short, multidimensional COMI-neck as a practicable, valid and responsive outcome instrument in patients with cervical spine disorders undergoing surgery.

PODIUM PRESENTATIONS 03
Decompression for multisegmental spondylotic stenosis of the cervical spine: anterior or posterior approach?
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Introduction: Surgical decompression of the cervical spine may be performed using either an anterior or posterior approach. The arguments for choosing one method over the other mainly include: the main location and etiology of stenotic agent(s), preservation of lordotic alignment, trauma to the soft tissue and postoperative pain/rehabilitation. Few studies have examined whether patient-rated outcomes differ between the two approaches. The aim of the present observational study was to address this issue.

Methods: The SSE Spine Tango Registry was used to acquire the data from 62 consecutive patients presenting at our institution (2005-2009) with degenerative spinal stenosis of the cervical spine of more than one segment. Anterior decompressive surgery (N=36) consisted of discectomy (sequestrectomy), full or partial vertebrectomy with or without foraminotomy; posterior procedures (N=26) comprised laminectomy/laminoplasty and partial facetectomy. Pre-operatively and at 12 months follow-up (FU), patients completed the multidimensional Core Outcome Measures Index (neck pain, arm pain, function, quality of life, disability); at 3 and 12 mo FU, “global treatment outcome” and “satisfaction” were rated on 5-point Likert-scales and subsequently dichotomised (good/poor).

Results: Pre-operatively, the COMI score (0-10 scale) did not differ between the groups: anterior, 6.2 ± 2.5; posterior, 6.9 ± 2.5 (p=0.36). At 12 mo FU, COMI scores had reduced by 3.4 ± 0.31 (anterior) and 2.8 ± 2.4 (posterior) points, with no significant difference between the groups (p=0.49). 76% patients in the anterior group and 69% in the posterior declared a “good global outcome” at 3 mo FU (p=0.38); at 12 mo FU, the figures were 80% and 71%, respectively (p=0.52). 79% of the anterior group and 81% of the posterior were “satisfied with treatment” at 3mo (p=0.90), and 87% and 81% (p=0.70), respectively, at 12 mo.

Discussion/Conclusion: Although the preservation of neurological function and pain reduction may be the main goals of decompressive surgery, the subjective outcome evaluated by the patients represents the ultimate justification for each surgical procedure. Our results demonstrate no significant differences in outcome between anterior and posterior approaches of the cervical spine. We should continue to indicate surgery based on individual anatomic conditions and etiology.

PODIUM PRESENTATIONS 04
Dynamic Cervical Implant (DCI). An alternative between cage fusion and total disc replacement
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Preservation of motion and prevention of adjacent degeneration is a major concern in newer spinal implant development (disc prosthesis). DCI aims at combining the advantages of (cage) fusion technique with motion preservation philosophy (total disc replacement). DCI developed by the author is in clinical use since 2004. The design is an anatomical- shaped, self-fixing dynamic spacer made of titanium, easy to implant like a cage. The Dynamic Cervical Implant stabilizes the cervical spine while providing controlled motion in flexion-extension, the main motion in subaxial C-Spine. Shock absorption, a significant advantage compared to most existing prostheses prevents adjacent accelerated degeneration. Indications for DCI concern all mobile cervical segments (>3° motion in flexion-extension) from C3 to C7 in disc herniation, degenerative discopathy, central or lateral stenosis. Adjacent level protection above or below an already fused level is an excellent indication. In the first 24 cases treated with DCI, segmental motion is mostly preserved. A slow fusion observed does not produce AD at 5 years of follow-up. Implant migration is avoided by a strict operative technique. I had 1 reoperation for asymptomatic anterior migration. Only one heterotopic ossification happened in the first 24 cases. Clinical outcome is superior to cage fusion with no long term reoperation. In a multicenter prospective study on 102 patients, satisfaction overall was 78% and 96% would have surgery again. Although anterior cervical fusion works well at one level, long term studies have shown symptomatic adjacent level disease needing reoperations in 7 to 15% at 20 years follow-up. A motion preservation and control procedure is clearly indicated to delay fusion as long as possible. DCI has much larger indications than conventional disc prosthesis because of controlled rotation: therefore degenerative arthropathy, a cervical pain generator remains an indication for DCI contrary to most arthroplasties. Cervical spine arthrodesis is involved in AD. Delaying fusion as long as possible with arthroplasty seems wise. Slow fusion may also reduce AD. DCI is an interesting alternative between cage and disc prosthesis.

PODIUM PRESENTATIONS 05
Comparative Effectiveness of Ventrail versus Dorsal Surgery for Cervical Spondylotic Myelopathy
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Objective: To determine the feasibility of a randomized clinical trial (RCT) comparing the clinical effectiveness and costs of ventral versus dorsal decompression with fusion surgery for treating cervical spondylotic myelopathy (CSM).

Methods: A non-randomized prospective clinical trial was conducted. Patients aged 40-85 with degenerative CSM were enrolled at 7 sites over 2 years (2007-2009). Outcome assessments were obtained pre-operatively, 3 months, 6 months, and 1 year post-operatively. A hospital-based economic analysis was performed by applying Medicare cost-to-charge ratios (CCR) to reported hospital charges.
Results: The pilot study enrolled 50 patients. 28 were treated using ventral fusion surgery, and 22 with dorsal fusion surgery. Average age was 61.6 years. Baseline demographics and HR-QOL scores were comparable between groups. At baseline, dorsal surgery patients had a significantly greater amount of myelopathy (P<0.01). Comprehensive 1-year follow-up was obtained in 44/50 (88%) patients. Significant improvement in mJOA was observed in both groups (P<0.01). Greater HR-QOL improvement (SF-36 PCS) was observed after ventral surgery (P=0.05). Complication rate (16.6% overall) was comparable between groups. Dorsal fusion surgery had significantly greater unadjusted hospital costs ($29,465 versus $19,344; P<0.01) and longer average length of stay (4.0 versus 2.6 days; P<0.01) compared with ventral fusion surgery.

Conclusions: Surgery for treating CSM was followed by significant improvement in disease-specific symptoms and in HR-QOL. Greater improvement in HR-QOL was observed after ventral surgery. Dorsal fusion surgery was associated with longer length of stay and higher hospital costs. The pilot study demonstrated feasibility for a larger RCT.

PODIUM PRESENTATIONS 06
5-year results of the prospective, randomized, multicenter Investigational Device Exemption (IDE) ProDisc®-C vs. ACDF clinical trial
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Introduction: Cervical total disc arthroplasty is intended to address pain and preserve motion in patients with symptomatic cervical disc disease (SCDD). Previously, the 2-year outcomes from the randomized clinical trial (RCT) of the ProDisc®-C (Synthes USA Products, LLC, West Chester, PA) total disc replacement (TDR) were reported. We are presenting the 5 year results of ProDisc®-C compared to anterior cervical disectomy and fusion (ACDF) for treatment of 1-level SCDD between C3-C7.

Methods: A prospective, randomized, controlled, multicenter investigational device exemption study was conducted at 13 sites, utilizing a 1:1 randomization ratio. A total of 236 patients (103 ProDisc®-C; 106 ACDF) were treated. Patients were evaluated pre-operatively, at 6 weeks, 3, 6, 12, 18, 24, 36, 48, and 60 months. Assessments included Neck Disability Index (NDI), Visual Analog Scales (VAS) for pain and satisfaction, SF-36, physical and neurological exam, and radiographic evaluation.

Results: Demographics were parallel between the two groups. NDI scores were similar between treatment groups at baseline, significantly decreased for both at 6 weeks follow-up (p <0.0001), and maintained improvement to 60 months. VAS pain assessment showed significant improvement from pre-operative levels regardless of treatment (p <0.0001). SF-36 scores improved to 60 months for both groups. The assessment scores of ProDisc®-C patients showed greater improvement at 60 months than those of ACDF patients, though not significantly. Between 24-60 months, VAS satisfaction rates continued to improve for ProDisc®-C, though not for ACDF patients; at 60 months, 100% of ProDisc®-C vs. 95.2% of ACDF patients would have surgery again. At 60 months, ProDisc®-C patients achieved a mean range of motion of 8.2°±7.30. Within 60 months, the number of required secondary surgeries differed significantly (ProDisc®-C: 2.9%; ACDF: 14.2%; p <0.005).

Conclusions: At 5 years, ProDisc®-C performed at least equivalently to ACDF in terms of pain relief, satisfaction, and maintenance of motion with no deterioration of outcomes from 2-year results. Prodisc®-C patients were significantly less likely to require repeat surgery at 5 years and did not develop adjacent level radiculopathy seen in ACDF patients.

PODIUM PRESENTATIONS 07
Acute craniocervical ligament injuries after major trauma detected with a new MRI protocol
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Severe ligament injuries of the craniocervical junction, CCJ, may occur in high energy trauma. We present a MRI protocol for evaluation of these. 14 consecutive MVA victims with suspected injuries to the CCJ, were examined with the suggested protocol: Overview of cervical spine including, sag T1 and T2, axial T2/grad echo. In cases of suspected cranial nerve injury also MRI of the brain. Due to the dimensions of its ligaments the examination of the CCJ consists of proton weighted sequences with a small field of view, FoV 130mm and slice thickness of 2 mm with preserved resolution including T1 and fat suppressed T2. We propose a high resolution protocol tailored for detecting partial and total ruptures of the alar ligaments, effusions in condylar and atlantoaxial joints, distensions of the joint capsules as well as tears of the tectorial membrane. Injuries of the apical dental ligament and anterior and posterior atlanto-occipital membranes may not always be detected but indirect findings may indicate injuries of these structures. Injuries of various severities were detected in 10 of the patients. Combination injuries of the CCJ were common but no patient had rupture of all structures. Injury to the abdusence nerve was detected in two patients with strabismus. Three patients with extensive injuries were treated with fusion of the CCJ whereas the rest of the injured patients were treated in braces. The high resolution MRI protocol has been of great value in diagnosing these injuries in our patients.

PODIUM PRESENTATIONS 08
Combined injury of the dens axis, the atlas bow and the ligamentum transversum-“the unhappy triad” of the atlanto-axial joint in elder people
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Purpose: Due to the often seen atlanto-axial instabilities we found a new entity in elder patients- the combined injury of the dens axis, the atlas bow and the ligamentum transversum- the “unhappy triad” of the atlanto-axial joint.

Methods: Since 01/2007 we found 12 multimorbid patients with combined injury of the dens axis, the atlas bow and the ligamentum transversum. They were all treated with the anterior transarticular C1/2 (ATF) fusion, were regular examined radiologically (x-ray/CT) and the procedure critically judged.
Results: In the preoperative diagnosis (x-ray, CT) the described entity was seen. It was suspicious, that concerning this “triad” the fractures of the dens were very cranial. 7 times we saw anterior atlas bow fractures, in 5 times posterior ones. ATF was performed in 12 patients (7f, 5m, average 81,67 years). The main symptoms was pain radiating in the upper cervical spine and the occiput. 2 Patients had radiating pain with paraesthesia in both upper extremities. The average operationtime took 64,5 min. Leftside the screws of Ø 39,5mm (32-44mm), rightside of 36mm (32-44mm) were inserted in addition accesspoint and the insertionangle (mediolateral Ø 32,0°, ventrodorsal Ø17,6°). No intraoperative complications concerning the procedure occurred, one revision had to be done because of p.o. bleeding, one because of screw dislocation. Postoperative x-ray and CT control of the upper cervical spine showed 16/22 (72,7%) screws in 12 patients in correct position. 3 (13,6%) screws were too long, 2 (9,1%) screws were placed too anterior and 1 (4,3%) too medial compared to the named position in the literature. A low intraoperative blood loss, a non traumatic access as well as an immediate postoperative pain decrease have to be valued positively for this procedure.

Conclusions: The combined injury of the dens axis, the atlas bow and the ligamentum transversum is an entity which is more and more often seen in injuries of the atlantoaxial joint and has to be thought of in the preoperative diagnosis as well as intraoperatively. The ATF represents a gentle procedure for these patients with high unstable fractures. It assures an immediate pain reduction as well as high stability.

PODIUM PRESENTATIONS 09
A systematic review of the evidence supporting a role for vasopressor support in acute SCI
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Study design: A systematic review of clinical and preclinical literature.

Objective: To critically evaluate the evidence supporting a role for vasopressor support in the management of acute spinal cord injury and to provide updated recommendations regarding the appropriate clinical application of this therapeutic modality.

Background: Only few clinical studies exist examining the role of arterial pressure and vasopressors in the context of spinal cord trauma.

Methods: Medical literature was searched from the earlier available date to July 2009 and 32 articles (animal and human literature) answering the following four questions were studied: what patient groups benefit from vasopressor support, which is the optimal hypertensive drug regimen, which is the optimal duration of the treatment and which is the optimal arterial blood pressure. Outcome measures used were the incidence of patients needing vasopressors, the increase of arterial blood pressure and neurologic improvement.

Results: Patients with complete cervical cord injuries required vasopressors more frequently than either incomplete injuries or thoracic/lumbar cord injuries (P<0.001). There was no statistical difference in neurologic improvement between patients on vasopressor support with a mean arterial pressure (MAP) of less than 85 mm Hg and those with MAP less than 90 mm Hg. Duration of treatment is often recommended between 5 and 7 days although this is not supported by high-level evidence and no single vasopressor appeared superior over the variety used in clinical treatment.

Conclusion: There is currently no gold standard on vasopressor support. Based on non-randomized human studies, complete cervical cord injuries require vasopressors more frequently than other spinal cord injuries.

PODIUM PRESENTATIONS 10
Are there therapy algorithms in isolated and combined atlas fractures?
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Aim: Injuries of the atlas are always a challenge in diagnostics and therapy. Different clinical manifestations, inconspicuous neurological results, uncertain findings of radiological diagnostics and possible accompanying injuries require individual therapeutic concepts.

Methods: Patients with injuries of C1 and C2 seen between 2001-2007 were evaluated and especially the morbidity and treatment of the C1-injured patients were verified. To systematise the injuries, a subdivision in isolated and combined trauma took place. Furthermore, the post-traumatic accompanying neurological deficits were evaluated.

Results: Altogether 121 fractures/ injuries of the upper cervical spine (C1/2) were counted, 22 (18,2%) concerning the atlas. There were 11 fractures of type Gehweiler I, 9 of type III and 1 each of types II and IV, isolated fractures of type I (5/11) were treated conservatively, combined injuries (6/11), depending on the stability and location of the attendant injuries, were treated with semi-rigid collars, anterior or posterior fusions. Stable fractures of type III (2/9) were primarily treated in Halo extension. Because of an attending dens fracture type Anderson II in a case, a spondylodis of the dens was additionally performed in the conservative treatment of the atlas. The therapy of isolated unstable atlas fractures of type III (4/9) ranged, depending on the general conditions, from Halo extension, transoral C1 stabilisation, anterior transarticular C1/C2 fusion to posterior occipitocervical fusions. The therapeutic regime of combined unstable type III injuries (2/9) depended on the additional trauma: anterior fusion in C6/7 luxation fracture combined with Halo extension for C1, posterior C0/ C3 fusion in unstable dens fractures of type Anderson II.

Conclusions: The therapy for atlas fractures orients on the type of C1 fracture, the accompanying injuries and the general condition of the patient. Isolates stable C1 fractures without dislocation can be treated conservatively (cervical collar), unstable fractures, depending on the general condition, should be refered to surgical therapy or halo extension. In combined atlas fractures the strategy of treatment has to take the stability of the C1 fractures into consideration, but also the additional injuries of the rest of the cervical spine and the attendant circumstances.

PODIUM PRESENTATIONS 11
Can prevertebral hyperintensity and intramedullary high-signal intensity on magnetic resonance imaging predict neurologic outcome in cervical spinal cord injury without radiological abnormality?
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Introduction: Spinal cord injury without radiologic abnormality (SCIWORA) was first described in 1982 by Pang and Wilberger who
classified this condition as a spinal cord injury that is accompanied by the presence of neurologic symptoms in the absence of positive radiologic findings before the emergence of magnetic resonance imaging (MRI). However, there have been few reports about the image features on MRI of patients with SCIWORA. The purpose of this study was to investigate the prognostic factors and clinical value of MRI findings in patients with SCIWORA.

Methods: 100 consecutive patients with SCIWORA who had undergone surgery were enrolled. There were 79 males and 21 females; the mean age was 55 years (range 16–87). All of the patients underwent functional X-ray and MRI. MR T2 weight imaging sagittal view including prevertebral hyperintensity (PVH), intramedullary high-signal intensity (IMHSI) and these range were evaluated. The range was defined as C3 vertebral height. Neurologic status was evaluated with the Japanese Orthopaedic Association scoring system (JOA score).

Results: PVH was found in 90 patients, IMHSI was done in 92 patients preoperatively. Mean JOA score of patients was 8.4 points preoperatively. The range of PVH negatively correlated with the JOA score. There was a strong negative correlation between the range of IMHSI and JOA score (r = -0.505, P < 0.0001). Mean JOA score of patients was 11.6 points postoperatively. The recovery rate of JOA score was 40.1%. The range of PVH negatively correlated with the recovery rate. There was a significant negative correlation between the range of IMHSI and recovery rate (r = -0.401, P < 0.0001).

Conclusions: The presence of PVH and IMHSI influenced the neurologic status of the patients. IMHSI and IMHSI were significantly associated with poor prognosis for neurologic outcome. PVHI and IMHSI may be a possible indicator of severity in patients with SCIWORA.

PODIUM PRESENTATIONS 12
Prognostic prediction of hyponatremia and hypertonic complication in spinal cord injury - Risk factor analysis using multivariate logistic regression

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Introduction: Hypotension associated with hyponatremia is a major complication and remains a great issue in spinal cord injury (SCI). Uncontrollable low blood pressure causes syncope or infarction which frequently interferes with rehabilitation and sometimes be fatal. Prediction of hypotension is very important for planning rehabilitation and for proper medical care, however, there are few studies mentioning the risk factors of these complications. The purpose of this study is to clarify the predictors of hypotension after SCI, and to discuss the pathology affecting this complication.

Materials & Methods: This study comprised 172 SCI patients, who underwent medical treatment in our institute within 2 days after injury. All of them were followed up for the minimum of 3 months. Age, gender, ASIA motor score (MS), blood pressure (BP), blood electrolytes (Na, Cl, K), and biochemical markers were evaluated every month. Risk factors of hypotension and hyponatremia were analyzed using univariate and multi-variate logistic regression models.

Results: There were 82 complete quadriplegias and 90 incomplete. According to the statistics, hyponatremia was the most important risk factor of hypotension (odds ratio [OR]: 3.78 per -10mmol/L, p<0.01). As a second step, risk factors of hyponatremia were initial MS (OR: 1.36 per -10 point, p<0.01) and age (OR: 1.55 per 10 years, p<0.01). Potential risk of hyponatremia especially rises in elder patient over 70 years old and in complete quadriplegia according to the statistics.

Conclusions: As is well known, hypotension and hyponatremia cause an amount of severe systemic complication. This study showed that most important risk factors of hypotension and/or hyponatremia are severity of quadriplegia and age. Prognostic prediction can be calculated easily using this logistic regression model. The result reveals that special attention should be paid in order to avoid severe complications in case with complete quadriplegia over 70 years old.

PODIUM PRESENTATIONS 14
Intrathecal morphine in cervical laminoplasty: a novel technique for postoperative pain relief after cervical spine surgery

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Introduction: Spinal cord injury is a major disease which causes great medical and social burden. The development of spinal cord injury (SCI) is a major complication and remains a great issue in spinal cord injury (SCI). Uncontrollable low blood pressure causes syncope or infarction which frequently interferes with rehabilitation and sometimes be fatal. Prediction of hypotension is very important for planning rehabilitation and for proper medical care, however, there are few studies mentioning the risk factors of these complications. The purpose of this study is to clarify the predictors of hypotension after SCI, and to discuss the pathology affecting this complication.

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Conclusions: As is well known, hypotension and hyponatremia cause an amount of severe systemic complication. This study showed that most important risk factors of hypotension and/or hyponatremia are severity of quadriplegia and age. Prognostic prediction can be calculated easily using this logistic regression model. The result reveals that special attention should be paid in order to avoid severe complications in case with complete quadriplegia over 70 years old.
Amyotrophy and Factors Relating to the Prognosis of Surgical Treatment for Cervical Spondylotic Myelopathy

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Introduction: Cervical spondylotic amyotrophy (CSA) is a clinical entity in cervical spondylosis, which is characterized by severe muscular atrophy in the upper extremities with an absence or insignificance of sensory deficit. However, the exact pathomechanism of the disease is still controversial, and clinical outcome of surgical intervention have not been fully discussed. The purpose of this study was to investigate the surgical result for CSA and to extrapolate the factors relating to the prognosis of the treatment. We also refer the duration of muscle strength recovery after surgery along time course.

Methods: Sixty-three consecutive patients with cervical compressive myelopathy who underwent laminoplasty were prospectively involved in this study. Thirty-two patients were assigned to control group. Following thirty-one patients were assigned to morphine group. The patients were 40 males and 23 females, mean age was 62 year-old. There was no significant difference in age or sex between two groups. The control group was given diclofenac sodium as supportive at the end of surgery. Muscle function was estimated on a fixed schedule for one week after surgery. Number of compensated analgia agent was counted for 72 hours. Nausea, vomiting, hypoxemia (SpO2 under 90%) and rash were observed as adverse effects of morphine. For the statistical analysis, Chi-squared test and Student’s T-test were performed. P value less than 5% was considered to be significant.

Results: VAS scores 4 hours and 24 hours after surgery were 5.1cm and 4.8cm in control groups, 3.8cm and 3.3cm in Morphone groups. Pain is significantly less in Morphine group at 4 hours and 24 hours after surgery. Incidence ratio of adverse effects was not different significantly in both groups. The amount of compensated analgia was also insignificant.

Conclusion: Morphine effects on spinal cord and brain neural cell directly. Intrathecal morphine is effective and safe method for pain relief in cervical spine surgery.

PODIUM PRESENTATIONS 15

Clinical Outcomes of Surgical Treatment for Cervical Spondylotic Amyotrophy and Factors Relating to the Prognosis

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Objective: Cervical spondylotic amyotrophy (CSA) is a clinical entity in cervical spondylosis, which is characterized by severe muscular atrophy in the upper extremities with an absence or insignificance of sensory deficit. However, the exact pathomechanism of the disease is still controversial, and clinical outcome of surgical intervention have not been fully discussed. The purpose of this study was to investigate the surgical result for CSA and to extrapolate the factors relating to the prognosis of the treatment. We also refer the duration of muscle strength recovery after surgery along time course.

Methods: Thirty-eight patients (34 men and 4 women, mean age) who underwent surgical intervention were involved. Seven patients underwent anterior decompression and fusion, and 27 did laminoplasty with or without selective foraminotomy. The classification of CSA were 24 proximal type, 9 distal type, and 5 combined type. The degree of motor deficit of the patients were classified, and were evaluated at admission and at final follow-up. Clinical and radiological factors such as age, duration of symptom, and numbers of compression in MR images were also investigated to extrapolate the factors relating to the prognosis. The duration for the patients to recover muscle strength after surgery was also examined.

Results: Muscle function was improved in 30 patients (79%), unchanged in 6 (16%), and worsened in 2 (5%). Factors which related to better prognosis of the surgical treatment were proximal type and single-level stenosis. It took mean of 16.3±13.6 months (2months - 6 years) for their muscle strength recovery of 30 patients whose symptom was improved by surgeries, and there were 5 patients who required more than 2 years to obtain muscle recovery.

Discussion: This study has indicated that surgical treatment for CSA was good as 79% of the patients improved motor function, especially in proximal type and single-level stenosis. However, the duration of muscle strength recovery was longer than we expected, therefore it is necessary to take at least 2 years for follow-up after surgery.
Methods: Potentials (SCEP) and physical performance in the elderly patients with cervical spondylotic myelopathy (CSM). The purpose of this study was to investigate the relationship between spinal cord evoked potentials (SCEP) and physical performance in the elderly patients with cervical spondylotic myelopathy (CSM).

Materials & Methods: Seventy-four patients who underwent ACDF (two contiguous levels) or ACCF (single level including 2 disc spaces) for treatment of myeloradiculopathy due to disc herniation and uncovertebral joint osteophytes were included. The perioperative parameters (hospitalization, blood loss, operation times, complications), clinical parameters (visual Analog Scale [VAS] scores of neck and arm pain), and radiologic parameters (cervical lordosis, fusion rate) were compared between two groups. Intergroup comparisons were made by using the t test and p values of less than 0.05 were considered statistically significant.

Results: There were 47 patients (21 male, 26 female) with a mean age of 53.7 years in the ACDF group while there were 27 (11 male, 16 female) patients with a mean age of 55.3 years in the ACCF group. Mesh cages filled with allograft and semi-dynamic plates were used for all patients in both groups. Mean follow-up period was 48.4 months. There was no difference between both groups in terms of hospitalization period. Blood loss and operation time was lower in ACDF group but statistically insignificant. Complications in ACDF group were dural laceration in one patient and hoarseness in 3 patients. Complications in the ACCF group were dura laceration in one patient and incomplete transient C5 palsy. Postoperative neck and arm VAS scores were similar in both groups (2.8 versus 2.5). Solid fusion was observed in all patients. Cervical lordosis improved meanly from 18.3 degrees to 24.4 degrees in ACDF group and meanly from 17.4 degrees to 21.6 degrees (p<0.05).

Conclusion: Surgical management of 2-level cervical degenerative disc disease with myeloradiculopathy by ACDF or ACCF showed no significant differences in terms of clinical symptom improvement and fusion rates. Although statistically insignificant, blood loss and operation times were lower in ACDF group. In addition, ACCF provided less improvement in cervical lordosis.

PODIUM PRESENTATIONS 18
Surgical treatment of cervical degenerative disc disease with myeloradiculopathy: Two-level anterior discectomy versus one level anterior corpectomy

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Introduction: The optimal surgical strategy of two level cervical degenerative disc disease with myeloradiculopathy remains controversial. The aim of this retrospective study is to compare two fusion techniques with reference to radiological and clinical outcomes in patients.

Materials & Methods: Seventy-four patients who underwent ACDF (two contiguous levels) or ACCF (single level including 2 disc spaces) for treatment of myeloradiculopathy due to disc herniation and uncovertebral joint osteophytes were included. The perioperative parameters (hospitalization, blood loss, operation times, complications), clinical parameters (visual Analog Scale [VAS] scores of neck and arm pain), and radiologic parameters (cervical lordosis, fusion rate) were compared between two groups. Intergroup comparisons were made by using the t test and p values of less than 0.05 were considered statistically significant.

Results: There were 47 patients (21 male, 26 female) with a mean age of 53.7 years in the ACDF group while there were 27 (11 male, 16 female) patients with a mean age of 55.3 years in the ACCF group. Mesh cages filled with allograft and semi-dynamic plates were used for all patients in both groups. Mean follow-up period was 48.4 months. There was no difference between both groups in terms of hospitalization period. Blood loss and operation time was lower in ACDF group but statistically insignificant. Complications in ACDF group were dural laceration in one patient and hoarseness in 3 patients. Complications in the ACCF group were dura laceration in one patient and incomplete transient C5 palsy. Postoperative neck and arm VAS scores were similar in both groups (2.8 versus 2.5). Solid fusion was observed in all patients. Cervical lordosis improved meanly from 18.3 degrees to 24.4 degrees in ACDF group and meanly from 17.4 degrees to 21.6 degrees (p<0.05).

Conclusion: Surgical management of 2-level cervical degenerative disc disease with myeloradiculopathy by ACDF or ACCF showed no significant differences in terms of clinical symptom improvement and fusion rates. Although statistically insignificant, blood loss and operation times were lower in ACDF group. In addition, ACCF provided less improvement in cervical lordosis.

PODIUM PRESENTATIONS 17
Quantitative analysis of spinal cord evoked potential in the elderly patients with cervical spondylotic myelopathy
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Purpose: In elderly patients with spinal cord compression, it was sometimes difficult to determine a causal relationship between spinal cord damage and the physical performance. The purpose of this study was to investigate the relationship between spinal cord evoked potentials (SCEP) and physical performance in the elderly patients with cervical spondylotic myelopathy (CSM).

Methods: Sixty-nine patients with CSM underwent SCEP before surgery. Three patients with positive SCEP waves were excluded. Sixty-six patients enrolled in this study were divided into two groups by the age of 65, elderly group (37 patients, 28 male, average 74.5 years old) and younger group (29 patients, 24 male, average 52.4 years old). Stimulation electrodes were placed in the lower thoracic epidural space. Ascending SCEPs were recorded at every cervical intervertebral and vertebral body levels with epidural bipolar electrodes. We defined the ratio of negative amplitude at the immediately cranial vertebral level to negative amplitude at the immediately caudal level of the conduction block level as “amplitude ratio”. Preoperative Japanese Orthopaedic Association scoring system (JOA score), 10 second grip and release tests were evaluated. Statistical significance level was set at 0.05 for Mann-Whitney U test and Spearman’s correlation method.

Results: 1) Average amplitude ratio was 0.54 in elderly group and 0.51 in younger group. Significant difference was not found between the two groups. 2) Average total JOA scores (motor of upper extremity, motor of lower extremity and bladder scores) were 9.6 (2.5, 2.0, 2.3) in elderly group and 10.1 (2.7, 2.2, 2.5) in younger group. Average grip and release tests were 15.9 in elderly group and 19.0 in younger group. 3) Significant positive correlations between amplitude ratio and motor score of upper and lower extremity and bladder functions were found in elderly group. There were no significant correlations in younger group.

Discussions: The degrees of severity of the patients with myelopathy in this study were relatively mild. SCEPs findings correlated with the physical performances in elderly patients rather than in younger patients with mild myelopathy. In the elderly patients, deterioration of the spinal cord immediately affected the upper and lower motor and bladder functions.

PODIUM PRESENTATIONS 19
Surgical Management of giant cervical dumbbell Schwannomas (Report of 5 cases)
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Objective: To present the clinical and radiological picture and mode of surgery in the patients with large dumbbell Schwannomas of the cervical spine.

Background: Very large cervical dumbbell schwannomas extending widely through intervertebral foramina and presenting as a giant mass in the neck or in thorax are rare and are only presented as a single case reports or small series. Surgical excision of such tumor is challenging.

Method: Five patients with dumbbell schwannoma of the cervical spine operated from 1994 to 2007 are presented. A large palpable mass...
in the anterior aspect of the neck in four and radiculopathy in two cases were the major complaint of the patients. According to Asazuma, 3 were type II b, one type IIc and one type VI. Two patients were operated through single stage modified posterior midline incision with laminectomy wide foraminotomy and partial facetectomy necessitating unilateral stabilization in one. The other three cases were operated in two stages. Initially via posterior midline incision and then through anterolateral or lateral approach.

Conclusion: awareness of a neurosurgeon with different approaches necessary to excise different types of dumbbell schwannommas at different locations from C2 to C7 is noteworthy especially if we have been faced with report of the cases inadequately excised.

PODIUM PRESENTATIONS 20
En bloc corpectomy for cervical spine tumors by a single anterior approach under vertebral artery control. Technique and two cases reports

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En bloc resection is the treatment of choice for malignant and benign aggressive tumours of the spine. Indications and surgical technique are well documented for thoracic and lumbar spine. In the cervical spine few cases are reported, due not only to anatomical difficulties but also to the rarity of tumours in this location. We report the technique for en-bloc resection of tumours in the cervical spine by anterior approach. We report a feasibility study on cadaver and two clinical cases with this specific technique.

Methods: This technique consists of an anterior approach, vertebral artery control, dissection and/or ligation, pedicle osteotomy, section of the disc and vertebral end plates above and below the level affected, posterior longitudinal ligament (PLL) dissection to obtain finally an en-bloc corpectomy.

Results: The first case is a C3 chordoma (Enneking IIB) that involved the left vertebral artery and the lower C2 end plate. The tumour had a big tissue mass that displaced the visceral structures anteriorly. The first diagnosis was infection and a transoral biopsy showed chordoma and the patient was submitted to our department. We performed a left extended prevascular presternocleidomastoid approach, with control of the superior laryngeal and hypoglossal nerves; a marginal dissection through the pseudocapsule; left vertebral artery dissection and displacement; lateral osteotomy, lower C2 end plate osteotomy and C3-C4 disc dissection. Finally, we performed a PLL section and extraction of the en-bloc anatomical piece. Pathological anatomy showed free margins. Standard reconstruction was made with a Harms cage, iliac crest graft and plate. At two years follow up a recidivist in the pharynx needed surgical resection. The patient is tumor free at four years follow up. The second case is a C6 desmoid aggressive benign tumor (Enneking 3) with involvement of the right vertebral artery. The same technique was performed and the patient is tumor free at two years follow up.

Conclusions: En-bloc resection for tumors involving the cervical vertebral body with compromise of one vertebral artery is possible by a single anterior approach. A preoperative angiography and block test is necessary to demonstrate the perivety of both vertebral arteries in case that one needs to be sacrificed.

PODIUM PRESENTATIONS 21
Surgical treatment of the high cervical spine tumors through an extensive trans mandibulo lingual approach. Indications, advantages and pitfalls

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Treatment of tumors involving the upper cervical spine is a demanding task for the surgeon. Due to the delicate structures often involved in the pathology, adequate resection and spinal cord decompression is difficult to achieve through a standard anterior trans-oral approach. It is then crucial, for accomplishing tumoral resection and reconstruction, to achieve a comfortable access to the upper cervical spine. In our institution since 1999, 7 patients were treated for anterior lesions involving the skull base and the atlo-axial spine. 4 cases presented cervical localization of metastatic disease, 3 were affected by primary tumors involving the cranio cervical spine. All patients underwent tumoral excision through a transmandibulolingual approach. A second surgery was always performed to achieve posterior stabilization. Patients were followed up periodically and evaluated by the Visual Analogue Scale for the assessment of pain and by the Nurick scale to assess myelopathy. SF36 was used to evaluate clinical outcome. We observed an immediate relief of symptoms in all patients with a reduction of 1 point on the Nurick scale for those patients suffering from myelopathy. Three patients returned back to their daily activities. One patient returned to work and, at the last follow up, did not show signs of local recurrence. Tumors of the cervical spine are rare, representing 4.2% of the tumors affecting the mobile spine. Metastases involve the the upper cervical spine in only 0.5% of the whole cases involving the spine Localization of the tumor to the atlo axial joints generally means a painful rotatory instability, often requiring cranio-cervical fixation. The transmandibulolingual approach is, in our institution, the treatment option of choice for the management of the anteriorly localized tumors involving the high cervical spine and requiring extensive surgical resection and reconstruction. In our opinion it allows for optimal exposure and, as a consequence, creating the best conditions for the resection and reconstruction. Particular care must be taken in the postoperative phase to avoid infections at the skull base level and in the nutrition of the patient, that should be necessarily administered in an extra-oral fashion. Transmandibular approach, cervical tumor, anterior resection, metastases.

PODIUM PRESENTATIONS 22
Outcome of Palliative Surgery Using Posterior Screw-rod System for Metastatic Spinal Tumor with Special Reference to Cervical Lesion (Is Posterior Reconstruction Surgery Alone Good Enough for Disease?)

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Introduction: The surgical procedures for metastatic spinal tumor are controversial, and if posterior surgery alone is good enough to accomplish both decompression and reconstruction, it must be an advantage in terms of less invasiveness for the immunocompromised hosts. In the cervical spine, posterior realignment and decompression
using posterior instrumentation can provide indirect decompression of the cord, and in other lesions, posterior realignment and direct decompression from posterolateral aspect can be accomplished. However, there is a biomechanical concern with this procedure because massive destruction of anterior column exists. The purpose of this study was to report the clinical and radiological outcomes of posterior reconstruction surgery alone for the treatment of metastatic spinal tumor, with special reference to the cervical lesion.

Methods: This retrospective analysis involved 111 patients (male 54, female 57, average age 61.4 years old) who underwent palliative posterior reconstruction surgery alone using modern screw-rod system for the treatment of metastatic spinal tumor, and 24 were at cervical and cervico-thoracic lesions. Common primary tumors were prostate, breast, and lung cancers. As neurological evaluation, Frankel grade was used. As radiological evaluation, correction angle between at postoperation and admission, and loss of correction between at final follow-up and post-operation were also evaluated.

Results: 76.5% of the patients were ambulatory at follow-up regardless of the lesions, and 45.4% of the patients gained one or more scores of Frankel grade. The cervical group demonstrated significant greater correction angle (7.1±5.3 degree) compared to other lesions (3.7±4.9 degree). The cervical group also exhibited smaller loss of correction (0.3±3.3 degree) compared to other lesions (2.8±3.1 degree).

Discussion: The present study has demonstrated that posterior alone procedure provided acceptable loss of correction and clinical recovery at any lesions. Among them, metastasis occurred at the cervical spine is especially a good indication of this procedure. Small loss of correction may be due to low activity of the patients and short prognosis of the primary cancers. Posterior reconstruction surgery alone can be the first choice of the surgical treatment for metastatic spinal tumor.

PODIUM PRESENTATIONS 23
Complications of Posterior Reconstruction Surgery for the Cervical Spine Using Modern Screw-Rod System
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Introduction: Posterior reconstruction surgery for the cervical spine is indicated for difficult cases accompanying kyphotic deformity/instability due to rheumatoid arthritis (RA), cerebral palsy (CP), cervical spondylosis, trauma, spinal tumor, infection, or previous surgery. Although the modern screw-rod system facilitates the procedures, complications due to this surgery do sometimes arise. The purpose of this study was to characterize these complications.

Methods: One-hundred and twenty-five patients (62 male, 63 female, average age 58.8 years old) were investigated over a follow-up period of 33 months. Conditions were: 21 RA, 17 CP, 44 spondylosis, 12 trauma, 17 tumor, and 5 infection. Fifteen cases were revision surgeries, and 11 were combined with an anterior procedure. Techniques using pedicle screw (PS), lateral mass screw (LMS) and combination of PS, LMS or transarticular screw for lower cervical spine were applied in 56, 20 and 49 patients respectively. Thirty-five underwent occipito-cervical fusions (OCF), 39 long fusions, and 51 short fusions. The JOA score recovery rate was recorded. Complications investigated were neural injury, vascular injury, pseudoarthrosis, C5 nerve palsy, postoperative neck/shoulder symptoms, adjacent segmental instability, and infection.

Results: The JOA score recovery rate was 41.8±27.2%. No neural or vascular injuries were demonstrated. Three pseudoarthrosis (2.4%) were encountered, and two of three were CP patients. Nine instances of adjacent segmental instability (7.2%) were also encountered, and this was seen in CP, spondylosis, and trauma patients. C5 nerve palsy was found in 7 patients (5.6%), all of whom had undergone OCF or long fusions. Postoperative axial symptoms were found in 36 patients including 10 patients who complained of ADL obstacle, and this was seen in CP, spondylosis, and revision surgeries. There were six infections (4.8%), and four of six were RA.

Conclusion: Although posterior reconstruction surgery using the screw-rod system was a beneficial procedure, we should take into account the possibility of occurrence of such complications when we decide the indications of this technique for several difficult conditions.

PODIUM PRESENTATIONS 24
Impact of cervical pedicle screws on primary stability of instrumented 2-level corpectomy reconstructions - Biomechanical investigation and first test bed results of ATPS-prototyping
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Cervical instability related to metastatic disease can indicate multilevel decompressions. Unfortunately, frequent failure with anterior instrumented multilevel corpectomies was reported. Posterior augmentation was recommended but necessitates second surgery. Thus, we evaluated the feasibility, pull-out characteristics and accuracy of AnteriorTranspedicularScrew(ATS)-fixation. Although first success with clinical series was reported, no data exist on biomechanical characteristics of an ATS-plate system enabling transpedicular end-level fixation for advanced instabilities. We evaluated biomechanical potentials of an ATS-prototype C4-C7 for reduction of ROM and primary stability in a non-destructive set-up among five constructs: Anterior plate, posterior all-lateral mass screw construct, posterior construct with lateral mass screws C5+C6 and end-level fixation using pedicle screws unilaterally or bilaterally, and a 360°-construct. 12 human spines C3-T1 were divided in two groups. 3 and 4 constructs were tested in each group, the ATS-prototypes were tested in both. Specimens were subjected to flexibility-test in a spine motion tester at intact state and after 2-level corpectomy C5-C6 with reconstruction using a distractable cage and one of the osteosyntheses. ROM in flexion-extension-(FE), axial rotation-(AR) and lateral bending-(LB) was reported as normalized values. All instrumentations but the anterior plate showed significant reduction of ROM for all directions compared to the intact state. The 360°-construct outperformed all others in terms of reducing ROM. While there were no significant differences between the 360°- and posterior constructs in FE+LB, the 360°-constructs were more stable in AR. Concerning primary stability of ATS-prototypes, there were no significant differences compared to posterior-only constructs in FE+AR. The 360°-construct showed significant differences to the ATS-prototypes in FE, while no significant differences existed in AR. But, in LB the ATS-prototype and the anterior-plate performed worse than the posterior constructs.
ATPS was shown to confer increased primary stability compared to the anterior plate in FE+AR. We demonstrated primary stability after 2-level corpectomy reconstruction using first ATPS-prototypes comparing favorable to posterior systems and superior to anterior plates. From biomechanical perspective, 360°-instrumentation was shown most efficient for reconstruction of 2-level corpectomies. Final studies will elucidate to which extend fatigue-testing will stress the benefit of transpedicular anchorage with posterior constructs and ATPS.

**PODIUM PRESENTATIONS 25**

**Posterior transpedicular corpectomy for malignant cervical spine tumors**

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**Objective:** Access to ventral lesions of the cervical spine can be challenging in patients with malignant tumors. Anterior approaches are the gold standard for ventral pathology in the cervical spine; however, there are cases, where a posterior approach is indicated (multilevel disease, previous radiation, preexisting dysphagia, poor general medical status). The goal of this study was to assess surgical clinical and radiographic outcomes of using a posterior transpedicular approach for ventral malignant tumors of the cervical spine.

**Methods:** Eight cases of ventral cervical spine malignant tumors (7 metastatic and one chordoma) underwent corpectomy through a posterior transpedicular approach. Tumors involved C2 (5), C3 (1), C5 (1), and C7 (1). Six cases had anterior reconstruction and 3 column fusion, and 2 cases had posterior fusion alone. Gross total resection was achieved in all cases.

**Results:** No hardware failure or worsening of neurological condition was seen (4 patient were neurologically intact and remained intact after surgery and 4 patients improved in their Frankel grade). Pain improved in all patients, mean VAS preoperative was 86 and improved to 22 after surgery. In two patients the vertebral artery was ligated without sequelae.

**Conclusion:** We conclude that cervical spine transpedicular approach is useful in cases where an anterior approach or a circumferential approach is not an option. It avoids the morbidity of anterior transcervical, transternal, and transoral procedures while providing decompression of neural elements and allowing three column stabilization when needed.

**PODIUM PRESENTATIONS 26**

A comparison between the carbon fiber cage and the Cloward procedure in cervical spine surgery: A 10-13 year follow-up of a prospective randomized study

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**Study design:** 10-13 year follow-up of a prospective randomized study.

**Objectives:** To compare the 10-13 year outcomes of anterior cervical decompression and fusion (ACDF) with a cervical intervertebral fusion cage (CIFC), and the Cloward procedure (CP) using a broad clinical and patient-centric assessment.

**Summary of Background Data:** There are few prospective studies and none with a follow-up of 10 years or more.

**Methods:** Patient questionnaires completed 10 years or more following ACDF. Seventy-three patients (77%) responded. Radiographs were obtained at 2 years.

**Results:** Apart from greater fulfillment of preoperative expectation (p=0.01) and less headache (p=0.005) in the CIFC group compared to the CP group, there were no significant differences in the outcomes of the two surgical methods. Pain intensity improved in comparison to preoperative levels in both the CIFC and CP groups (p<0.0001), but the Neck Disability Index (NDI) only improved in the CIFC group (p=0.04). Only those with a healed fusion benefited from an improved NDI (p=0.02). There was no deterioration in pain intensity or NDI after the 2-year follow-up.

**Conclusions:** The outcomes of the two surgical methods, with a few exceptions, were equal at 10-13 year follow-up, and there was no deterioration in outcome after the 2-year follow-up. Pain intensity improved more than disability, which may indicate that further improvement of physical function requires early postoperative rehabilitation. Despite persisting disability, repeat surgery was relatively uncommon.

**Key words:** cervical spine, disc, cage, Cloward, outcome.
Conclusion: Fusion is frequently found despite measures preventing it. Bony ridges suggesting an attempt of the human body to fuse the diseased segment is in nearly in 50% of the patients present. Whether this will evolve to fusion has to be proven. However, outcome is not affected by loss of motion.

PODIUM PRESENTATIONS 28
Cervical High-Intensity Intramedullary (CHII-) lesions in Achondroplasia: Prevalence, clinical relevance and etiology
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Introduction: Previously, it was established that in a large portion of achondroplastic patients with very mild complaints of myelum compression the cervical spinal cord exhibited an intramedullary (CHII) lesion just below the craniocervical junction without any sign of compression on the cord. In the current study we study the prevalence in the general achondroplastic population and explore the origin of the lesion.

Patients & Methods: Nineteen achondroplastic volunteers without clinical signs of myelum compression were subjected to dynamic MR images to evaluate the presence of a CHII lesion and compression on the cord in varying positions of the craniocervical junction. Furthermore, several morphological characteristics of the craniocervical junction with possible relation to compression on the cord were assessed.

Results: A CHII-lesion was observed in 37% of the subjects and only in one of these (slight) compression at the craniocervical junction was present. In two subjects compression on the cord existed, but these patients lacked a CHII lesion. No correlation between the CHII lesion and compression could be established (OR 0.833, CI 0.06-11.3). None of the morphological characteristics demonstrated a correlation with the CHII lesion.

Conclusion: CHII-lesions are a frequent finding in the achondroplastic population, and are remarkably unaccompanied by clinical symptoms or compression on the cord. It is possible that the lesion is caused by compression in the first months after birth by mechanisms that resolve upon maturation while the CHII lesion remains. Further research focusing on the origin of CHII-lesions and their clinical implications is warranted.

PODIUM PRESENTATIONS 29
Metanalysis of Class I and II Data on Results of Anterior Cervical Discectomy and Fusion
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Purpose: The purpose of this paper is to determine the true clinical results of anterior cervical discectomy and fusion (ACDF). ACDF is perceived by to be one of the most efficacious of all spinal surgeries. If asked, most would answer a onelevel ACDF has a 95% fusion rate. The literature often quoted is class III or class IV data. They are retrospective reviews typically by a spine fellow or resident on a senior author’s surgical series.

Materials & Methods: This abstract is a metanalysis of all class I and class II data available from five FDA IDE studies involving ACDF.

Results: At two year follow up the BAK-C had a 12% reoperation rate, the BAK-C control allograft without plating had a 17.5% reoperation rate, the Affinity cage had a 9.2% reoperation rate, the Affinity allograft control without plating had an 18.1% reoperation rate. This resulted in an overall reoperation rate of 12.7% of ACDF without plating. The studies involving an allograft with plating included the Bryan control, which had a 4.1% reoperation rate, the Prestige control had a 19.9% reoperation rate, and the ProDisc control had an 8.5% reoperation rate for an overall reoperation rate of 9.5% of ACDF with plating. Clinical success based on greater than 15 points improvement in neck disability index, no reoperation at index or adjacent level and no neurologic deterioration was achieved in all of the plated studies with a range of 67.8%-72.7% for an overall average of 70% success.

Conclusions: Based on a metanalysis of class I and class II data, the true results of ACDF are a 10% reoperation rate at two-year follow-up due to pseudoarthrosis, adjacent level degeneration or revision of the index surgical site and a 70% clinical success. The importance of this abstract is to determine the true clinical results of ACDF based on class I and class II data. These results emphasize the importance in differentiating the validity of information gained from class I and II versus class III and IV data.

PODIUM PRESENTATIONS 30
Prospective Randomized Double Blinded Clinical Study Evaluating the Correlation of Clinical Outcomes and Cervical Sagittal Alignment
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Introduction: Sagittal alignment of the cervical spine has recently received increased attention in the literature as an important determinant of clinical outcomes following anterior cervical discectomy and fusion (ACDF). Surgeons throughout the world use parallel or lordotically fashioned grafts based on surgeon preference or simple availability. The primary objective of this study was to quantitatively assess and compare cervical sagittal alignment and clinical outcome when lordotic or parallel allografts were used for fusion. The secondary objective was to determine if alteration of cervical alignment was associated with a higher degree of improvement in clinical outcomes.

Methods: A prospective, randomized, double blinded clinical study was performed that enrolled 122 patients. The mean follow-up time was 37.5 months (range, 12-54). Fifty-seven patients were randomized to receive lordotic and 65 patients received parallel allografts. Clinical outcomes were prospectively assessed using Visual Analog Scale (VAS), Health-related Quality of Life Questionnaire (SF-36 v2), Neck Disability Index (NDI) and Patient Satisfaction with Results survey. Sagittal alignment was measured by means of the posterior tangent method.

Results: The mean postoperative cervical sagittal alignment (CSA) was 18.6 degrees (range, -7.0 to 36.2) and 18.2 degrees (range, -7.0 to 37.3) in the lordotic and parallel graft patient groups, respectively. The mean segmental sagittal alignment (SSA) was 5.9 degrees (range, -4.2 to 19.3) and 6.6 degrees (range, -3.3 to 19.4) in the lordotic and parallel graft patient groups, respectively. There were no statistically significant differences in clinical outcome scores when comparing the lordotic...
and parallel graft patient groups. However, patients that maintained or improved SSA, regardless of graft type, also achieved a higher degree of improvement in SF-36 PCS and NDI scores. This was statistically significant (P<0.038).

Conclusions: The use of lordotically-shaped allografts does not increase cervical/segmental sagittal alignment or improve clinical outcomes. Maintaining a consistent segmental sagittal alignment or increasing segmental lordosis was related to a higher degree of improvement in clinical outcomes.

PODIUM PRESENTATIONS 31
Minimally invasive surgeries for cervical spinal cord tumors using Unilateral Posterior Arch Recapping Technique (UPART) and Pedicle-hinged UPART
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Introduction: For safe and secure excision of cervical spinal cord tumors, we have performed muscle-preserving Unilateral Posterior Arch Recapping Technique (UPART) in 10 cases, in which unilateral posterior arches were pivoted on the lateral gutter of the laminae with all their attached muscles preserved. Recently, we macro-totally excised 2 dumbbell-shaped cervical neurinomas by a new procedure, in which the unilateral posterior arches were pivoted on the divided pedicles (P-UPART). We will present surgical outcomes and advantages of these procedures.

Microscopic Surgical Technique: (UPART) The cervical laminae were exposed unilaterally to create lateral gutters and the spinous processes were sagittaly split, keeping the muscular attachments to the spinous processes undisturbed. Then, the epidural space was exposed by opening those laminae unilaterally. After excising tumor, the opened unilateral laminae were anatomically reduced to their counterparts with stitches. (P-UPART) Through antero-lateral approach with the patient laid on his side, the outer wall of the foramen transversarium of the affected vertebrae was removed to dislodge the vertebral artery, then the inner wall, the pedicle, was divided after excision of the anterior component of the tumor. Through midline posterior approach with the patient in prone position, unilateral posterior arches were pivoted on the divided pedicles after sagittally splitting the spinous processes with their attached muscles undisturbed. After excising posterior tumor component, the unilateral laminae were reduced just as in UPART.

Results & Discussions: All 12 patients had tumors successfully excised. No patient had neck motions decreased. Osteotomy was united in all patients. Postoperative MRI showed no significant difference in the cross-sectional area of the deep extensor muscles between the affected side and the opposite side. Since anatomical landmarks can be preserved almost completely by UPART, revision surgery for recurrent tumors can be safer and less invasive. Furthermore, P-UPART has following advantages; 1) the anterior component of the tumor is securely excised with the vertebral artery kept in control, 2) the intracanalicular space is more widely exposed by pivoting the unilateral posterior arch on the divided pedicle rather than the lateral gutter of the lamina, 3) the posterior musculature is kept undisturbed as lateral gutter is unnecessary.

PODIUM PRESENTATIONS 32
Randomized study of fusion versus conservative treatment in chronic whiplash states.
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Purpose: Some of the patients in the chronic WAD group present with symptoms that might indicate pain from a motion segment, possibly the disc. Our intention was to test this possibility.

Methods: All patients had a traffic accident as the origin of their pain. The primary symptom was a continuous dull aching pain in the midline of the neck and at sudden movements also stabbing pain. No motor, sensory or reflex disturbances were present. Plain X-ray and MRI showed no specific changes. Before treatment all patients filled in the disease specific questionnaire BIS (Balanced Inventory for Spinal disorders) and the generic SF-36. Randomization was performed by a statistician not involved in the treatment. The patients randomized to surgery were treated at the Clinic of Spinal Surgery in Strängnäs and those to conservative treatment at the Clinic of Medical Rehabilitation, Karolinska Hospital, Stockholm. Open mechanical provocation under local anaesthesia was used as the test aiming at pinpointing a presumed painful disc. Follow up was performed with the same questionnaires 18 months after treatment.

Material: Twenty-four patients were referred to surgery and 22 to conservative treatment. Six of the patients in the surgical group were not operated on for various reasons and 4 in the conservative group did not complete the treatment program. Median duration of pain was 46 months in the surgical group and 39 months in the conservative group. Mean age was 39 and 40 years, respectively.

Results: In the surgical group neck pain before treatment and at follow up, respectively, was assessed as very severe by 4/3 patients, rather severe by 12/1 and moderate by 2/6. At follow up 3 assessed the neck pain as negligible and 5 were free from pain. In the conservative group, neck pain before treatment and at follow up, respectively, was assessed as very severe by 5/5 patients, rather severe by 12/10 and moderate by 1/3. None in this group reported negligible pain or freedom from pain at follow up.

Conclusion: The results indicate that within the chronic WAD group there might be patients in whom the pain emanates from a painful disc.

PODIUM PRESENTATIONS 33
Multiplanar Fluoroscopy and Image Guidance in Reconstructive Surgery of the Cervical Spine
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Introduction: Complex cervical spine reconstruction requires three dimensional anatomical understanding and imaging to safely place instrumentation and achieve satisfactory alignment and balance. Freehand instrumentation can lead to neurologic injury in 1% and vascular injury in 5% of patients. We evaluate the use of multiplanar fluoroscopy with image guidance in reconstructive operations on the cervical spine and its impact on accuracy and complications.
**Materials & Methods:** Twenty-five patients underwent twenty-seven posterior or combined anterior-posterior cervical spine reconstruction operations for trauma, tumor, degenerative and infectious pathologies. O-arm multiplanar fluoroscopy was combined with image guidance in all cases. Intraoperative and postoperative images, clinical outcomes and complications were systematically analyzed.

**Results:** Two hundred screws were placed. There were no violations of the spinal canal and no pedicle breeches. No patient sustained a neurologic complication intraoperatively. There were no vertebral artery injuries. One pedicle was fractured with screw placement. One patient fractured a T1 pedicle screw 6 months postoperatively due to pseudoarthrosis.

**Discussion:** Multiplanar fluoroscopy and image guidance is ideally suited to the cervical spine as instrumentation must be placed in close proximity to critical structures including the vertebral arteries, spinal cord and cervical nerve roots. Furthermore pedicles can be quite small and screw trajectories variable. Intraoperative multiplanar fluoroscopy eliminates the problems associated with registration and cervical spine mobility that have plagued image guidance based on preoperative imaging. Mechanical forces used in instrument placement must still be minimized, however, to maintain image guidance accuracy in the face of spinal mobility.

**Conclusion:** Multiplanar fluoroscopy combined with image guidance enhances the accuracy and safety of cervical spine reconstruction.

**PODIUM PRESENTATIONS 34**

To clarify the clinical anatomical features of adult operated patients with occipitalization of the atlas.


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**Method:** We analyzed 12 patients with occipitalization of the atlas who underwent surgery at the craniovertebral junction (CVJ) in our hospital between October 2002 and March 2009. The patients include four men and eight women, with an average age of 60 years (range, 45-77 years). All patients presented progressive myelopathy. To clarify the clinical anatomical features of occipitalization, mainly using preoperative computed tomography and three-dimensional computed tomography angiography, we investigated the following: fusion type of occipitalization, occipital condyle, atlantoaxial joint, vertebral fusion.

**Results:** Complete fusion type of occipitalization and partial fusion type were detected in eight (66.7%) and four (33.3%) patients, respectively. Anomalous occipital condyle was detected in five patients (41.7%). Atlantoaxial subluxation (AAS) was detected in nine patients (75%). Two out of nine patients manifested deformed lateral atlantoaxial joints. C2-3 fusion was detected in six out of nine patients with AAS (66.7%). Occipitalization of the atlas was classified into three types. In both types 1 and 2, AAS was the main pathology. In type 1 the medial atlantoaxial joint is semi-dislocated and the lateral atlantoaxial joint is severely deformed. Type 2 is subdivided into two subtypes: type 2A is a complete fusion type of occipitalization and type 2B is a partial fusion type. Type 2A was more frequently associated with anomalies than type 2B. Three type 3 patients without AAS did not have osseous stenosis at the CVJ; therefore operative indications for type 3 were different from type 1 and 2.

**Conclusion:** Surgeons must pay great attention to pathological conditions in patients with occipitalization of the atlas because there are various anatomical anomalies in the patients. AAS is the main pathology in both types 1 and 2, so that reduction of AAS is essential. Type 3 is not associated with AAS, so that the pathological conditions are different from type 1 and 2.

**PODIUM PRESENTATIONS 35**

Adjacent segment degeneration after single level ACDF: cranial segment vs. caudal segment?

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**Object:** Anterior cervical disectomy and fusion (ACDF) is one of the gold standard operative methods for the treatment of cervical disc pathology. It is well known that ACDF might accelerate adjacent segment degeneration (ASD). In terms of ASD after lumbar spine fusion, cranial ASD is more common than caudal ASD. However, there was no well-known direction of ASD after ACDF: cranial segment vs. caudal segment. We investigated which segment was more susceptible to degeneration after single level ACDF

**Methods:** This is a retrospective study of sixty-six patients who underwent single segment ACDF with anterior plate fixation. All patients suffered from cervical radiculopathy due to cervical disc protrusion. The patients were grouped into C3/4 (12 cases), C4/5 (13 cases), C5/6 (26 cases), and C6/7 group (15 cases). And we evaluate the upper and lower segment degeneration using the heightsvertebral body ratio (disc height/AP diameter of vertebral body), end plate sclerosis, and bony spur formation. The minimal follow-up period was 2 years. The patients, who showed disc degeneration of adjacent segment on pre-operative MRI, were excluded from the study.

**Results:** In C3/4 group, there was 5.7% of disc heights loss on the cranial C2/3 segment and 12.1% on the caudal C4/5 segment (p = 0.002). In C4/5 group, there was 5.6% for cranial and 13.3% for caudal segment (p = 0.019). In C5/6 group, there was 12% for cranial and 9.7% for caudal (p = 0.026). In C6/7 group, there was 7.4% for cranial and 3.0% for caudal (p = 0.023). Also we found that anterior bony spur formations were seen more frequently on caudal adjacent segment in C3/4, C4/5, C5/6 group except C6/7 group. In C6/7 group, cranial adjacent segment bony spur were more frequently. We investigated adjacent segment sclerotic change but there was no definite progression of sclerotic change. Therefore there were significant differences of disc heights and anterior bony spur formation between cranial and caudal ASD.

**Conclusions:** The ASD after ACDF occurred mainly on caudal segment on C3/4, 4/5, and 5/6 group. However, the ASD after ACDF occurred mainly on cranial segment on C6/7 group.

**PODIUM PRESENTATIONS 36**

DISH-related cervical spine trauma: Injury characteristics and early outcome with surgical treatment

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Diffuse idiopathic skeletal hyperostosis (DISH) related cervical spine injuries represent a small but difficult subgroup to treat. This patient subset is fraught with potential complications related to injury of ankylosed spines and high rate of comorbidities. There is little data in the literature on treatment, outcomes and complications. Retrospective review of three hospitals (7 year period) searching for patients with cervical spine injuries undergoing surgery in face of DISH. Charts and radiographs were reviewed assessing demographics, injury characteristics and short-term outcomes. 34 pat (4 female, 30 male) with age 73.8±11y (53-98). Injured levels were: C3- 4(2x), C4-5(5x), C5-6(11x), C6-7(11x), C7-T1(4x). Injury of the cervical column affected the disc-level in 17 pat (50%), disc and vertebral body (VB) in 9 pat (26.5%) and VB-only in 7 pat (20.6%). DISH-affected segments (ankylosis) numbered 5.5±2.1/1-9. Injury severity as assessed by the SLIC (Subaxial-Injury-Classification scoring-system) was high: 7.2±1.4pts. DISH-affected levels above injury-level was 2.6±1.2, below 2.5±1.2. Follow-up (FU) was 4.2±6.4mo. 7 pat (20.6%) were ASIA-A on admission, 4 (11.8%) ASIA-B, 4 (11.8%) ASIA-C, 10 (29.4%) ASIA-D, and 7 (20.6%) ASIA-E. 6 pat (17.6%) presented with alcoholic intoxication, 8 pat (23.5%) with associated injuries, 2 pat (5.9%) had associated thoracolumbar fractures. All but 2 pat (6%) had significant co-morbidities: 11 pat (32.4%) were diabetics, 14 pat (41.1%) had art hypertonia and 6 pat (17.6%) were ETOH-abusers. Inpatient stay was 26.6±23.4days. Number of levels instrumented was 3.6±2.1(1-8). 16 pat (47%) had anterior-only, 12 pat (35.3%) had posterior-only, and 5 pat (14.7%) had combined anterior-posterior instrumented fusion. In 5 pat (14.7%) revision surgery was indicated for wound infection (2x), shortening of a screw (1x), indirect decompression (1x), construct failure (1x). 25 pat (73.5%) had medical/surgical complications. 7 pat (20.6%) had complication related to surgery. 3 pat (8.8%) had secondary dislocation at injury-level while immobilized. 20 pat (58.8%) suffered serious pulmonary complications. During short FU 9 pat (26.5%) had died. At FU, 7 pat (20.6%) showed improved ASIA-scores, 18 pat (52.9%) had no improvement and 2 pat (5.9%) deteriorated. These findings in the unique subset of DISH-related cervical spine injuries highlight the potential for medical/surgical complications in this high risk subgroup demanding further analysis. Surgeons should be aware of the unique aspects associated with treatment of these injuries. Surgical stabilization with rigid instrumentations is recommended for all patients with DISH-related instabilities.

**PODium PREsentations**

**37**

Long-term outcome of children undergoing Brooks-Jenkins’s technique for atlanto-axial instability or dislocation

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**Introduction:** Atlanto-axial instability is relatively frequent in children and lead currently to a C1/C2 fusion. In spite of the amount of papers on different techniques for surgical treatment and the different conditions causing the instability there is a real pacity of information on the outcome at a long term follow-up. The purpose of our study is to evaluate the long-term outcome of C1/C2 fusion in children by using the Brooks and Jenkins procedure.

**Patients & Method:** We reviewed a group of 6 children (out of a total of 8) operated on in our institution from 1985 to 1992. Three patients were male and 3 female. Average age was 9.5 years (5 to 12). Surgery was indicated as treatment of instability due to os odontoideum in 5 patients (one of them with C1/C2 total anterior dislocation) and total anterior dislocation in 1 patient with Down’ Syndrome. Fusion was achieved in all patients by following the Brooks-Jenkins’s technique. The patients were reviewed at a 17 to 23-year follow-up by evaluating the range of neck rotation, the existence of symptoms (if any) with a VAS and a cervical radiographic study (AP and L).

**Results:** One patient had a non desired fusion including C3. At the last consultation, (age: 27 to 35) all patients were asymptomatic (EVA: 0). 1 patient (Down syndrome, 35-year-old) showed some degenerative signs at C2C3, C3C4 and C4C5 levels. Dynamic radiographs did not show hypermobility at the adjacent levels in any patient. Total rotatory motion ranged from 95 to 140° (average 108°, from 45 to 70° on each side).

**Conclusion:** Brooks-Jenkins’s technique has proved to be effective when trying to achieve a C1/C2 fusion in children. The range of motion remains very acceptable at 17 to 23-year follow-up with a low incidence of adjacent disease.

**PODium PREsentations 38**

Prospective study and multivariate analysis of the incidence of C5 palsy after cervical laminoplasty


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**Introduction:** Postoperative segmental motor palsy on upper limbs, so-called C5 palsy, is reported one of the complications after cervical laminoplasty (LP). Although the incidence of C5 palsy has been reported to average 4.6% and there has been no difference of the incidence among surgical procedures, there were only indirect retrospective studies. The purpose of this study is to clarify the risk factors of occurrence of C5 palsy after LP by comparing two surgical procedures of open-door and double-door LP prospectively.

**Methods:** A total of 182 consecutive patients underwent LP between 2006 and 2007 was studied prospectively. In 2006, the patients were assigned to receive the open-door LP, and in 2007, were assigned to undergo the double-door LP. The patients who underwent LP with spinal fusion, with posterior fenestration of intervertebral foramen or extended caudal to D2 or more, and also the patients who developed postoperative palsy due to complication except for segmental motor palsy were excluded from this study. Both in 2006 and in 2007, the subjects included 73 patients respectively. The incidence of postoperative C5 palsy was compared prospectively between those two laminoplasty procedures and the risk factors of C5 palsy was detected with multivariate logistic regression analysis.

**Results:** Postoperative C5 palsy occurred in 7 of 73 cases after open-door laminoplasty (9.6%) and in 1 of 73 cases after double-door laminoplasty (1.4%). The incidence of C5 palsy after open-door laminoplasty was statistically higher than the one after double-door
laminoplasty (p=0.029) and open-door laminoplasty was recognized as a significant risk factor for postoperative C5 paralysis (odds ratio: 69.6, p=0.043). In addition, OPLL was recognized as a significant risk factor for postoperative C5 paralysis (odds ratio: 43.8, p=0.048).

Conclusions: This study showed significant evidence indicating the higher risk of postoperative C5 palsy in open-door laminoplasty than double-door laminoplasty. Since OPLL as well as open-door laminoplasty were recognized as the risk factors of C5 palsy, asymmetric decompression by open-door laminoplasty might introduce imbalanced rotational movement of spinal cord and result in C5 palsy. We recommend double-door laminoplasty especially for the OPLL patients, to minimize the incidence of postoperative C5 palsy.

PODIUM PRESENTATIONS 39
Clinical prognosis of postoperative segmental motor palsy as a complication of cervical spine surgery
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Introduction: Postoperative segmental motor palsy in the upper extremities is a common complication after cervical spine surgery. Although the prognosis of this palsy has been reported as favorable, not all cases showed complete recovery. The purpose of this study is to clarify the clinical prognosis of postoperative segmental motor palsy.

Methods: A total of 420 patients underwent cervical spine surgery between 2005 and 2008. Of those, 30 cervical nerve areas on 30 patients developed postoperative segmental motor palsy and were followed for more than 1.2 years (average 2.6 years). Kaplan-Meier analysis was performed for analyzing the persistence of postoperative segmental motor palsy. We defined two categories of endpoint as follows: 1) useful recovery; the day patients recovered muscle strength sufficient for normal daily activities even if lower grade than preoperative muscle strength, 2) complete recovery; the day patients recovered to the level of preoperative muscle strength. Log-rank testing was used to assess the differences of survival curves depending on the pathologies of myelopathy, preoperative neurological findings, surgical procedures and severity of the postoperative palsy.

Results: 49 of 50 cervical nerves (98.0%) recovered to useful level. Kaplan-Meier analysis showed that 60.0% of paralyzed nerves recovered to useful level within 3 months, furthermore, all cases (100%) reached to the useful recoveries within 3 years. However, complete recovery was gained in 41 cervical nerves (82.0%). The duration until complete recovery was significantly longer (average 22.8 months) in the cases with cervical spondylotic amyotrophy (CSA) than cases with other diseases (average 7.7 months) (P = 0.008). Postoperative palsy developed at the area of cervical nerve segment with preoperative abnormal neurological findings needed significantly longer period (average 16.9 months) for complete recovery than those without preoperative neurological abnormalities (average 5.5 months) (P = 0.010).

Conclusions: The prognosis of postoperative segmental motor palsy was demonstrated to be good, since 98.0% of the palsy recovered to useful level. However, the palsy developed in the case with CSA or in cervical nerve segment with preoperative abnormalities required significantly longer period to recover. These results indicated preexisting fragility of spinal cord influence the recovery of paralyzed nerve.

PODIUM PRESENTATIONS 40
Lateral mass screw complications. Analysis of 1662 screws
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Background: The usefulness of lateral mass internal fixation has been well documented in the clinical setting. However, there is a paucity of studies examining the complications associated with these devices in a degenerative clinical setting.

Methods: From 1999 to 2007, 225 consecutive patients who underwent posterior cervical fixation using a screw-plate and polyaxial screw–rod implant systems. There were 105 women and 120 men (age range, 45 to 84 years; mean, 68 years). In all patients, the surgical indication was cervical spondylosis with myelopathy. Mean follow-up interval was 18 months (range, 12–72). Screw position was evaluated by computed tomography (CT) scanning postoperatively in all patients. Clinical and radiographic outcome was assessed at each visit after surgery.

Results: Intraoperative complications include fracture of lateral mass in 27 screws placement, nerve irritation in 3 bicortical screws. Early complications include hematoma formation in 2 cases and C5 root palsy in 5 cases after spinal canal decompression. Late complications include pseudoarthrosis in 6 cases and screw pull-out in 3 cases. There were no cases of spinal cord or vertebral artery injury, infections, deaths, or adjacent segment disease. All patients had radiographic union, and no patient developed mechanical implant failure requiring removal of instrumentation. Re-operation was required in 14 (6.2%) cases due to nerve injury, hematoma formation, pseudoarthrosis and screw pull-out.

Conclusions: Our clinical findings indicate that lateral mass fixation can be used safely with minimal complications and low rate of morbidity for cervical myelopathy treatment.

PODIUM PRESENTATIONS 41
The clinical relevance of adjacent disc disease after anterior cervical fusion: Insights from a peculiar clinical study
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Introduction: Adjacent disc disease (ADD), following anterior cervical interbody fusions (ACIF), has been well documented in literature, yet the amount and origin of degeneration and its clinical relevance remain unclear. We used a clinical research model to investigate the effects of interpolated disc fusions on an intermediate, non-operated, disc in terms of disc height reduction (DHR) and disc range of motion (ROM).

Methods: Between 2003 and 2008, twenty patients (12 men, 8 women) underwent interpolated anterior cervical decompression followed by cages implantation. The intermediate disc level was left intact, because there was no pre-existing radiographic evidence of degeneration. In all cases, at the last follow-up control, a spine static and dynamic
X-ray and magnetic resonance imaging (MRI) was done. Disc heights, and angular motion, and translational motion of the intermediate, non-operated, segment were measured. Compression of neural elements was assessed on MRI scans. Clinical outcome was studied using Neck disability index (NDI) and visual analogue scale (VAS). Age, gender, fusion rate were investigated as potential factors affecting the outcome.

**Results:** Mean follow-up was 50 (16–81) months. Clinical outcome showed an improvement of 54.6% in NDI and 53.8% in VAS Fusion rate was 95%. Disc height of the intermediate segment in all patients was reduced by on average 10%. Advanced age correlated with progressive DHR (P ≤ 0.003, r = 0.5), whereas gender had no influence. There was no correlation between the clinical outcome and DHR. The mean segmental ROM of intermediate segments did not show significant instability, despite an overall compensatory increase of 12%.

**Discussion & Conclusions:** Cervical fusion is associated with DHR of intermediate disc; however, clinical outcome does not correlate with it. Our results indicate that interpolated ACIF had no influence on the intermediate disc; however, clinical outcome does not correlate with progressive DHR (P ≤ 0.003, r = 0.5), whereas gender had no influence. There was no correlation between the clinical outcome and DHR. The mean segmental ROM of intermediate segments did not show significant instability, despite an overall compensatory increase of 12%.

**PODIUM PRESENTATIONS 42**

Biomechanical comparison of posterior cervicothoracic instrumentation techniques after one level laminectomy and facetectomy

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**Objective:** Posterior instrumentation is the preferred method of fixation in the unstable cervicothoracic junction (CTJ). Several posterior rod constructs of different diameters and configurations are available for instrumentation across the cervicothoracic junction. The objective of this study was to compare the biomechanical stability of various posterior instrumentation techniques that cross the CTJ after a two column injury by complete removal of the posterior elements at C7.

**Methods:** Eight fresh frozen human cadaveric spines (C3-T4) were used. After the intact spine analysis, each specimen was destabilized (C7 laminectomy and bilateral facetectomies) and reconstructed as follows: Group 1-Posterior instrumentation C5-T2 with a 3.5 mm rod. Group 2- Posterior instrumentation C5-T2 with a transitional rod (3.5 mm to 5.5 mm). Group 3- Posterior instrumentation C5-T2 with side to side rod connector (3.5 mm to 5.5 mm). All reconstructed groups were tested with posterior instrumentation using the Cervifix system (Synthes Inc. West Chester, PA, USA). We hypothesized that group 2 is the most stable.

**Results:** Following laminectomy, facetectomy and application of the instrumentation, there was a decrease in range of motion for all the treatment groups compared to the intact spine. This trend was observed in all three planes of motion, but was only significant in right/left lateral bending and flexion (for transitional rod only). Although, the instrumented spines were stiffer than the intact spine in right/left axial rotation, flexion and extension, these differences did not reach statistical significance. Based on observation during the testing, it was evident that in the implanted spines, the majority of the motion that did occur was localized at the segments adjacent to the instrumented levels.

**Conclusions:** Based on the results of this investigation, the biomechanical stability of the transitional rod, side to side connector (“wedding band”) and 3.5 mm rods appear to be similar.

**PODIUM PRESENTATIONS 43**

Morphology of cervical spine and spinal cord on MR imaging in 1200 asymptomatic subjects

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**Objectives:** Magnetic resonance imaging (MRI) is useful and vital tool to diagnose cervical disorders. Normal values and age-related changes are crucial to judge abnormality of cervical morphometry in imaging study. The aim of this study was to establish standard values of cervical spine and spinal cord morphology in MRI and elucidate the prevalence of abnormal images in asymptomatic subjects.

**Materials & Methods:** MR imaging examination of cervical spine was performed in 1211 asymptomatic volunteers. The persons with previous history of spinal surgery, neurological symptom, neck pain, or extremity pain numbness, were excluded beforehand. They included at least 100 men and 100 women in each decade from 20's to 70's. T1-weighted sagittal and T2-weighted sagittal & axial images were obtained using 1.5T MRI scanner. AP diameter of spinal canal, dural tube and spinal cord were measured at each disc and vertebral level from 2nd to 7th cervical vertebrae (C2-C7). Cross-sectional area of spinal cord was also calculated as well.

**Results:** The mean AP diameter of spinal canal was 12.9 / 12.5 mm (male / female) at C5 vertebral level and 11.7 / 11.6 mm at C5/6 disc level. The AP diameter of dural tube was 11.2 / 11.1 mm at C5 level and 9.5 / 9.6 mm at C5/6 level. The AP diameter of spinal cord was 6.5 / 6.4 mm at C5 level and 5.9 / 5.8 mm at C5/6 level. The cross-sectional area of spinal cord was 78.1 / 74.4 mm2 at C5 level and 70.6 / 68.9 mm2 at C5/6 level. These data was significantly decreased with age. The age-related change was seen more at disc level than at vertebral level. Compression of the spinal cord was seen in 38 subjects (3.1%). Increased signal intensity of spinal cord was shown in 28 subjects (2.3%).

**Conclusions:** Anatomical values in cervical MRI were established in each gender and each decade from 20' to 70'. The prevalence of abnormal MRI of the cervical spine as related to age in asymptomatic individuals emphasizes the dangers of predicting operative decisions on diagnostic tests without precisely matching those findings with clinical symptoms and signs.
POSTER PRESENTATIONS 01
Unilateral locking of cervical facet joints - The simple signs
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Unilateral locking of cervical facet joints is often misdiagnosed and inadequately treated, because it is not readily detected on plain radiographs. Primary radiographs of 17 patients were analysed to evaluate radiographical signs with reference to frequency and significance. Direct signs of locking were present in no more than 53% of cases. Of these, an abrupt change in laminar space width, seen in 88.2%, proved to be the most reliable sign. Displacement of the spinous processes above and below the lesion was found in the same percentage of cases, but it carries less diagnostic weight. While present in all cases, anterolisthesis is only diagnostic if additional oblique views show evidence of lateralized cervical anterolisthesis. Clearly less reliable indirect signs included: the bow tie sign (29.4%), dehiscence of the spinous processes (23.5%), differences in the sagittal diameters of the vertebral bodies above and below the lesion (35.2%), double facet contour (43%) and tilting of the cranial segment of the cervical spine away from the locked facets (58.8%). Abnormalities of disc shape were not seen on ap-projections. Those detectable in axial views are irrelevant to locking, as are empty facets. If more than one indirect sign is present and if unilateral locking is suspected but cannot be established unequivocally even on additional oblique views, computed tomography is indicated, because reduction continues to be the first step in the management of fresh injuries.

POSTER PRESENTATIONS 02
CT Evaluation of Cervical Spine Trauma in multitrauma patients
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The management of cervical spine injuries in polytraumatized patients remains a great challenge for the diagnostic procedures and institution of appropriate treatment by integrating spinal trauma treatment into the whole treatment concept as well as following the treatment steps for the injured spine itself. The concept of CT EVALUATION OF CERVICAL SPINE \(^\text{V}^\prime\) criteria regarding the optimal time and manner for operative treatment of the injured cervical spine in the polytrauma setting is presented and discussed. We retrospectively analysed the clinical records of all polytrauma patients who were admitted to our hospital between 1997 and 2007. All patients presenting acutely to the Emergency Department with haemodynamically stable trauma involving more than two body systems were imaged with a comprehensive pre-set helical CT protocol (including non-contrast head, cervical spine: cranio-cervical and cervico-thoracic junctions

This is a retrospective study of a consecutive series of traumatic cervical spine injuries treated with halo vest immobilization over an 10-YEAR period at our hospital. Aim of this study was to assess survivorship, success, and causes of failure of the halo vest immobilization in the management of cervical spine injuries in elderly patients. A discharge database was searched for patients 65 years of age or older who had undergone placement of a halo device in our hospital. In a search of cases managed between 1999 and 2009 data pertaining to 43 patients (mean age 79.9 years, range 65-98 years) met these criteria. 40 patients were treated for traumatic injuries. Ten patients had deficits ranging from radiculopathy to quadriplegia, and 30 had no neurological deficit. Adequate follow-up material was available in 32 patients (mean treatment duration 120 days-4 months). Halo immobilization was the only treatment in 20 patients, and adjunctive surgical fixation was undertaken in the 20 patients. There were 30 complications in 21 patients: respiratory problems in 5 patients, gastrointestinal in 5, and other complications in 11. 6 patients died, the cause of death was clearly unrelated to the halo brace. In our opinion external halo fixation can be used safely to treat cervical instability in elderly patients.

POSTER PRESENTATIONS 04
Post-traumatic instability of the cervical spine-20 years experience
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Introduction: Spinal injuries with instability are usually an indication for surgery. On the basis of 20 years’ experience, the authors presents indications for anterior approach surgery, based on the mechanism of injury and the patient's neurological status following an injury to the cervical spine.

Material & Methods: A total of 138 patients have been operated on. Indications are defined for surgery using rod or plate implants and compression plates. Radiographic and neurological outcome data are presented for 91 who had been followed up for at least 6 months.

Results: A good radiographic outcome was obtained in a total of 65.9% patients. Neurological improvement was seen in 72% of patients with neurological symptoms, including substantial improvements in 26% of the patients.

Conclusions:
1. Assessment of the stability of the cervical spine following an injury is an important part of the diagnostic work-up
2. It is not always easy as the mechanism of injury does not always determine the degree of spinal stability.
3. An actual instability is often confused with increased compensatory instability that is still within physiological limits.
4. It is essential to distinguish actual instability requiring surgery from a compensatory increase in mobility of the segment lying above the immobilised segment of the spine.
5. An anterior approach procedure, apart from stabilising the spine, serves to decompress the spinal cord and offers a chance of neurological and functional improvement.

POSTER PRESENTATIONS 03
Evaluation of Halo Fixation in elderly patients
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This is a retrospective study of a consecutive series of traumatic cervical spine injuries treated with halo vest immobilization over an 10-YEAR period at our hospital. Aim of this study was to assess survivorship, success, and causes of failure of the halo vest immobilization in the management of cervical spine injuries in elderly patients. A discharge database was searched for patients 65 years of age or older who had undergone placement of a halo device in our hospital. In a search of cases managed between 1999 and 2009 data pertaining to 43 patients (mean age 79.9 years, range 65-98 years) met these criteria. 40 patients were treated for traumatic injuries. Ten patients had deficits ranging from radiculopathy to quadriplegia, and 30 had no neurological deficit. Adequate follow-up material was available in 32 patients (mean treatment duration 120 days-4 months). Halo immobilization was the only treatment in 20 patients, and adjunctive surgical fixation was undertaken in the 20 patients. There were 30 complications in 21 patients: respiratory problems in 5 patients, gastrointestinal in 5, and other complications in 11. 6 patients died, the cause of death was clearly unrelated to the halo brace. In our opinion external halo fixation can be used safely to treat cervical instability in elderly patients.

POSTER PRESENTATIONS 04
Post-traumatic instability of the cervical spine-20 years experience
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Methodology: Spinal injuries with instability are usually an indication for surgery. On the basis of 20 years’ experience, the authors presents indications for anterior approach surgery, based on the mechanism of injury and the patient's neurological status following an injury to the cervical spine.

Introduction: Spinal injuries with instability are usually an indication for surgery. On the basis of 20 years’ experience, the authors presents indications for anterior approach surgery, based on the mechanism of injury and the patient's neurological status following an injury to the cervical spine.

Material & Methods: A total of 138 patients have been operated on. Indications are defined for surgery using rod or plate implants and compression plates. Radiographic and neurological outcome data are presented for 91 who had been followed up for at least 6 months.

Results: A good radiographic outcome was obtained in a total of 65.9% patients. Neurological improvement was seen in 72% of patients with neurological symptoms, including substantial improvements in 26% of the patients.

Conclusions:
1. Assessment of the stability of the cervical spine following an injury is an important part of the diagnostic work-up
2. It is not always easy as the mechanism of injury does not always determine the degree of spinal stability.
3. An actual instability is often confused with increased compensatory instability that is still within physiological limits.
4. It is essential to distinguish actual instability requiring surgery from a compensatory increase in mobility of the segment lying above the immobilised segment of the spine.
5. An anterior approach procedure, apart from stabilising the spine, serves to decompress the spinal cord and offers a chance of neurological and functional improvement.

POSTER PRESENTATIONS 03
Evaluation of Halo Fixation in elderly patients
N. Syrmos, Ch. Iliadis, G. Gavridakis, V. Mparchatsa, K. Grigoriou, V. Valadakis, D. Arvanitakis & F. Charalampopoulos
Neurosurgical Department, CT Scan Department, Venizeleio General Hospital, Heraklion, Crete, Greece

This is a retrospective study of a consecutive series of traumatic cervical spine injuries treated with halo vest immobilization over an 10-YEAR period at our hospital. Aim of this study was to assess survivorship, success, and causes of failure of the halo vest immobilization in the management of cervical spine injuries in elderly patients. A discharge database was searched for patients 65 years of age or older who had undergone placement of a halo device in our hospital. In a search of cases managed between 1999 and 2009 data pertaining to 43 patients (mean age 79.9 years, range 65-98 years) met these criteria. 40 patients were treated for traumatic injuries. Ten patients had deficits ranging from radiculopathy to quadriplegia, and 30 had no neurological deficit. Adequate follow-up material was available in 32 patients (mean treatment duration 120 days-4 months). Halo immobilization was the only treatment in 20 patients, and adjunctive surgical fixation was undertaken in the 20 patients. There were 30 complications in 21 patients: respiratory problems in 5 patients, gastrointestinal in 5, and other complications in 11. 6 patients died, the cause of death was clearly unrelated to the halo brace. In our opinion external halo fixation can be used safely to treat cervical instability in elderly patients.
POSTER PRESENTATIONS 05
Anterior Cervical Discectomy and Fusion with a Locked Plate and Wedged Graft Effectively Stabilizes Flexion-Distraction Stage-3 Injury in the Lower Cervical Spine
Department of Orthopaedics, 251 Hellenic Air Force Hospital, Athens, Greece

Study Design: An in vitro three-dimensional (3D) flexibility test of human C3–C7 cervical spine specimens.

Introduction: ACDF with posterior instrumentation is generally recommended to address the insufficiency of the posterior element, but there is emerging clinical evidence that ACDF with a locked plate alone may suffice especially in young patients.

Methods: Eight fresh frozen human lower cervical spines (C3–C7) from young donors (age, 44.5 years; range, 21–63 years) were used. A 3D flexibility test was conducted using a moment of 0.8 Nm without preload. Flexion-extension was additionally tested using a moment of 1.5 Nm under 0 and 150 N follower preload. Spines were tested first intact, then after complete C5–C6 discectomy with posterior longitudinal ligament resection and ACDF with a wedged bone graft and a rigid locked plate, and finally after complete release of the supraspinous, interspinous, and intertransverse ligaments; the facet capsules; and ligamentum flavum.

Results: When tested under 0.8 Nm moment without preload, complete posterior and anterior ligamentous release did not significantly increase the ROM of the ACDF construct in flexion-extension (P = 0.025), lateral bending (P =0.025), and axial rotation (P =0.025). When tested under 1.5 Nm moment with or without a compressive preload, the complete posterior and anterior ligamentous release did not significantly affect the ROM of the ACDF construct (P =0.01). The application of preload significantly reduced the motion at the C5–C6 ACDF construct with ligamentous disruption in comparison with the motion in the absence of a preload (P =0.01).

Conclusion: Anterior cervical fusion with a wedged graft and a rigid constrained (locked) plate can effectively stabilize the nonosteoarthrotic cervical spine after complete posterior element injury when excessive ROM is prevented (for example, by the use of postoperative external immobilization). Even when the construct is subjected to higher moments, adequate stability can be achieved when physiologic preload is present. Osteoporosis and lack of sufficient preload due to poor neuromuscular control may affect long-term screw stability, and additional external immobilization may be needed until fusion matures.

POSTER PRESENTATIONS 06
Unstable Lesion at C7-T1 treated conservatively. Case report with a 12 years follow-up
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Purpose: We present a case of an unstable lesion at the cervico-thoracic junction with a follow-up of 12 years.

Materials: A 22 years old male was involved in a RTA on the 6th of March 1998. He was hospitalized in the local Hospital for head injury, as well as for a fracturedislocation at C7-T1 level, a fracture of the right scapula and hemotorax. The patient was transferred to our Department because of the fracture-dislocation at the cervico-thoracic junction. The patient underwent a full clinical and radiological evaluation including conventional x-rays, CT scan and MRI. On clinical examination no neurological signs were detected (no muscle weakness, no loss of sensation, jerks not altered, negative Babinski sign bilaterally) and was classed as ASIA E. Initial A-P and lateral films were not revealing, but oblique films clearly showed the bilateral fracture-dislocation, as did the CT Scan and the MRI; the latter showed no abnormal spinal cord signal. In spite of the instability of the lesion, we decided to treat the patient conservatively in a halo vest.

Results: The patient was discharged home two months later in a satisfactory condition. Regular follow-up examinations were done, the last one being on the 20th of April 2010, 12 years and one month after the accident. The patient was working in his pro-accident job and had no complains at all. Conventional x-rays, as well as dynamic ones in flexion and extension were nearly normal, as was the MRI.

Discussion: Fracture-dislocation is a serious lesion having a high rate (75 %) of neurological involvement. The location at the cervico-thoracic junction makes this lesion even more serious. The literature is referring to those injuries indicating the necessity for an early reduction and surgical stabilization by anterior, posterior or combined approaches. However, under certain circumstances conservative treatment is indicated.

Conclusion: Conservative treatment may be applied to unstable cervical spinal lesions, provided that a meticulous handling of the lesion is carried on. The risk of late myelopathy is reported, making regular observation of the patient imperative.

POSTER PRESENTATIONS 07
The fate of unstable instrumentation 20 and 25 years later
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We present two cases of two different types of fracture dislocations of the cervical spine which were treated with posterior fusion, 20 and 25 years ago respectively. As it is described below, in both cases, the initially scheduled guideline's based fusion surgical approach was modified due to intraoperative complications. In both cases the main complication was major bleeding during the operation, which forced us to alter the preliminary plan and modify our operation by using one sided plate. This complication affected the postoperative treatment and our patients were immobilized for a longer period. Despite our concern, both patients had a very good postoperative outcome. Although in both cases a slight local displacement and the expected degeneration of adjacent distal level were observed, no major clinical complaints were assessed.
POSTER PRESENTATIONS 08
Delayed Treatment of Atlantoaxial Dislocation and associated multiple level fractures of the spine.
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Aim: The presentation of a traumatic rotational atlantoaxial dislocation in a young female patient with accompanying double level spinal cord injury. Conservative treatment was successful despite the delayed diagnosis.

Materials and Methods: A 20 years old female was admitted to our department from another institution due to intense cervical spine pain and a head injury (a wound in the left temporal area) following a road traffic accident. The mechanism of injury was described as flexion, rotation to the right and axial compression of the cervical spine. Immediately after the accident the patient was hospitalized due to progressive cervical spine pain and two days later torticollis was manifested. The initial radiographic assessment comprised of plain anteroposterior and lateral X rays, revealed a rotational atlantoaxial subluxation, type I according to the Fielding classification and a tear drop fracture of the C5. The diagnosis was confirmed with a CT scan.

Results: A skeletal traction was applied following an unsuccessful attempt for closed reduction. The bearing weight was gradually increased up to 1,5 kgr per spinal level, for five days. A second attempt for closed reduction was performed on the fifth day. It was successful and torticollis resolved. The success of the reduction was confirmed by X rays and Ct scan. A Halo vest was applied and the patient was mobilized. She was discharged from the hospital the next day and she has been followed up at our outpatient clinic.

Conclusions: Rotational atlantoaxial subluxation is a rare injury. Suspicion should be high in any patient with post traumatic torticollis. Complete radiographic assessment of the entire cervical spine is essential. Early diagnosis and conservative treatment can offer excellent results.

POSTER PRESENTATIONS 09
An uncommon lesion of the second cervical vertebra
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Introduction: Multiple fractures of the axis are rare lesions that are challenging to diagnose and their treatment remains controversial.

Materials: We present a case of a 44 year old male, victim of a road traffic accident. Upon admission to our department, a thorough clinical and radiological assessment was performed. It revealed an uncommon combination of fractures of the second cervical vertebra and a fracture of the body of the sixth cervical vertebra. Plain X rays and CT scan, with three dimensional reconstruction, revealed three distinct fractures of the axis. The first one was a fracture at the base of the odontoid process (type C). The second was a fracture of the body of the axis (tear drop fracture) and the third one was a fracture of the posterior arch of the axis (traumatic spondylolisthesis). Since there was no greater displacement and no neurological symptoms, the patient was treated conservatively. Skeletal traction was applied for three weeks and treated later with a Hallo vest for three months.

Results: The patient was then followed up at regular intervals at our outpatient clinic. At the latest follow up, ten years after the accident, the patient experiences no significant symptoms and he has no complaints. There is a spontaneous fusion of the C2 and C3 vertebrae. Clinically, there is a minor reduction at the rotational movements of the cervical spine. Despite that, there is no neurological deficit and he is able to work and function at his daily routine without any complaint.

Conclusions: Careful X ray evaluation and particularly CT scanning is the key for the prompt diagnosis of these lesions. Conservative treatment has satisfactory results and seems to be the treatment of choice for multiple axis fractures.

POSTER PRESENTATIONS 10
Prediction of instability in unilateral facet fractures of the subaxial cervical spine
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Introduction: The literature is not capable of supporting treatment protocols for unilateral facet fractures of the cervical spine. Some authors have recommended anterior fusion in all patients. One study advocated computed tomography (CT) and another study magnetic resonance imaging (MRI) for predicting instability. All these studies were retrospective in nature.

Aim: To investigate the relation between CT and MRI characteristics and the development of anterolisthesis after a unilateral facet fracture of the subaxial cervical spine.

Methods: All patients with a unilateral facet fracture of the subaxial cervical spine diagnosed by CT with maximum 2mm of anterolisthesis entered a prospective protocol in which MRI of the cervical spine was performed and patients were treated in a Miami J stiff collar for at least 6 weeks. Patients were followed in the outpatient clinic with regular X-ray or CT imaging for at least 3 months.

Results: Between September 2006 and September 2009 14 patients entered the study. MRI was performed in 13/14 patients. Two were lost for follow up. Three patients developed a clear slippage with significant neck pain for which anterior fusion surgery was performed. Minimal slippage, not considered a surgical indication, was seen in 6 patients. Three patients retained normal alignment. Ligamentous injury at the index level on MRI was 100% predictive of >2mm slippage. No clear relation between slippage and CT characteristics could be found.

Conclusion: Although numbers are limited in this prospective study, development of significant anterolisthesis after unilateral facet fracture could accurately be predicted by ligamentous injury on MRI.

POSTER PRESENTATIONS 11
Clinical and radiologic outcome of screw fixation for an upper cervical spine - The tough cases with using transarticular screw fixation in upper cervical lesion
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Stabilization with rigid screw fixation is essential for unstable cranio cervical lesions. C1/2 transarticular screw (TS) allows rigid
Background: Closed reduction and internal fixation of type II odontoid fractures by an anterior approach to the spine is a widely accepted choice of treatment in case of polytrauma, neurologic damage, need of intubation, increased fragment dislocation and angulation and failed conservative treatment. We present a new technique to improve primary stability of CRIF using a standard vertebroplasty cement to increase the stability of the screw in the corpus of C2.

Population: We performed the procedure in a total of 11 patients. Four patients died within the first 6 months and were not available for follow-up. The remaining 7 patients had a mean age of 82 years, male: female distribution 2: 9. The mean follow up time was 16.8 months.

Material and methods: We use the standard instrument set-up with one cannulated 4.2 mm spongious screw. After closed reduction and anterior approach to the inferior border of C2, the guide K-wire is inserted and after fluoroscopic control, a Yamshidi-needle is laterally to the guiding wire and into the body of C2. The body of C2 is cemented with standard low viscosity PMMA cement as used for vertebroplasty. During polymerization of the cement, the screw is inserted and the fracture is compressed.

Results: In the 7 patients available for follow-up, no cement leak-out was observed. The radiologic analysis showed 1 cases of minor dislocation of the screw. In the conventional radiologic follow-up, no pseudoarthrosis was observed. No case of re-operation was registered.

Conclusion: Cement augmentation of the screw seat in type II odontoid fractures seems to be a promising technique in order to improve screw purchase, especially in an osteoporotic body of the axis. Further analysis in a randomized, prospective case-control study is planned in order to show the benefits of this new procedure.
One was successfully treated with occipitocervical fusion. The other had multisystem trauma and severe neurological injury and survived less than 24 hours. The two remaining cases presented subacutely after less severe mechanisms of injury. One after repetitive trauma with OAD treated with occipitoatlantal fusion. The other with a remote history of trauma, diagnosed with unilateral OAD, vertebral artery occlusion and late onset accessory nerve palsy not requiring surgical intervention.

Conclusions: We present 4 cases of OAD, each with different clinical presentations and management. Two of the cases are highly unusual in that they presented subacutely with minor neurological problems, and only one of these required surgical stabilisation. The potential pathophysiological mechanisms of these two cases is discussed.

POSTER PRESENTATIONS 15
The “TYPE D” fracture of the Odontoid Process
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Objective: To present our experience with a rare fracture type of the odontoid process: the type D complex fractures (according to Korres DS classification). To analyze their overall behavior and fracture mechanism.

Introduction: The use of Computed Tomography has revealed certain patterns of injuries that have not yet been described in the currently used classifications. The mechanics producing such injuries has not been analyzed. Based on our experience of such patterns of injury we attempt to clarify their mechanism as well as their responsiveness to the applied conservative treatment.

Materials: During the last 40 years one hundred and twenty two fractures of the odontoid process were treated in our Department. Five out of them represented complex fracture patterns that are not described by current classifications; they do however fit in the senior author’s classification of odontoid process fracture as type D. There are two cases of comminuted fracture of the dens, two split fractures and one case of double fractures of the dens. A detailed history of the mode of injuries was necessary in analyzing these patterns of injuries. All the cases were recognized with the help of CT scans. One patient died because of cardiopulmonary insufficiency, not directly related to his injury. The remaining four patients were followed at regular intervals for 8, 17, 29 and 36 months respectively. All had x-rays and dynamic films at each outpatient appointment. Follow up CT scans were not performed.

Results: All four cases recovered uneventfully. Fusion of the fracture was achieved with conservative treatment with skeletal traction followed by a halo vest.

Conclusion: Following a detailed history we could assume of the forces applied on the odontoid process and the body of the axis resulting in the complex type D fractures. In all the cases more than one force were applied simultaneously or successively to the upper cervical spine resulting in the complexity of the injury. We also concluded that the structural properties of the axis vertebra, related to the age of the patients, play an important role in the induction of the fracture pattern. Conservative treatment is an accepted mode of treatment for type D fractures of the odontoid process.

POSTER PRESENTATIONS 16
Posterior cervical decompression and fusion in Cervical Myelopathy
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Introduction: Cervical myelopathy is a common entity in the elderly due to the presence of spondylotic changes. Several treatment options are available in the treatment of this condition.

Objective: To present our experience in the treatment of cervical myelopathy by laminectomy and posterior fusion.

Method: In 3 year period (June 2006 to June 2009) we treated 25 patients of cervical myelopathy. In 19 patients the symptoms were due to cervical stenosis following spondylosis. There were 5 cases of incomplete tetraplegia following cervical fracture and 1 case of adjacent level degeneration and stenosis following anterior cervical fusion. 22 patients were grade D in the ASIA scale and 3 were grade C. All patients underwent laminectomy at the affected and the adjacent levels and posterior fusion with lateral mass screws and rods. Where the fusion extended to C2 or T1 pedicle screws were inserted. Patients were followed at 3-6 weeks, at 3 and 6 months and then yearly. At each appointment they had AP and Lateral X-rays and a clinical examination. ODI and VAS score were recorded preoperatively and at each appointment.

Results: All patients achieved fusion within 6 months. There was neurological improvement in 96% (24/25) of patients. The assessment was done by 2 examiners independently and was measured in grades of key muscle strength below the level of injury. The 3 patients that were grade C improved to grade. Although there was neurological improvement no patient was classified to be grade after 6 months. ODI score showed an improvement by an average of 14 points 3 weeks postoperatively and a further 16 points at the 3 month appointment. A similar change was recorded in the VAS scale. There were 2 subcutaneous infections that were treated with surgical debridement and antibiotics. 19 patients complained for neck pain gradually improving over the first 6 months.

Conclusion: Laminectomy and posterior cervical fusion is an effective treatment strategy for cervical myelopathy. It allows extended access to the cervical spine and stability can be augmented by extending the fusion to the upper thoracic vertebrae. It has good clinical result and fusion rates. The disadvantage is that it has relatively high subcutaneous infection rate. Clinically it is associated with neck pain which lasts for several months with gradual improvement.

POSTER PRESENTATIONS 17
Increased incidence of fractures related to ankylosing spondylitis requiring operative stabilisation. Results from the Swedish National Hospital Discharge Register during 1987 to 2008
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Objective: Ankylosing spondylitis (AS) is a reumatoid disease leading to progressive ossification of the spinal column. These patients are highly susceptible to unstable vertebral fractures and often require
surgical stabilisation due to long lever arms. Medical treatment of these patients improved during the last decades. Until now it is unknown whether the incidence of vertebral fractures changed during the last years.

**Methods:** Data for all patients with AS admitted to hospital between 1987 and 2008 were abstracted from the Swedish National Hospital Discharge Register (SNHDR). The data in the register are collected prospectively, recording all inpatient admissions throughout Sweden. The SNHDR uses the codes for diagnoses at discharge and surgical procedures according to the Swedish version of the International Classification of Diseases (ICD).

**Results:** A total number of 724 patients with AS were treated as inpatients due to vertebral fractures during the years from 1987 to 2008. Of these 369 were operated with spinal stabilisation. The annual incidence of cervical and thoracic fractures and the number of operated patients increased until 2008.

**Discussion:** Despite the improved treatment of AS the incidence of vertebral fractures requiring inpatient care increased during the years. Possible explanations are greater awareness of fractures, improved diagnostics, improved emergency care reducing fatalities, and a higher activity level of the patients. In Sweden an increasing number of patients with AS and instable fractures was seen with a trend to a further rise. Obviously the improvement of medical treatment did not reduce the susceptibility of these patients to unstable fractures.

**POSTER PRESENTATIONS 18**

**Surgical treatment for chronic atlantoaxial rotatory fixation in children**


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Atlantoaxial rotatory fixation is uncommon disorder, which often can be treated conservatively. But occasionally it persists and causes torticollis that is resistant to conservative treatment (traction, rigid brace/Halo vest). We report our experience in treating 6 patients with chronic atlantoaxial rotatory fixation who were not successfully treated by conservative treatment for at least three months. From 1995 and 2008, 6 patients whose mean age was 11 years old (6 -17 years old) underwent posterior fusion at the hospitals of the Nagoya Spine Group. The causes of torticollis were upper respiratory infection in two patients, minor trauma in two, post-otolaryngological operation in one, unknown in one. The mean duration between the onset of torticollis and the operation was 6.3 months (3.2 months-1.1 years). CT reconstruction demonstrated a deformity of the C-2 superior facet in all patients. Occipitocervical fusion was performed from the occiput to C3 in 1 patient. C1-C2 fusion was performed in 2 patients by Magerl & Brooks, in 3 patients by C1 lateral mass screw & C2 pedicle screw / hook. The mean follow-up duration was 4.8 years (9 months-9.1 years). Complications related to the operation occurred in 3 patients (50%). As a conclusion, all patients who underwent surgical treatment have a deformity of the C2 superior facet. C1 lateral mass screw and C2 pedicle screw fixation may be considered as a good option for chronic atlantoaxial rotatory fixation in children.

**POSTER PRESENTATIONS 19**

**Post traumatic cervical wedge kyphosis treated with modified wedge osteotomy of upper thoracic vertebral**

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Severe kyphosis of the cervicothoracic junction is mainly seen in ankylosing spondylitis. Post traumatic sagittal imbalance can also be a challenging condition to treat. Several methods have been described in correcting severe flexion deformities the Simmonds technique. Other techniques have been described usually in case reports 1;2. Two cases of post traumatic kyphosis addressed with a modified spinal osteotomy, combining pedicle subtraction (PSO) and partial vertebral body resection. 49 year old patient who 4 months previously sustained a flexion injury with avulsion of the C7 spinous process resulting in severe painful kyphosis. Treatment consisted of a PSO at T1 involving the cranial end plate and the C7-T1 disc followed by a C4-T5 posterior fixation. Post operatively she developed bilateral C8 radicular symptoms improving over time but left her with paraesthesia lasting for 6 months. 44 year old who developed kyphosis and signs of myelopathy six years following flexion injury with posterior C6-T4 laminar fractures treated with sublaminar wire fixation and C7 laminectomy. A T2 PSO involving the upper end plate and the T1-2 disc was carried out followed by a C2- T11 fixation (Fig 1). Postoperatively she developed left hand mild weakness which recovered fully at 3 months while myelopathy symptoms improved immediately. Both osteotomies showed evidence of anterior interbody union at 12 months on CT. Development of radicular symptoms could be due to the fact that this type of osteotomy further narrows the space available for the 4 exiting nerve roots compared to a simple pedicle subtraction osteotomy. Adding an interbody cage could counter this problem but might interfere with fusion. The described technique proved otherwise safe and successful in obtaining 30 degrees correction in the sagittal plane.
age: 44.6y) had history of hidden discoligamentous injury at index diagnostics without signs of neurology. Late instability was identified by subsequent subluxation/dislocation, persisting/increasing neck pain and/or scheduled radiographic follow-up.

We retrospectively analyzed radiographs at time of index diagnostics, radiographic follow-up and before scheduled surgery. For each patient a set of two plain lateral radiographs was available with the index segments at both radiographs. These images were subjected to QMA (MedicalMetrics, Houston, US) and analyzed regarding anterior shear (AS), segmental rotation angle (SRA) and COR-location. Calculation of AS showed translation of 0.07mm (-0.5 to 3.3mm), SRA of -0.9° (-11.1° to 17.7°), 2 patients (12.5%) full-filled one of the radiographic instability criteria. Because of only small angulations in sagittal plane, poor visibility of the C6-7 segment and C2-3 anatomy, QMA was only accomplishable in 3 of 16 patients. In 2 patients COR was within normal bounds, while one showed a pathologic shift. Most patients had AO-type B1.1-injuries. The current data show low reliability of using conventional radiographic analysis and criteria and even accurate QMA in a trauma setting to detect hidden discoligamentous unstable cervical spine injuries. MRI is increasingly used, but also frequently used conventional radiographic analysis and criteria.

Introduction: In developed countries, surgeons have recently had more opportunities to treat patients aged 80 years or older. This multicenter retrospective study was performed to clarify whether patients aged 80 years or older with cervical spondylotic myelopathy (CSM) would likely have a reasonable surgical outcome.

Materials & Methods: We retrospectively reviewed 605 consecutive patients with cervical myelopathy who underwent decompression surgery between 2004 and 2008 at our seven hospitals. Patients who had previously undergone cervical surgery, who had surgery for other neurological or joint disease within one year before or after decompression surgery, who were receiving hemodialysis, or had ossification of the posterior longitudinal ligament, disc herniation, rheumatoid arthritis, tumor, cerebral palsy, or symptoms aggravated after trauma were excluded. Of the remaining 189 patients, 161 CSM patients who could be evaluated six months after surgery were studied. The patients were divided into two age groups: 80 years or older (Group A, 37 patients) and under 80 years of age (Group B, 124 patients). We evaluated the differences in symptom duration, clinical data, surgical outcome, comorbidities, and postoperative complications between the two groups. The clinical data were evaluated using the Japanese Orthopaedic Association (JOA) score. The surgical outcome was evaluated using the recovery ratio calculated using preoperative and six-month postoperative JOA scores.

Results: Average symptom durations were 10.9 and 22.3 months in Groups A and B (p=0.023). The average preoperative JOA scores were 8.4 and 10.2, (p=0.002), and recovery ratios were 37.5% and 40.8% in Groups A and B (p=0.352), respectively. The percentages of patients with comorbidities were 86.5% and 75.9% in Groups A and B, respectively (p=0.167). The percentages of patients with postoperative complications were similar (8.1% and 12.9% in Groups A and B, respectively) (p=0.428).

Discussion & Conclusion: Although the preoperative neurological condition was poorer compared to that in younger patients, elderly patients achieved as much neurological improvement as younger patients. Moreover, there was no significant difference in the percentages of patients with postoperative complications between elderly and younger patients. Therefore, decompression surgery could be the optimal treatment even in elderly patients over 80 years old.

POSTER PRESENTATIONS 21
Clinical features and surgical outcomes of cervical spondylotic myelopathy in patients aged 80 or older: A multi-center retrospective study

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Object: ACDF, posterior laminoplasty, and laminectomy and fusion alone in elderly patients with severe progressive cervical myelopathy and critical canal stenosis may carry a significant risk of intraoperative neurological deterioration. Combined posterior and anterior decompression and stabilization may be a safer surgical alternative. We present our experience with posterior decompressive laminectomy followed by anterior decompression (discectomy with/without corpectomies) and anterior spinal reconstruction and fusion under one anesthesia.

Methods: Patients with severe progressive spondylitic myelopathy with radiological evidence of critical canal stenosis and myelomalacia who underwent the abovedescribed procedure in our institute between 7/2004-4/2009 were enrolled.

Results: 43 patients (13 females, 30 males) mean age 65 years (range 53-78) underwent surgery that lasted 130±25 minutes. Transcranial motor evoked potentials (MEPs) improved following anterior decompression in ten subjects, somatosensory spinal evoked potentials and MEP recordings improved following laminectomy in 6 and 8 patients respectively, and transient deltoid weakness resolved in 9. The mean hospitalization stay was 4.2 days (2-11). A follow up of 12-60 months was recorded. No infections, pseudoarthrosis or hardware failure occurred. All patients with improved intraoperative neuromonitoring recordings demonstrated clinical neurological improvement postoperatively. Overall, 27 patients improved neurologically, 16 remained neurologically stable, and none had neurological deterioration. The average preoperative Nurick score of 3 dropped to 2.1 postoperatively. Hand function improved in seven patients.

Conclusions: Posterior decompressive laminectomy and anterior decompression stabilization and fusion can be performed safely under one anesthesia without significantly extending operating time and possibly providing a neurologically safer approach to severe progressive cervical spondylotic myelopathy and improved neurological outcome.
POSTER PRESENTATIONS 23

The Entropy in Fractional Anisotropy Mapping of Healthy and Injured Spinal Cord of Human Beings

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Purposes: Diffusion MR imaging has been employed to delineate the functional ultrastructure of spinal cord (SC) experimentally and clinically. The ultrastructural complexity of SC builds the foundation of its normal function of spinal cord. Loss of the ultrastructural complexity would lead to functional abnormality. In the present study, we aimed to introduce the concept of entropy to describe the ultrastructural complexity of spinal cord in fractional anisotropy (FA) mapping among healthy and cervical spondylotic myelopathy (CSM) patients.

Subjects: Total 30 volunteers were recruited in this study with informed consent, including 13 adult healthy subjects (group A, 25±3 yrs), 12 elderly healthy subjects (group B, 53±7 yrs) and 5 CSM patients (group C, 53±15 yrs).

Diffusion MR Imaging: MR imaging of cervical spinal cord were performed with a 3T Philips MR system (Philips Medical System, Netherlands). Diffusion MRI images were taken using pulsed gradient, spin-echo-echo-planar imaging (SE-EPI) sequence (data acquisition parameters: TR/TE=5000/60 ms; 13 slices (7mm slice thickness, 2.2mm gap); field of view (FOV) = 80 (RL) ×36 (AP) mm; matrix size =128×128; non-collinear diffusion encoding directions=16, b=600s/mm²; reconstruction resolution= 0.63×0.64×7.0mm3; acquisition time=8 minutes).

Image analysis: Fractional anisotropy mapping of cervical spinal cord was generated via DTI studio. Region of interest was defined based on B0 images to cover the cord in. The mean and Shannon entropy of FA values were calculated for comparison.

Statistics: The comparisons were performed among three groups using one-way ANOVA and post-hoc test. The P value was set at 0.05.

Results: As compared with adult and aged healthy subjects, the entropy was significantly lower in CSM patients (group A: 6.07±0.18; B: 6.01±0.23; C: 5.32±0.44; p<0.05). Whereas there were no significant difference in FA values among groups (group A: 0.62±0.08; B: 0.64±0.09; C: 0.64±0.12). Among the healthy subjects, the coefficient of variance (CV) for the entropy was 3–4% yet the CV of FA was 13–14%.

Conclusion: Loss of entropy in fractional anisotropy mapping of cervical spinal cord in CSM patients. Entropy might be a new index in diffusion MR imaging for the diagnosis of CSM.

POSTER PRESENTATIONS 24

Anterior cervical pedicle screw and plate fixation for multilevel cervical reconstruction

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Objectives: Anterior procedures in the cervical spine are feasible in cases of anterior aetiology such as anterior neural compression and/or kyphosis. Halo vests or anterior plates are used concurrently for cases with long segmental fixation. However, halo vests are troublesome and anterior plate fixation is not adequately durable. We have, therefore, developed a new anterior pedicle screw and plate fixation procedure using the fluoroscope-assisted pedicle axis view imaging technique.

Materials & Methods: Sixteen patients (9 men and 7 women; mean age, 53 years) were included in this study. Their original diagnoses comprised cervical myelopathy and/or radiculopathy (n = 11), posterior longitudinal ligament ossification (n = 3) degenerative kyphosis (n = 1) and post-traumatic kyphosis (n = 1). Thirteen patients underwent anterior pedicle screw and plate fixation alone and three patients had anterior pedicle screw fixation and posterior instrumentation.

Results: Mean operative time was 213 min and average blood loss was 147 ml. All patients were permitted to ambulate next day with a cervical collar. Local sagittal alignment was characterised by 4.7° of kyphosis preoperatively, which improved to 4.5° of lordosis postoperatively and 3.9° of lordosis at final followup. Postoperative improvement and early bony union were observed in all cases. There was no serious complication but for one case of mild dysphagia. Total 45 anterior pedicle screws were used and postoperative imaging demonstrated screw exposure in 4 screws (8.9%), but no pedicle perforation.

Conclusions: Anterior pedicle screw and plate fixation is useful in selected cases of multilevel anterior reconstruction of cervical spine. However, adequate familiarity and experience with both cervical pedicle screw fixation and imaging technique used for visualising the pedicle during surgery are crucial for this procedure.
Histology: rat spinal cord was embedded in wax and sectioned to 8μm for H&E and luxol fast blue staining.

Results: Under DTI evaluations, the fractional anisotropy were lower at the compression level than the adjacent levels in the model rats. It was echoed by less myelin staining of white matter histologically. Yet under micro-CT evaluation, the intensity of the contrast agent were relatively higher at the compression level. It might be explained by the cavitation changes of white and gray matter.

Conclusion: The combination of diffusion MR imaging and micro-CT could illustrate the disruption of structural integrity of spinal cord with induced chronic injuries, including demyelination and organization.

POSTER PRESENTATIONS 26
Surgical outcomes of selective laminoplasty for kyphotic cervical spondylotic myelopathy
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Introduction: We have performed selective laminoplasty including skip laminoplasty for cervical spondylotic myelopathy (CSM) since 2001. This procedure has two unique points; first, it preserves the deep neck extensor muscles, second, decompression levels are selected by dynamic MRI. A paper published in 2003 reported that cervical kyphosis exceeding 13° often deteriorated and resulted in poor neurological recovery after conventional laminoplasty. The purpose of this study is to verify its effectiveness in preventing the deterioration of kyphosis.

Methods: Between April 2001 and July 2008, there were 433 CSM patients who underwent the procedure at three institutes. Twenty-six patients (6.0%) had cervical kyphosis defined when preoperative C2-C7 angle on lateral radiographs in neutral position was lower than 0°. This group included 17 males and 9 females. Follow-up periods ranged from 9 months to 43 months. None of the patients had surgical complications including C5 paralysis or revision surgery.

Results: Nineteen patients had mild kyphosis (C2-C7 angle: -1°~ -12°, A group), 6 patients had moderate kyphosis (C2-C7 angle: -13°~ -23°, B group) and 1 patient had severe kyphosis (C2-C7 angle: -24°~, C group) preoperatively. There were 4 patients (15%) whose preoperative kyphosis had deteriorated by less than 6°. In A group, JOA scores averaged 11.5 (4.5–16) preoperatively and 14.4 (9.5–16.5) postoperatively. One (5%) of 19 patients had kyphosis deteriorated by 5°, but the neurological improvement rate was 54% without axial pain 15 months after surgery. In B group, JOA scores averaged 13.0 (11–16) preoperatively and 15.6 (13–16.5) postoperatively. Two (33%) of 6 patients had deterioration of kyphosis by less than 6°, but both enjoyed improvement of ADL. The neurological improvement rates were 67% and 83%. One patient in C group was 85 year-old woman whose kyphosis deteriorated from -41° preoperatively to -46° postoperatively. The neurological improvement rate was very low (28%).

Discussion & Conclusions: This procedure successfully prevented deterioration of preoperative kyphosis of less than 23° for 85% of the patients and 96% had satisfactory neurological improvement.

POSTER PRESENTATIONS 27
Formulation protocol for management cervical myelopathy secondary to spondylosis and OPLL
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Objective: To express an easy formulation in order to facilitate preoperative planning for the most appropriate mode of surgical decompression in cervical myelopathy caused by spondylosis and OPLL.

Background data: Numerous forms of management for cervical myelopathy secondary to OPLL and spondylosis exist, but there are few consistent recommendation in this controversial issue.

Method: We have operated on 134 patients with cervical myelopathy secondary to cervical spondylosis and OPLL from 1993 to 2010. Retrospective analysis of the first 80 patients till 2007 and long lasting and good clinical outcomes encouraged us to review our formulation in preoperative planning in these cases. So we used this protocol in the next 54 cases prospectively. Our formulation is based on mode of anterior compressions whether it is derived from the disc, body or both, and the number of the affected levels indicating: small medium and prominent (D/B). Posterior compression by folded hypertrophied ligamentum flavum known as Pc which can be Mild, Moderate or Marked). Curvature of the neck in neutral position which can be lordotic, straight or kyphotic or angulated, presence or absence of instability known as UnStable or stable (UnSt, St). The age of the patients, coexistence of developmental narrow canal

Results: Through the application of this formulation protocol we were guided to achieve the most appropriate method of decompression and gain very good postoperative MJOA score.

Conclusion: The surgeon should draw a similar mode of cervical cord compression, number of the levels, curve of the spine and pattern of posterior compression. Also, he should consider the age of the patient, presence of instability, concurrence of developmental narrow canal and coexistence of comorbidities. Practicing this simple guideline will undoubtedly help him to decide fast and accurate.
correction via the anterior approach. Then anterior decompression and correction and fusion was done. Unlocking the posterior lower anchor points enabled manipulation and correction of kyphosis via the anterior cage and plate. Recexposure of the posterior incision was done at the third stage and posterior rods bend to physiologic contours were placed and fixed.

**Results:** Average follow-up was 45 months (range: 24 to 96). Mean age of the patients (8 male, 7 female) at the time of operation was 66 (range: 31 to 81) years. Mean preoperative local kyphosis angle was 12 degrees and was corrected to 10 degrees at the extension lateral x-ray. Mean preoperative global kyphosis was +9.2 degrees (range: 4 to 29 degrees) and was corrected to -13.3 (range: 8 to 24) degrees of lordosis. An average of 3 corpectomies and 2 laminectomies was done. The mean operation time was 420 minutes and the average blood loss was 423 ml. Average hospitalization period was 12 days. There was no pseudarthrosis at the final follow-up and loss of correction was an average of 1.5 degrees. There was a significant improvement both in myelopathy and neck pain. Four patients developed bilateral C5 root palsy postoperatively and resolved within 3 months. Other complications included 2 wound dehiscences requiring an additional operative procedure and 1 superficial wound dehiscence treated conservatively.

**Conclusion:** Posterior-anterior-posterior surgery for spondylotic myelopathy associated with rigid kyphosis restored the sagittal alignment and provided a succesful neurologial and clinical outcome.

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**POSTER PRESENTATIONS 29**

Myelopathy due to an Ossification of the Vertebral Longitudinal Posterior Ligament (OPPL), Ligamentum Flavum and Dura mater in a Caucasian Patient

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Myelopathy due to a OPPL is described more frequently in the oriental patients, some surgical treatment is currently indicated for decompression. OPPL and ossification of the ligamentum flavum is less frequent, being rare a multilevel involvement and exceptional the ossification of the dura mater.

**Case Report:** A 55-year-old caucasian male was referred to our consult with a 3 month evolution of symptoms such as hypoesthesia in lower limbs, not in a defined dermatoma territory; but distal to de waste line, and progressive strength loss in both lower limbs. Physical examination demostrated a T10 sensitive level, strength in lower limbs was classified as Frankel D, generalized hyperreflexia without a positive Hoffmann sign or clonus bilaterally. MRI shows spinal stenosis at 3 levels: C3-C4, C4-C5; T1-T2,T2-T3, due to an OPPL and flavum ligament ossification and the third stenosis at T10-T11 level due to an dural ossification also. Surgical treatment consisted in decompression and instrumental arthrodesis; in the first procedure the lower dorsal spine was approached performing a T10 laminectomy and a T9-T11 arthrodesis. During the intervention a liguage was observed and the dura was repaired with a dural patch. In a second surgery we performed a C3-C4 laminoplasty, partial laminectomy of C5 and total laminectomy at T2-T3 associating an instrumented arthrodesis from C2 to T4. The patient had a non septic suture dehiscense, requiering a third intervention. He immediately felt improvement, recovering strength and sensitivity during the first week. In the last visit, 18 months after surgery, the patient was completely autonomous, strengh in lower limbs was classified as Frankel A, he had complete sensitivity and a minor hyperreflexia.

**Conclusion:** Dural ossification can be suspected in the preoperative CT and MRI study in patients with ossification of the ligamentum flavum and the OPPL with the ‘tram track’ and ‘comma’ sign, nevertheless sometimes it can appear as an intraoperative finding.

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**POSTER PRESENTATIONS 30**

Cervical cord injury without fracture in degenerative spine

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**Object:** It is known that the spinal cord can sustain traumatic injury without associated injury of the spinal column in a preexisting narrowed spinal canal. The purpose of this study was to characterize the clinical features and to understand the mechanisms in cases of acute cervical cord injury in which fracture or dislocation of the degenerative cervical spine has not occurred.

**Methods:** 11 patients who sustained an acute cervical cord injury were treated in our hospital between 2007 and 2009. No bone injuries of the cervical spine were demonstrated, and this group was retrospectively analyzed. There were 7 men and 4 women, aged 48 to 88 years (mean 67.9 years). The initial neurological examination indicated complete injury in 3 patients, whereas incomplete injury was demonstrated in 8.

**Results:** We found degenerative changes of the cervical spine such as spondylotic or ossification of the posterior longitudinal ligament. The mean sagittal diameter of the cervical spinal canal, as measured on computerized tomography scans, was significantly narrower than that obtained in the control patients. Magnetic resonance (MR) imaging revealed spinal cord injury in all patients and paravertebral soft-tissue injuries in 4 (36.3%) of the patients.

**Conclusions:** Degenerative changes of the cervical spine and narrowing of the spinal canal are important preexisting factors of spinal cord injury without bone injuries of the spinal column.

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**POSTER PRESENTATIONS 31**

Can elderly patients recover well after laminoplasty? Operative results of double-door laminoplasty in 520 patients with cervical spondylotic myelopathy

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**Introduction:** In the aging of the population, degenerating spine disease such as cervical spondylotic myelopathy (CSM) is increasing, and surgical treatment is becoming more common. However, the influence of aging for the surgical outcome is still unknown. There have been few reports on the operative results in big mass of patients with CSM. The purpose of this study was to compare the surgical outcome between non elderly patients and elderly patients with CSM who underwent treatment by double-door laminoplasty.
Methods: 520 consecutive patients with CSM who underwent double-door laminoplasty were included in this study. There were 331 males and 189 females; the mean age was 62 years (range 23–93), mean duration of disease was 20 months. The average postoperative follow-up period was 33 months. The patients were divided into three groups by age; non-elderly group (age<65), young-old group (65–74) and old-old group (age>=75). The number of patients was each of 287, 143 and 90. Neurologic status was evaluated with the Japanese Orthopaedic Association scoring system (JOA score) pre- and postoperatively.

Results: Average pre- and postoperative JOA score were 11.0/14.4 points in nonelderly group, 10.2/13.2 points in young-old group and 8.7/11.8 points in old-old group. The elderly group showed significantly lower the recovery rate of JOA score compared to the non-elderly group (p<0.0001). Achieved JOA score (postoperative JOA score - preoperative JOA score) was 3.4 points in the non-elderly group, 3.0 points in the young-old group and 3.1 points in the old-old group. There was no significant difference among groups in achieved JOA score (p=0.1653).

Conclusions: Pre- or postoperative JOA score was basically lower in elderly patients. But the achieved JOA score was not different among the three groups. Advanced age is not a reason to hesitate to perform surgical treatment, as long as the patient is in good physical condition.

POSTER PRESENTATIONS 33

Introduction: Cervical spondylotic myelopathy (CSM) is the most commonly acquired cause of spinal cord dysfunction in people over 55 years of age. It is an intractable disease that progresses slowly over time and displays clinical manifestations of cervical spinal cord compression including gait disturbance, clumsiness and parasthesia of the hands along with signs of pyramidal and posterior column dysfunction, and if left untreated leads inevitably to tetraparesis or tetraplegia. Many pathophysiological mechanisms have been implicated in the progress of the disease such as spinal cord ischemia, neurons and oligodendrocytes apoptosis, spinal cord edema, gliosis etc. A deeper understanding of the pathobiology of CSM at the cellular and molecular level could lead to improve reparative and regenerative therapeutic strategies.

p50 and p65 expression in glial cells and neurons of cervical spinal cord in a rabbit animal model with cervical spondylotic myelopathy

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Materials & Methods: In this study we used a new animal experimental model of CSM developed in our laboratory. We used 23 New Zealand rabbits 1.5-2 kg in which we performed posterior cervical laminectomy and chronic compression (15 weeks) by introducing a piece of aromatic polyether 5mm thick. We evaluated the expression levels of p50 and p65 subunits of NF-kB in paraffin embedded sections of cervical spinal cord coming from 13 rabbits with CSM and from 10 control animals (sham operation). The evaluation performed using immunohistochemistry technique and the results were analyzed using SPSS for Windows, release 12.0 (SPSS Inc., Chicago, IL).

Results: Elevated nuclear immunostaining for both p50 and p65 in neurons and glial cells was detected in animal’s spinal cord with CSM. This elevated immunostaining was statistically significant compared to control animals.

Conclusion: The overexpression of NF-kB subunits p50 and p65 in spinal cord with chronic myelopathic damage compared to normal spinal cord suggests an important role of this transcription factor in the pathocellular process of the disease. Additional studies in the molecular intracellular pathways upstream and downstream to NF-kB will contribute to a thorough understanding of its pathocellular role to the disease.
Multiple laminectomies and subaxial lateral mass fixation for the treatment of cervical spondylotic myelopathy

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Introduction: The study presents the results of the surgical treatment of cervical spondylotic myelopathy via a posterior approach involving laminectomies, subaxial lateral mass fixation and fusion.

Methods: Between July 2006 and July 2008, 77 patients with cervical spondylotic myelopathy underwent posterior decompression with laminectomies and pedicle screw fixation of the cervical spine. All patients were selected based on the presence of multi-level degenerative disease and the correction of cervical lordosis on the pre-operative dynamic radiographs. Patient demographics, co-morbidities and post-operative complications were recorded and analysed. Functional outcome was assessed using the Japanese Orthopaedic Association (JOA) score.

Results: There were 38 male and 39 female patients with an average age 68.8 years. The average follow up period was 17 months. The mean pre-operative JOA score was 9.1, whereas the mean post-operative score was 12.6 on the latest follow-up visit. 10 patients had unsatisfactory clinical results and consequently underwent anterior procedures with significant improvement. Complications included 1 epidural haematoma, 3 superficial infections and 4 cases of myofascial pain. In three cases there was mild dysfunction of the C5 nerve root which resolved spontaneously with conservative measures.

Newly Devised Provocative Tests for Relief of Cervical Radiculalgia, Shoulder Girdle Active Elevation Test and Extension Test: Analysis in 75 Patients with Cervical Radiculalgia Verified by Whole Posterior Decompression of Cervical Nerve Root.

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Introduction: Among the cervical radiculalgia relief tests, shoulder abduction test (Davidson) needs patients’ active shoulder abduction, which cannot be performed with C5 palsy or shoulder involvement. The authors devised new provocative tests which relief the cervical radiculalgia and whose results are not affected by concomitant shoulder diseases, range of motion was measured with difference of ROM,34.9±15.0°was significantly smaller than preoperative ROM,34.9±15.0°(p<0.001). Postoperative O-C2 angle, 17.7±9.2°is significantly larger than preoperative one, 14.2±7.7°(p<0.001). There was no difference of pre- and postoperative C3-C7 angle, ROM, and O-C2 angle among basic disease. Loss of lordotic angle was correlated with the range of laminoplasty, and was significant in the group both C2 and C7 spinal process were removed. Increasing O-C2 angle slightly correlate with loss of lordotic angle. Although little change of lordotic angle, sniffing position, i.e. tendency of dropped head, was shown on radiograph.

Postoperative alignment change after cervical laminoplasty

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Introduction: Cervical laminoplasty(CLP) is common method for decompression of spinal cord and nerve root in degenerative spinal disease, or making access to intracanal lesion like spinal cord tumor. Postoperative malalignment sometimes become a problem after CLP. Risk factors and evaluation method are assessed in this study.

Methods: The 67 patients, who were treated with CLP between 2005 and 2007, were retrospectively analyzed with cervical radiograph. The diseases which need to be treated with CLP were cervical spondylodiscitis in 28 cases, cervical OPLL in 25 cases and spinal cord tumor in 14 cases. The range of laminoplasty depended on the area of lesion, between 2 and 8 laminae(mean 4.7), but 4 laminae of C3-C6 was the most frequent. The method was bilateral open-door laminoplasty for C2- C7. C1 and below T1 laminae was done with laminectomy. Lordotic angle of C3-C7 and occipital-C2(O-C2) angle was measured in neutral position, range of motion was measured with difference of flexion and extension. Postoperative course of C3-C7 angle in neutral position, ROM and O-C2 angle was evaluated. And influence of basic diseases, range of laminoplasty and muscle dissection of C2 and C7 spinal process for measured values was assessed.

Results: Pre- and postoperative C3-C7 angle was 9.3±11.4° and 6.2±14.9°, respectively, with significant decrease. And postoperative ROM, 28.3±12.5°was significantly smaller than preoperative ROM,34.9±15.0°(p<0.001). Postoperative O-C2 angle, 17.7±9.2°is significantly larger than preoperative one, 14.2±7.7°(p<0.001). There was no difference of pre- and postoperative C3-C7 angle, ROM, and O-C2 angle among basic disease. Loss of lordotic angle was correlated with the range of laminoplasty, and was significant in the group both C2 and C7 spinal process were removed. Increasing O-C2 angle slightly correlate with loss of lordotic angle. Although little change of lordotic angle, sniffing position, i.e. tendency of dropped head, was shown on radiograph.
Conclusions: Loss of lordotic angle was significant in the patients including C2 and C7, and broad laminoplasty. And increase of O-C2 angle could be used as index of sagittal balance.

POSTER PRESENTATIONS 37
Anterior cervical arachnoid cyst (Report of two cases and review of the literature)
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Study design: Report of two cases of anteriorly located cervical intradural arachnoid cyst one presenting in a 2 year old child with chief complaint of torticollis, with later appearance of left hand weakness, and the second in a 17 year old boy with neck pain and severe upper extremity weakness and gait difficulty.

Objective: To review the age gender, clinical presentation and imaging features of anteriorly located intradural arachnoid cysts with special reference to the surgical management of this rare pathology

Background: Intradural arachnoid cysts of the cervical region are uncommon and those located anterior to the cervical cord are rare. With thorough review of the literature we could find only 18 cases reported in the past.

Method: Two girls one 2 yrs and another 7 years old were hospitalized because of weakness of upper extremities in both cases. Neck pain was preceded before paresis in both while the former had also torticollis. MRI of both cases revealed an anteriorly located CSF density cyst extending from C4 to C5 in the child and from C2 to C3 in the young one. Limited laminectomy of two level was performed in one and laminatomy for subsequent laminoplasty in the other, after midline dural opening, the anteriorly located translucent cyst was fenestrated widely with complete cysts membrane removal. With uneventful recovery, the patients were discharged in a few days.

Conclusion: Anterior cervical arachnoid cyst although rare, but should be considered in the diagnosis of children and young adults with neck pain and torticollis. Upper extremity weakness as we demonstrated in both of our cases might be also a good indicator of such pathology.

POSTER PRESENTATIONS 38
Solitary plasmacytoma of the odontoid process and body of C2 (Report of 2 cases, and review of the literature)
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Objective: To present the clinical picture and radiological features of two men with solitary plasmacytoma of odontoid process and body of axis. Steps of management, surgical indications and mode of surgery as well as the value of Adjuvant external beam therapy will be discussed.

Background: Solitary plasmacytoma of the cervical spine are rare and affection of C2 is very rare and only 5 cases had been reported in the past. Surgical management of the tumors affecting this region is also challenging.

Method: Two male patients both in the 4th decade of life one with quadriaparesis and the other with intractable neck pain are reported. Plain X-Ray showed expansion of the axis in both case. Accompanying with atlantoaxial instability in one. Ct scan in both cases showed expansive trabeculated tumor of axis. Surgery was indicated in both cases. In the first case because of odontoid destruction and instability and in the latter because of failed Ct guided biopsy. Retropharyngeal approach was used in both cases followed by occipitocervical stabilization (Oasys, Stryker). Both patients recovered. A course of radiotherapy was applied two months later.

Conclusion: We found that in solitary plasmacytoma of the axis have sufficiently pathognomic features which include expansive trabeculated body and odontoid sparing posterior elements. CT Guided biopsy followed by radiotherapy is the treatment of choice. However in presence of instability and failure of biopsy surgical excision of the tumor is indicated that can be best achieved through retropharyngeal approach followed by occipitocervical instrumentation and fusion.

POSTER PRESENTATIONS 39
Case report of two rare cervical spine tumors
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We present two clinical cases of two rare clinical entities concerning primary cervical spine neoplasms. The first one refers to an old lady 85 years old who presented to our department with symptoms of cervical spine pain and progressive weakness of all four extremities. The patient had a long history of cervical spine pain.

Clinical Examination: The deep reflexes were augmented, pinprick and vibration sensation were reduced to upper and lower limbs. There was decreased power 2/5 in right and left lower limbs and 3/5 to right and left upper limbs. Hand grip was severely affected and the patient could not stand or walk. Babinsky sign was abnormal bilateral.

Imaging Review: Osteolytic mass was identified at Cervical CT scan from C2-C4. No other mass was identified by CT investigation of the abdominal or thoracic cavity. Management: CT guided biopsy diagnosed CHORDOMA.

Result: the patient eventually succumbed to the disease without any further treatment.

The second case report refers to a man 44 years old who presented to our department with symptoms of cervical spine pain that was getting worse during the night and tingling to both hands. Clinical Examination: Neurological Examination was normal. Imaging review: Cervical Spine MRI and CT diagnosed a tumor expanding the body of C6 vertebrae. Treatment: C6 tumor excision and biopsy with C6 corpectomy and anterior cervical stabilization with cage and anterior plate with screws. The biopsy diagnosed eosinophilic granuloma of the spine. The postoperative period was without any complication. Scintigrafi ng imaging did not reveal any other lesion and the patient referred to a hematologist for further consultation. He has not received any further treatment and he remained stable without symptoms three month post op.
Surgical treatment of cervical spine tumors

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Object: Communicate our experience in treating cervical spine tumors.

Methods: Between 2000 and 2009 we treated 18 patients in our Department for a cervical spine tumor. 13 patients (7 men and 6 women) aged 16-75 years (mean age: 53.4 y), had surgical treatment, while 5 were sent in an oncologic centre because of multiple metastases. 6 of the operated group (46.13%) presented with neurological symptoms of varying severity at the time of admission to the hospital. Their preoperative screening included x-rays, CT and MRI scan, CT biopsy, as well as scintigraphy with Tc 99. In 8 patients (61.53%), a type of benign tumor was found, while 5 (38.47%) were diagnosed with malignancy.

Results: 4 patients had an anterior procedure only and in 9 we used a combined anterior-posterior approach, at the same or in separate surgical sessions. From the 6 patients with a neurological lesion, 5 (83.33%) improved postoperatively while 1 remained unchanged. There was 1 postoperative wound infection on a posterior approach treated with antibiotics.

Conclusions: Cervical spine tumours can be treated effectively by total removal, with single or combined approaches.

Treatment of spinal osteoid osteoma: Is in-block resection the best option?

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Introduction: In-block resection is widely accepted as the best option in the treatment of spinal osteoid osteoma (OO) but frequently leads to fuse one or two mobile segments. Authors review the present validity of this concept.

Patients & Method: A series of 6 spinal osteoid osteoma surgically treated (confirmed by pathological) means of an intraslesional resection (curettage of the nidus with no fusion) is reviewed in order to determine its therapeutic efficiency.

Results: 5 patients were male and 1 female. Average age was 19 y. (6 to 27). Within the vertebra, the OO the articular process in 4 patients and the pedicle in 2. The affected vertebrae were C1, C3, C4, C6, C7 and T1. One patient was first operated elsewhere with misdiagnosis of soft tissue sarcoma (with no resection of the OO) due to the “flare phenomenon”. One tumour located in an articular process of C1 was partially resected and needed a second operation five days later on in order to remove the remaining tumoral mass totally. The final outcome was satisfactory being the total resection proved by the postoperative image exams in all cases.

Conclusion: In a time in which percutaneous approach to spinal OO is being progressively done, simple resection by total curettage of the nidus -with no sacrifice of any mobile segment- can be efficient enough as to be considered the gold standard in the surgical treatment of cervical spine OO.

POSTER PRESENTATIONS 42

Metastatic Tumors at the Cervical Spine associated with severe neurologic deficits: Operative Treatment

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Introduction: Three cases of metastatic tumors at the cervical spine are presented, that produced significant neurologic deficit. The tumors were treated operatively.

Material & Methods: 2 women and 1 man age from 55 to 80 years old, were admitted to the Orthopaedic Department complaining of neck pain and progressive neurologic deficit. The radiologic examination revealed extensive destruction of the vertebral bodies due to metastasis. The origin of the malignancy was the thyroid, the breast and the pneumon. The operative treatment consisted of a) posterior decompression and stabilization in 2 cases and b) anterior - posterior decompression and stabilization (vertebrectomy). Post operatively the patients were submitted in complementary chemotherapy.

Results: Significant reduction of the pain and the neurologic deficit was succeeded. In the follow up (3 months to 3 years) there was no observation of failure of the implants or destabilization.

Conclusions: In cases of cervical instability and neurologic deficit due to metastasis, the decompression and stabilization of the involved levels is the treatment of choice.

POSTER PRESENTATIONS 43

Clinical-radiological correlation between dysphagia and retroesophageal soft tissue increase after cervical spine surgery

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Purpose: Evaluate with postoperative plain X-ray the correlation between dysphagia and retroesophageal soft tissue increase after cervical spine surgery.

Material & Methods: We included 47 patients with cervical spine surgery (arthroplasty and arthrodesis), comparing specific clinical sensation of foreign object during deglutition with radiological findings of retroesophageal soft tissue increase at immediate first 24 hours after surgery.

Results: Patients with a retroesophageal space lower than 3mm presented hematoma symptoms in 11.76%. In patients with a retroesophageal space higher than 3mm hematoma symptoms appeared in 55.55% (p=0.006). Two from that group required surgical evacuation. There were no significant differences in the frequency of clinical symptoms presentation between arthroplasty and arthrodesis, but in the last group the mean retroesophageal space was higher (5.22mm) than in arthroplasty (2.28mm).

Conclusions: A retroesophageal space higher than 3mm measured by plain Xray shows an increased possibility to develop clinical retroesophageal hematoma symptoms. Most of the symptoms are mild, but they can help us to prevent and control further evacuations surgeries.
POSTER PRESENTATIONS 44
Our experience with the PCM artificial disc. Results from a retrospective study
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Objectives: Cervical disc replacements have reached great relevance in the treatment of degenerative cervical spine disease. Anterior cervical discectomy and fusion (ACDF) is routinely used in the treatment of symptomatic radiculopathy and/or myelopathy. Since 2004 we gathered our first experiences with cervical arthroplasty with the Bryan Disc and Bryan Accel (126 prosthesis in 110 patients up to Sep 2009) and from 2005 also with the PCM.

Material & Methods: Sixty-six PCM prostheses were placed in a consecutive series of 60 patients (37 males and 24 females) from January 2005 to September 2009. Out of 66 prosthesis 35 were PCM up to June 2006 and 31 PCM-V from then. We evaluated the clinical and radiological outcome and associated complications of all elective cases after at least 3 months of follow-up.

Results: Overall, according to the Odom criteria, 80% of patients were in an excellent or good clinical postoperative status. Dysphagia and dysphonia were the most frequent complications, always minor and transient. Our mortality rate was 0%, with no postoperative hematoma, infection or new neurological deficit. Two heterotopic calcifications were observed, one a year after surgery in a patient without clinical symptoms, and the other in a patient with minimal cervical pain. Two patients were reoperated due to dysphagia and cervical pain secondary to luxation of the PCM prosthesis.

Conclusions: The goal of most disc arthroplasty designs is to attempt to simulate the normal spinal motion as much as possible. We observed good clinical outcomes and a low complication rate in this group of patients. Our results suggest that patients in the PCM-V group compared with those implanted with the standard PCM have a lower rate of subluxation. In our experience, the best candidates are younger patients, below 55, with a cervical disc herniation without major bony degeneration.

POSTER PRESENTATIONS 45
Dysphagia in anterior cervical disk surgery
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Dysphagia is common after anterior cervical spine surgery, however usually with a favorable prognosis. The objectives of this study were to establish the time course of dysphagia and to evaluate any difference between total disk replacement and fusion. 122 patients (63 women; age 46.7±7.0 years, from an ongoing RCT comparing TDR and fusion (n=70) and fusion (n=32) completed the Dysphagia Short Questionnaire, DSQ, preoperatively, and at 4 weeks, 3 months and one year after the operation. The DSQ is validated. It measures dysphagia qualitatively and quantitatively, and correlates to EQ-5D. Preoperative 50% of the patients reported some dysphagia symptoms, but the DSQ showed a very low value of 1,5±2 points. At four weeks dysphagia was present in 85% with an average DSQ value of 3.1±2.4. At three months 60% still had some symptoms, but the magnitude was mild and the average DSQ value was 1.7±2. At one year 46% had some, but very mild symptoms with a DSQ of 1,3±1,6. There were no differences in incidence or severity of dysphagia at any time between TDR and fusion. Dysphagia is common in patients with cervical disk herniation already before surgery; however at low levels. After surgery almost all patients develop some but still relatively mild dysphagia. Already at three months the dysphagia approaches preoperative levels which are reached by one year. No difference can be detected with regard to reconstruction method, TDR or fusion.

POSTER PRESENTATIONS 46
Design and validation of a short questionnaire to assess dysphagia after anterior cervical spine surgery
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Dysphagia is frequent after anterior C-spine surgery. An easy-to-use instrument to quantify dysphagia (DSQ) was constructed and its validity and reliability evaluated. 45 patients (22 women) with dysphagia were included; mean age 64.8±10.4 years. At the first visit the patients completed DSQ, MD Anderson Dysphagia Inventory (MDADI) and Bazaz scores. 2 weeks later they completed DSQ and a quality-of-life score: EQ-5D. Five patients missed the second occasion why 40 patients participated in the test-retest analysis and the correlation to EQ-5D. The DSQ averaged 6.3±2.7 and was fairly normally distributed as was the MDADI but not the distribution of the Bazaz score. The DSQ correlated to the MDADI (r= -0.64, P<0.05) but not to Bazaz score (r= 0.07). The MDADI and the Bazaz score did not correlate (r=-0.12). There was a significant correlation between the DSQ at the two occasions (r=0.69, P<0.05). A Bland-Altman diagram showed good agreement between the two tests. There was a weak, but significant, correlation between the DSQ and the EQ-5D (r=0.27, P<0.05), whereas no correlation could be detected with the MDADI; r=0.18. There was a paradox inverse correlation between the Bazaz score and the EQ-5D with higher QOL values associated with more dysphagia (r=0.31, P<0.05). We can conclude that the DSQ is a valid instrument for measuring dysphagia.

POSTER PRESENTATIONS 47
Revision surgery after multilevel cervical anterior discectomy.
Strategies of revision
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The study objective is to analyze the role of the anterior approach when revision surgery is required for failures of anterior cervical discectomy and fusion with cage stand alone (ACDF-CA) 3 or more levels. The discussion of results accompanied by review of literature analyze biomechanical challenges in multilevel cervical procedures.

Summary of Background Data: In literature, revision surgeries for failed anterior fusions showed high success rate when the used
approach is only posterior (94-98%) and circumferential fusion (94-100%) compared to anterior only (55-57% success rate). However, in our experience anterior revision is more useful for the purpose of removal of failed implants, resection of pseudoarthrosis, and correction of anterior localized deformity. Extending the length of fusion can enhance the overall stability of the construct thus avoiding additional posterior fixation.

Methods: A total of 8 consecutive patients with previous surgery for degenerative multilevel instability and spondylotic myelopathy were analyzed. In our series there were 5 patients with previous 3 level ACDF-AC and 3 patients with previous 4 levels ACDF-AC. This patients suffering from neck pain or cervical radiculopathy thus requiring reoperation. Indications included degenerative multilevel instability and spondylotic myelopathy. Revision surgery was effected only by anterior approach. Standing plain lateral radiographs and MRI was performed before and after the redo surgery. A minimum follow-up of 6 months was considered. Clinical outcomes were assessed using SF-36.

Results: The goal of revision surgery was to correct the size and/or pseudoarthrosis subsidence of one or more cage and sometimes also global sagittal alignment. We observed significant improvement of clinical outcome related to the correction of that components. Solid fusion was achieved in 83 % of subjects and pain reliefe in 90 %. Conclusion: In revision surgery for failed ACDF-AC at 3 or more level, the anterior approach only, with cages and locking plate systems, permit stronger anterior fixation and can avoid the need for posterior supplemental fusion. Posterior fixation remains a viable option but the only anterior approach with cage and plate construct in 3 or more-level results in a increased lordotic alignment, disc height, higher fusion rate, and a lower complications.

POSTER PRESENTATIONS 48
How to prevent post-operative dyspnea and/or dysphagia following occipito-cervical (thoracic) fixation; evaluation using M-C angle and O-C2 angle
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Introduction: Posterior occipito-cervical (thoracic) fusion in a flexed position may cause dysphagia or, rarely dyspnea. Miyata, et al reported that maintaining an O-C2 angle not less than the pre-operative angle is important to avoid postoperative dysphagia and/or dyspnea. We reported in this meeting last year that more than post-operative 10° decrease of M-C angle (McGregor line - CCL angle; CCL=Cervical Spinal Column Line) and less than 90° of this angle may be one of the risk factor to develop post-operative dysphagia and/or dyspnea. The purpose of this study was to investigate the relations with the fixed position and postoperative dysphagia and/or dyspnea following occipito-cervical (O-C) or occipitocervicothoracic (O-C-T) fixation.

Methods: We measured pre- and post-operative O-C2 angle and M-C angle on the lateral cervical radiograph in the neutral position of 15 patients with postoperative dysphagia and/or dyspnea who underwent O-C or O-C-T fusion surgery in multiple centers.

Results: Pre-operative O-C2 angle was 10.1 degrees (-14° to +8722; 31 degrees), and decreased 7.3 degrees (-23° to +8722; 21 degrees) to 2.8 degrees (-8° to +8722; 13 degrees) postoperatively. In 10 cases (66.7%), O-C2 angles were less than the pre-operative angle. Pre-operative M-C angle was 94.5 degrees (74° to +8722; 116 degrees), and decreased 8.5 degrees (-26° to +8722; 17 degrees) to 86.1 degrees (73° to +8722; 103 degrees) postoperatively. Eleven cases (73.3%) were in the risky area that we proposed.

Conclusions: O-C or O-C-T fusion in a flexed position was thought as one of the major cause of post-operative dysphagia and/or dyspnea. These data suggest that we might be able to avoid post-operative dysphagia and/or dyspnea in 67% cases in this series by using O-C2 angle and in 73% cases using M-C angle. However there were some cases that have no relation to fixed angle, and it is necessary to find another causes.

POSTER PRESENTATIONS 49
Does the side of approach affect the incidence of recurrent laryngeal nerve injury in anterior cervical spine surgery? Single surgeon's experience in two hundred cases
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Introduction: The risk of injury to the recurrent laryngeal nerve (RLN) is often the basis for selecting the approach's side in anterior cervical spine (ACS) surgery. The question as to whether to approach the ACS from the right or from the left still remains a matter of debate.

Clinical Material & Methods: The data of 234 patients who underwent anterior cervical spine surgery by a single right-hand neurosurgeon during a nine years period were reviewed. Diagnoses included radiculopathy and myelopathy caused by soft or “hard” disc, traumas, tumors. The most common diagnosis was radiculopathy caused by herniated disc (156). In 45 patients with “hard” disc and/or spondylosis, the indication was myelopathy. 25 were operated for cervical spine traumas and 8 for primary or metastatic spine tumors. In case of unilateral radiculopathy the approach's side was from the opposite side in order to improve visualization of the disc herniation and make foraminotomy easier to perform. In case of use of mesh and cervical plate a right side approach was felt more comfortable for the right-hand surgeon. Re-operation were always performed from the opposite side. The technique of cuff pressure deflation and then re-inflation was used in 192 patients.

Results: Two hundred and thirty-eight procedures were completed. There were 160 men and 74 women, ranged from 35 years to 73 years. A right-sided approach was used in 123 procedures and a left-sided exposure in 111 procedures. There was one postoperative superficial wound infection and one deep wound haematoma. One patient had a screw dislodgement. One patient had a mesh dislodgement with revision. Mild throatache was noted for few days in 15 patients. There was only two documented RLN injury.

Conclusions: Our results support the hypothesis that the incidence of RLN injury does not correlate with the side of exposure; we believe that the use of the procedure of deflating and then re-inflating the ET cuff plays a major role in avoiding this complication. We agree, with others, that the choice of the side of exposure may be based on the side of pathology, anticipated use of instrumentation, and individual surgeon's preference.

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**POSTER PRESENTATIONS 50**

A Case Report: Early implant failure that occurred after single session anterior stabilization and secondary Halo-vest treatment failure, after delayed diagnosis. Development of severe pulmonary, septic complications and pin infection

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A case of a 57 year old female who sustained a luxation fracture C7/Th1 with incomplete quadriplegia was referred to our department after 10 days. The initial MRI was misinterpreted as subluxation von C7/Th1 and chronic cervical myelopathy. She was treated urgently with a Crutchfield extension for joint reduction. After 2 days and reduction (Ct-scan) an anterior cervical stabilization C5- Th2(discectomy C7/Th1, iliac crest bone gaff,plating) was performed. Immobilization by Philadelphia-Collar. Disorders of the patient: M. Parkinson, osteoporosis, cervical instability C3/C4. Post operatively after 8 days she developed again neurological symptoms by loosening of the plate. The patients was treated with a Halo-Vest due to the aggravation of the M. Parkinson. As a result of the Pin infection of the Halo-vest, pneumonia and subileus symptoms the conservative treatment with the Halo was stopped after 27 days. Immobilization by Philadelphia-Collar was started again. Necessity of artificial respiration and i.v. antibiotic therapy on the intensive care unit. Deterioration of ileus symptoms emergency operation, during the intubation aspiration. In the course development of sepsis. After solving the respiratory and septic problems, there was the need of plastic surgery due to the pin infection. If the conditions for conservative treatment of upper cervical spine injuries with halo fixation are right, are the clinical and radiological results good and similar in patients regardless of their age?, Is there a tendency for more complications in older people? (Review of literature). Is dorsal or combined 360° fusion superior to anterior stabilization and secondary Halo-vest treatment failure?

**OVER PRESENTATIONS 52**

Revision and retrieval of failed cervical disc replacements. Report on characteristics and early outcomes

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Cervical revision surgeries increase due to the numbers of primary procedures performed. There is scant information on indications, techniques and results of revisions for failed cervical disc replacement (ICDR) indicating deeper analysis. Retrospective review of 12 patients undergoing revision surgeries for ICDR using plated-ACDF (ACDFP). Preoperative age of patients (4xmale, 8xfemale) was 45.4±7.3(34.5-65) and 47.2±7.0(38-65.5) at follow-up(FU). Interval between CDR-procedure and revision was 20.6±16.4mo(4-57). CDR-levels were: C4-5(1x), C5-6(3x), C5-7(6x), C6-7(1x), C7-T1(1x). Preoperative lordosis-C2-7 was -19.7±7.2°(-8to-30°). 7 pat had CDR of non-constrained type (high translational ability), 4 had a rather constrained type (low translational ability). At index revision patients had 1.7±0.7(1-3) previous surgeries. We used a customized osteotomy preserving bone surrounding the fCDR while chiseling straight-forward along the fCDR. Patients were grouped whether there was radiographic instability/loosening/mechanical failure/objective pathology (Type-A,11x) or whether there was no obvious failure but pain responding to surgery (Type-B,2x). Main indications for fCDR-revision was loosening, dynamic stenosis, segmental instability, CDR-misplacement, and facet syndrome. FU was 8.6±6.4mo(4-27). Patients had implant removal, reconstruction with bone, mesh-cages and constrained-ACDFP, no corpectomies. Histologic analysis of scar-tissue surrounding fCDR showed wear-debris. No patient experienced neurologic sequel, persistant dysphagia or permanent disabilities. 7 patients (58%) were satisfied with clinical outcome, 4 very satisfied (33%) and one dissatisfied. Fusion levels: C3-6(1x),C4-5(1x),C4-6(1x),C4-T1(1x),C5-6(1x),C6-C7(3x),C6-7(1x). There were 4 complications: haematoma at iliac crest(1x), temporary rec.lyrngeal nerve lesion(1x), non-union(1x). Subsequent surgery was indicated in 3 patients including extension of fusion length(1x), non-union repair(1x),haematoma removal. All ACDFP fused with one delayed union. Cervical lordosis-C2-7 was -18.2±7.0°(-7.5to-30.9°). 7 patients had preoperative radiculopathy that resolved. In comparison to standard revisions the differences with CDR-revisions are 1) Extended & thicker scar-tissues; 2) Mobility at the fCDR-site during mobilization&retrieval of the ICDR. Notably, although some fCDRs showed no signs of radiographic loosening, intraoperative assessment revealed failed osseous integration. Patients subjected to fCDR-revision
show increased prevertebral scar-tissues. Some fCDR do not show radiographic loosening but intraoperatively lack osseous integration. Revision of fCDR is possible without need for corpectomies. Patients with radiographically normal CDR-position but recalcitrant neck pain should be critically assessed for ‘CDR-removal&revision-ACDFP’ that can confer favourable outcomes in the majority.

**POSTER PRESENTATIONS 54**

Radiological and functional comparison between arthrodesis and arthroplasty in degenerative cervical disc disease


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The gold standard technique for the treatment of cervical spine degenerative disease is arthrodesis; nevertheless the use of arthroplasty is becoming more frequent in specific cases.

**Purpose:** Compare between arthrodesis and arthroplasty techniques in single level degenerative cervical disc disease, measuring subjective health quality, function and radiological results.

**Study Design:** Retrospective longitudinal analytic study including 47 patients, 25 with an arthrodesis and 22 with an arthroplasty. Surgery was performed between January 2003 and May 2008. Patients were evaluated using the SF-36 and the Oswestry Disability Index questionnaires and with radiological outcomes, in preoperative and one year after surgery.

**Results:** The mean age was different in both groups: 50.88 in arthrodesis and 40.05 in arthroplasty. In 57.8% of the patients we found no complications or clinical complaints after surgery, being cervical pain the most frequent symptom. 69% of the cases did not recuperate their working activity. In health quality questionnaires we found a postoperative improvement of 23.48 points in SF-36 and 21.22 points in ODI after arthroplasty. Postoperative improvement after arthrodesis was 12.82 points in SF-36 and 10.27 points in ODI (p=0.085 SF-36, p=0.049 ODI). We observed no significant differences in postoperative Cobb angle, but 70% of the segments with arthroplasty were in kyphosis.

**Conclusions:** With a correct surgical indication, clinical results are similar or even better in cervical arthroplasty compared to arthrodesis. In our environment, a search for economical compensation and absenteeism from work tendency is present. More long term studies to evaluate results and complications of cervical arthroplasty are necessary.

**POSTER PRESENTATIONS 55**

Intra-operative 3D Imaging and Navigation with a new mobile device (O-Arm®)-Our experience in the cervical spine surgery

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**Introduction:** In complex cervical spine surgery computer assisted image guidance can be useful to illustrate the anatomy and to increase implant placement accuracy. However preoperative data collection by CT or MRI may not well depict the situation of the patient positioned on the OR table. We report about our experience with a new device for intra-operative 3D image acquisition and intraoperative navigation.

**Materials & Methods:** The O-Arm® (Breakaway-Imaging, Medtronic) is a mobile fluoroscopic device for 3D image acquisition. The gantry can be opened for positioning around the patient. In the operating room the O-Arm completes in a the 3D Multiplanar Reconstruction (MPR) Imaging mode a 3D spin taking almost 355 images within 13 seconds, reconstructs them and performs in connection with an navigation device (Stealth-Station®, Medtronic) an automatic registration to the patient. The digital flat panel image technology derived from current generation CT scanners is superior to the still wide spread analogous fluoroscopic devices.

**Results:** We report about our results of total number of 172 navigated screws placed in the cervical spine 28 Patients (14 male,14 female, 63 +/-15 years old range 86-11, BMI 26 +/-54 range 36-17, number of segments treated: 11x one, 1x two, 16x more). The screw placement was assessed using a 3 grade scale (accurate, minor aberration of the desired track i.e. threads outside the cortical wall and major aberrations or misplacements). The majority of 162 (93%), screws were found accurately placed the CT artefact of 6 (3.5%). Screws showed a minor but well acceptable aberration from the desired track Another 6 (3.5%) showed major aberrations from the desired position in the final intra-operative scan, two of them (1.1%) has the be repositioned during the same operation. We had no re-operations for implant repositioning and no implant related complications.

**Discussion:** The described device proved to be a reliable tool for intra-operative image acquisition and navigation in image guided spinal surgery. Specific pitfalls and intraoperative hints are outlined. The technology opens new opportunities for minimally invasive spine procedures.

**POSTER PRESENTATIONS 56**

Box-designed interbody fusion cage with autologous cancellous bone graft versus autologous tricortical iliac crest bone graft without plate fixation in the cervical spine: a retrospective study

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Anterior cervical disectomy and fusion (ACDF) without plate fixation is still the gold standard of treatment for patients with one level cervical disc herniation. Patients receiving ACDF using autologous tricortical iliac crest bone graft without plate fixation sometimes have graft bone collapse and donor site morbidity. To avoid problems with malalignment and donor site morbidity, fusion cages of different designs have been employed in the cervical spine over the last decade. We have been using a box-designed cage (Syncage-C) with autologous cancellous bone graft for ACDF without plate fixation since 2004 in our hospital. The objective of this study was to determine how box-designed cages with autologous cancellous bone grafts influence the surgical outcome of ACDF compared to ACDF using autologous tricortical iliac crest bone grafts without plate fixations. From 2004 to 2008, seven patients with cervical disc herniation received ACDF using box-designed cage with autologous cancellous bone grafts without plate fixation and were followed for more than 1 year after.
operation at our hospital (cage group). From 2000 to 2003, 7 patients with cervical disc herniation received ACDF using Smith-Robinson method with tricortical iliac crest bone graft without plate fixation (bone graft group). All patients had myelopathy. The evaluation factors for comparison of the two groups were operation time, blood loss, Japanese Orthopaedic Association (JOA) scores, fusion rate, change in lordosis at fusion level, decrease in height of intervertebral space at fusion level and adjacent level problems. These factors were compared between the two groups. Operation time, blood loss JOA scores before operation and after operation, fusion rate, change in lordosis at fusion level, and adjacent level problems were not significantly different between the groups at one-year follow up, however decrease in height of fusion level was significantly smaller in the cage group compared to the bone graft group (4.7±1.4mm, 2.6±1.1mm, respectively, p<0.05). In conclusion, subsidence of the box-designed cage was smaller than collapse of autograft bone after ACDF. Thus box-designed interbody fusion cage may prevent decrease in height of intervertebral space at fusion level after ACDF.

**POSTER PRESENTATIONS 57**

C7 preservation is not significant in maintaining cervical curvature and reducing axial pains. Comparative study of selective laminoplasty of two adjacent laminae between cases with C7 sacrificed and those preserved

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**Introduction:** The purpose of this study is to elucidate the significance of C7 preservation in maintaining cervical curvature and reducing axial pain postoperatively.

**Materials & Methods:** Since 2002, 32 patients with cervical spondylotic myelopathy (CSM) underwent selective laminoplasty of adjacent two laminae. For example, a patient with 3-level stenosis between C3/4 and C5/6 had posterior spinal cord decompression by sacrificing the extension units of the C4 and C5 spinous processes and their attached muscles (C4-5 laminoplasty). To evaluate surgical outcomes, Japanese Orthopaedic Association (JOA) scores and Visual Analog Scale were recorded for each patient pre- and postoperatively. On the lateral radiographs with the neck in neutral position, C2-7 angles were measured pre- and postoperatively according to Cobb’s method.

**Results:** Improvement rate calculated with JOA scores averaged 42.4% for C3-4 laminoplasty, 36.4% for C4-5 laminoplasty, 51.1% for C5-6, and 65.1% for C6-7. There was no statistical difference in the rate among each laminoplasty. Postoperative increase (+value) or decrease (-value) in C2-7 angles averaged -2.8° for C3-4, -0.2° for C4-5, +2.3° for C5-6, and +1.0° for C6-7. There was a statistically significant difference in the value between C3-4 and C5-6 laminoplasty (P<0.05). Average pre- and postoperative VAS scores were 1.5 and 1.5 for C3-4, 3 and 0 for C4-5, 2.4 and 0.7 for C5-6, and 1.3 and 1 for C6-7 respectively. There was no statistical difference in pre- and postoperative scores between C6-7 laminoplasty and the others.

**Discussion:** In previous papers which emphasized the significance of C7 preservation, outcomes of C3-C7 continuous laminoplasty were compared with C3-C6 laminoplasty, disregarding the number of sacrificed extension units. It is highly likely that the more the extension units are sacrificed, the worse cervical curvature and axial pain become. Selective laminoplasty minimizes the number of sacrificed units. In this study, adjacent two units were sacrificed for each case to make a fair comparison of the results between the cases with C7 sacrificed and those with C7 preserved.

**Conclusion:** C7 Preservation was not significant in maintaining cervical curvature and in reducing axial pains. Cervical curvature tended to decrease postoperatively in the cases with higher extension units sacrificed.

**POSTER PRESENTATIONS 58**

Results of Transsternal Approach to the Cervicothoracic Junction Lesions

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The surgery for lesions involving anterior column of the cervicothoracic junction is still challenging. Many different approaches have been described. Median transternal approach provides a direct approach to this junction. The aim of this study is to present results of cases who were operated using median transternal approach.

**Materials & Methods:** There were eight cases (7 male, one female) aged between 18-39 (mean 28.2). The compression was secondary to trauma in 3 cases, to infection in 3, and secondary to tumor in 2 cases. The lesion was located at T1-2 in 3 cases, at T2-3 in 2 cases, at T3-4 in 1, at T2 in 1, and T3 in one case. Median sternotomy was performed from right side in 6 cases, and from left side in 2 cases. 14 level corpectomy was performed in 8 cases. Reconstruction was performed using fibula allograft in 6 cases, and using iliac autograft in 2 cases. The mean followup duration was 104 months.

**Conclusion:** It is concluded that median sternotomy is an appropriate approach for selected cases with lesions involving anterior column of cervicothoracic junction.

**POSTER PRESENTATIONS 59**

“Safety zone concept” for a new patent-device of cervical pedicle screw placement: A morphological study of normal human volunteers

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**Introduction:** Cervical pedicle screw system (CPS) cannot obtain global standards because of their technical difficulties and potential risk of neurovascular complications. In order to solve these problems, a new patent-device has been developed for the safe and accurate CPS placement. In this study, based on a morphological analysis of normal human volunteers, the safety zone and ideal aiming point of the patent-device are clarified in order to improve the precision and safety of CPS placement.

**Materials & Methods:** This study comprised 55 healthy human volunteers (33 males and 22 females), who were evaluated with computer tomography. Total of 220 vertebrae and 440 pedicles were
POSTER PRESENTATIONS 60
Comparison of BAGUERA-C Cervical Disc Arthroplasty with ACDF with cage FIDJI or Methyl-methacrylate. Two years radiographic results
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Objective: To assess the safety and efficacy of cervical disc arthroplasty using a new arthroplasty device at 24-months follow-up.
Methods: The last two years (2008-2009), 78 patients underwent a single-level anterior cervical discectomy and decompression. Forty (40) of them received the investigational device (BAGUERA-C) and thirty-eight (38) cage FIDJI or Methyl-methacrylate. All patients were followed-up radiographically at 6 weeks and 3, 6, 12, 24 months postoperatively.
Results: Analysis of the radiographic data shows that intra and postoperative complications were similar for the two groups. One patient needed a secondary surgical procedure due to implant (cage) transposition. Mobility of the investigational device (BAGUERA-C) was satisfied in all patients.
Conclusion: Cervical disc arthroplasty with BAGUERA-C device is a viable alternative to ACDF in patients with persistently symptomatic, single-level cervical disc disease. The possibility of minimizing adjacent segment degeneration by using the mobile disc still needs a long term following-up period.

POSTER PRESENTATIONS 61
Anterior Cervical Fusion with Peek cage (FIDJI) in the treatment of degenerative disc disease. Radiographic observations in 319 patients with a 2-year mean follow-up
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Objective: To determine the safety and efficiency of FIDJI cage for ACDF.
Methods: During a 7-year period (2003-2009), 319 patients had an ACDF at 442 levels between C3 and C7. All operations involved one, two, three, or four disc spaces for degenerative disc disease. We implanted all disc spaces with FIDJI cage containing bone substitute DBM. All patients were evaluated radiographically after 6 weeks, 6, 12 and 24 months postoperatively.
Results: All patients with radicular pain had excellent outcome. We had no cage transposition and the cervical fusion rate was 100% at one-year follow-up.
Conclusions: FIDJI cage appear to be safe and efficient for ACDF. With the right indications we have the best results.
the device must be continued in order to improve its accuracy and safety.

**POSTER PRESENTATIONS 63**

Upper Cervical Spine Surgery with an Intraoperative 3D Imaging and Navigation System

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**Purpose:** It is important to be able to avoid serious complications, such as vertebral artery damage, spinal damage, when inserting screws during surgery to treat diseases of the upper cervical spine. We assessed the usefulness of a 3D imaging and navigation system for surgery to the upper cervical spine.

**Methods:** We entered by a posterior approach that preserved the semispinalis cervicis muscle, and performed occipitocervical fusion or atlantoaxial fixation. We performed safer and more stable fixation by using a 3D imaging system (ARCADIS Orbic 3D, Siemens) coupled with a navigation system (StealthStation TRIA, Medtronic Sofamor Danek) when inserting screws into the axis.

**Results:** There were 14 subjects: 2 with a retro-odontoid mass, 8 with atlantoaxial subluxation, and 1 with vertical atlantoaxial dislocation. Occipitocervical fusion was performed to treat the cases of retroodontoid mass and the case of vertical atlantoaxial dislocation, and the Mageerl and Brooks method was selected to treat the cases of atlantoaxial subluxation. There were no surgical complications in any of the cases, and their postoperative course was favorable with rapid improvement in the neurological symptoms. A total of 28 screws had been inserted: 8 into vertebral arches, 10 into the atlantoaxial joint, 8 into pedicles of vertebral arches, and 2 in lateral masses. The screw failure rate of 0%

**Discussion:** Vertebral artery damage or spinal damage in surgical operations on the upper cervical spine can be fatal. Moreover, because the spinous process of the axis lies at the center of the posterior supporting tissue, excessive invasion is a cause of posterior arch degeneration and neck pain. As a result of the combined use of the intraoperative 3D imaging and navigation system, intraoperative registration was unnecessary in this series of 14 cases, and it was possible to insert screws into the axis without invasion of the semispinalis muscle. This system appears to be useful as a means of increasing the safety and reducing the invasiveness of surgery on the upper cervical spine.

**POSTER PRESENTATIONS 64**

24 month prospective results of a New Cervical Staple in Anterior Cervical Discectomy and Fusion: Quality of life and fusion

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**Background Context:** Anterior cervical discectomy and fusion (ACDF) is currently the most used technique in cervical surgery. Arthrodesis is generally obtained with an intersomatic spacer secured using a screwed osteosynthesis plate. A new cervical compressive staple has been developed to maintain the position of the spacer and to increase bone fusion while maintaining dynamic compression.

**Purpose:** To evaluate clinical and radiological results of a new cervical staple.

**Study Design:** Prospective multicenter non comparative study. Patient Sample: 82 patients from 5 centers with single level cervical disc herniation and cervicobrachial neuralgias were included.

**Outcome Measures:** Neck Disability Index score (NDI), Visual analogic pain scales (VAS) and SF-12 as well as functional outcome (odom) and patient satisfaction were reported. Radiographic examinations were used to assess fusion.

**Methods:** All patients were treated with an ACDF using a PEEK spacer secured by the compressive staple. Preoperatively and at follow-up, radiographic control and clinical evaluation were done and each patient has completed self-questionnaires (NDI, VAS, SF-12 and satisfaction).

**Results:** The mean operating time was 35min. At last follow-up: 90% of the patients had a solid fusion; Mean NDI score was significatively improved by 20.2 preoperatively to 6.6; Mean Neck and Arm pain were significatively improved by 6.1 and 7.0 to 1.8 and 2.2 respectively; Mean SF-12 PCS and MCS scores were significatively improved by 37.0 and 38.4 to 48.9 and 30.9 respectively; 91% are satisfied by the surgery and 89% had a successful functional outcome. On the 82 patients: 1 had a peroperative vascular lesion and 1 had a transient dysphagia, without consequences; 3 patients experimented an implant-related event (2 breakage and 1 minor back-out) without clinical consequence or revision (all patients reported no complains and had solid fusion); 2 revision surgeries were required for pseudarthrosis and 2 additional surgeries for a degeneration at adjacent level.

**Conclusions:** Patients presented solid fusion with significant pain relief and improvement of their quality of life. Compared to previous data, success rates and occurrence of complication were similar. The staple seems to provide a safe and effective new way to secure an intersomatic spacer with a reduced surgical time.

**POSTER PRESENTATIONS 65**

Anterior transarticular C1-2 fusion in atlanto-axial instabilities. 2 year-results of a considerate procedure in elder patients

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**Purpose:** In spite of a high primary instability it holds risks to injure the A. vertebrais as well as neurological structures. Furthermore the posterior approach of the upper part of the cervical spine requires a huge and traumatic preparation of the soft tissue. However the anterior transarticular C1-2 fusion (ATF) is less traumatic and offers almost the same strength of the stabilisation.

**Methods:** Since the 01/2007 22 multimorbid patients with atlantoaxial instabilities of different entities were treated via the ATF, were regular examined radiologically (x-ray/CT) and the procedure critically judged.

**Results:** C1-2 fusions were performed in 22 patients (17f, 5m, Ø 81,67 years). Main symptoms was pain radiating in the upper cervical spine and the occiput, 2 Patients complaining radiating pain with paraesthesia. The average operation-time took 64,5 min. Leftside the screws of Ø 39,5mm (32-44mm), rightside of 36mm (32-44mm) were inserted in addition to the point of access and the angle of insertion (mediolateral angle Ø 32,0°, ventrodorsal Ø17,6°). No intraoperative...
complications occurred, one revision had to be done because of p.o. bleeding, one because of screw dislocation. Postoperative x-ray and CT control of the upper cervical spine showed 30/44 screws in 22 patients in correct position. 8 (18.2%) screws were too long, 3 (6.8%) screws were placed too anterior and 3 (6.8%) too medial. 8 additional positioned dens-screws were in correct position. After a clear learning curve both screws of the 6th patient were postoinated correct. Two aspects are important for success: Correct entry point and right insertion of the angle in the coronal and sagittal view. A low intraoperative blood loss, a non traumatic access as well as an immediate pain decrease have to be valued positively for this procedure.

Conclusions: The gentle procedure of the ATF requires - despite of the huge experience in anterior surgery of dens fractures - a learning curve, because of the more proximate insertion point, the flat insertion angle and the closeness of the A. vertebralis. If these aspects are going to be noticed, failed screw positioning and excessive length as well as injuries of the A. vertebralis can be avoided.

**POSTER PRESENTATIONS 66**

Novel technology for posterior cervical fusion with tension band principle
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Introduction: In the past years tension band wiring has been universally accepted for achieving C2/C6 arthrodesis. At this time multiple methods have been proposed for posterior cervical fusion (PCF) but they may present high risk of complications, are technically complicated or require special instrumentation. There are just singular reports about using of ceramic implants for PCF. None information was found about interpolation of tension band principle to subaxial cervical lateral mass wiring in conjunction with corundum ceramic implants for arthrodesis. The purpose of this paper is to evaluate the safety and efficiency of a novel technique, which allows for a combination of screws, tension band lateral mass wiring and corundum ceramic implants, in patients with injuries and disorders of the cervical spine.

Materials & Methods: A total of 12 patients at the age ranging from 18 to 57 were enrolled in this study, including 9 male (75%), and 3 female (25%) patients. A novel technique for PCF was developed providing combined use of corundum ceramic implants and lateral mass screwing and wiring in accordance with tension band principle. All patients were treated surgically by means of this novel technology. In 6 (50%) patients was performed one-level PCF, in 5 (41.7%) - bi-level PCF and in 1 (8.3%) - multi-level PCF. Among these patients in 3 (25%) ones decompressive laminectomy was performed. Nine (75%) patients were treated with PCF alone, and 3 (25%) with circumferential fusion. A total of 39 screws and ceramic implants were inserted into lateral masses according to the developed technique. Dynamic X-rays and Odom’s criteria were assessed. Maximum follow-up period made 83 months.

Results & Discussion: No cases of surgical complications related to screwing, wiring or arthrodesis with ceramic implants were recorded in early and late postoperative period. Fusion occurred in 100% patients. Odom’s criteria revealed good/excellent outcomes in all cases.

Conclusion: The novel technique is easy to handle, it does not require the use of bulky instrumentation or complicated PCF techniques. It trolled restoration of segmental cervical sagittal contour. The assessment of clinical application of this technique proves its safety and efficiency.

**POSTER PRESENTATIONS 67**

SWISSpine: governmentally mandated HTA-registry for total disc arthroplasty; Methodology and results of 925 cervical disc prostheses in 808 patients

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Introduction: The Swiss federal office of public health required a mandatory nationwide HTA-registry for cervical total disc arthroplasty (TDA), amongst other technologies, to decide about reimbursement of these interventions.

Objective: The goal of the SWISSpine registry is to generate evidence about the safety and efficiency of these medtech innovations.

Methods: From 3.2005 until 6.2008 808 interventions with implantation of 925 discs from five different suppliers were performed. Surgeon administered outcome instruments were primary intervention, implant and follow-up forms; patient self-reported measures were EQ-5D, COSS, and a comorbidity questionnaire. Data is recorded perioperative, at 3months and 1year postoperative, and annually thereafter.

Results: There was significant and clinically relevant reduction of neck (preop/postop 59.3/24.8 points) and arm pain (preop/postop 64.9/17.6) on VAS and a consequently decreased analgesics consumption. Similarly, quality of life improved from preop 0.42 to postop 0.82 points on EQ-5D scale. There were 4 intraoperative complications and 23 revisions during the same hospitalization for 691 monosegmental TDAs and 2 complications and 6 revisions for 117 two-level surgeries. A pharmacologically treated depression was identified as important risk factor for achieving a clinically relevant pain alleviation >20 points on VAS. Two-level surgery resulted in similar outcomes compared with the monosegmental interventions.

Conclusions: Cervical TDA appeared as safe and efficacious in short-term pain alleviation, consequent reduction of pain killer consumption and in improvement of quality of life. A clinically relevant pain reduction of 20 points was most probable if patients had preoperative pain levels >40 points on VAS. A pharmacologically treated depression and two-level surgery were identified as risk factors for less pronounced pain alleviation or quality of life improvement.

**POSTER PRESENTATIONS 68**

Anterior Cervical Reconstruction using height-variable Titanium Implant

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Object: During the surgery of anterior fusion after the cervical corpectomy, several kinds of material are used for cervical reconstruction. There were many reports that mentioned complications of autogenous bone from iliac crest. On the other hand, in some implants for cervical corpectomy, it needs some effort to apply the implants because there is
not always just adjusted to the size in each case. In the present study, we evaluated the safety and efficacy of using anterior distraction device (ADD/ADD plus) which is a height adjustable titanium cylindrical implant.

Materials & Methods: Anterior corpectomy was performed in 55 patients (men/ women: 37/18 patients) in this study, including 41 patients with cervical OPLL, 9 patients with cervical spondylitis, 4 patients with cervical schwannomas, and one patient with cervical spinal arteriovenous fistula. Twenty-nine patients underwent a one corpectomy, and four patients did two corpectomy. Following the corpectomy and decompression of spinal cord, we implanted ADD or AD plus that allows in situ distraction during surgery. Anterior cervical corpectomy and decompression of spinal cord, we implanted ADD or corpectomy, and four patients did two corpectomy. Following the corpectomy and decompression of spinal cord, we implanted ADD or AD plus that allows in situ distraction during surgery. Anterior cervical plate was also implanted too, when used ADD.

Results: Follow-up observation ranged from 6 to 105 months, with a mean of 31.9 months. The Neurosurgical Cervical Spine Score (NCSS) was improved from 8.8 to 11.5 on average. In the radiographic analysis, the cervical lordotic angle in X-ray films was improved from 5.46° to 8.91°. The number of cases with implant subsidence more than 3 mm was 19 cases (34.5%), none of them were needed for second surgery. As a complication, there were 3 transient C5 palsy and 2 plate failure; one of them was removed 3 months after the surgery. There was no implant extrusion or pseudoarthrosis after surgery.

Conclusion: The greatest advantage of the ADD/ADD plus is that these can be adjusted to the size of the corpectomy in situ. Although longer follow-up is needed, we concluded that the use of the ADD/ADD plus following the cervical corpectomy seems to offer less invasive surgery with satisfactory stability.

POSTER PRESENTATIONS 69
The reliability and accuracy of cervical pedicle screw placement using intraoperative 3D image based navigation: A comparative study O-arm based navigation with Iso-C3D based navigation
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Introduction: Cervical pedicle screw (CPS) fixation offers greater biomechanical stability and increases fusion rates, but carries the risk of serious neurovascular injury because of the proper anatomy of cervical spine. The O-arm is a new computer-assisted surgical device that allows CPS navigation and placement with full intraoperative 3D images in high definition. The goal of this study was to retrospectively compare the reliability and accuracy of CPS placement using the O-arm navigation system with the 3D-fluoroscopy (Iso-C3D) navigation system.

Methods: A total of 56 consecutive patients undergoing posterior stabilization of the cervical spine between December 2006 and December 2009 were reviewed. The 32 patients (150 screws) were treated using CPS placement based on intraoperative 3D images with Iso-C3D, whereas 24 patients (122 screws) treated with O-arm. All screw positions were classified into 3 grades with regard to pedicle wall perforations using postoperative CT.

Results: There were 2 patients of intraoperative injury to vertebral artery (VA) in which the pedicle probe penetrated it in Iso-C3D group, further VA-related complications did not occur throughout the follow-up period. The rate of perforations classified as Grade 2, CPS breached and >50% of the screw diameter was outside the pedicle, was 5 screws (4.0%) in O-arm group and 5 screws (3.3%) in Iso-C3D group (P=0.74), and no screw was classified as Grade 3, perforation more than 4mm (complete perforation).

Conclusion: O-arm have higher resolution image and can keep surgical area clean more easily than Iso-C3D. CPS placement with O-arm based navigation can offer high reliability and accuracy as well as that of Iso-C3D. Although each system could reduce the risk of complications related to CPS malplacement, but there are potential risk of significant CPS malplacement may occur VA injury even if intraoperative 3D image based navigation.

POSTER PRESENTATIONS 70
One stage transoral decompression and posterior stabilization of the craniovertebral junction
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Objective: To review our experience with the transoral surgical management of fixed anterior craniovertebral junction (CVJ) lesions, with particular attention to the decision making and to the indication for a consecutive stabilization.

Materials & Methods: Retrospective study (2000-2009) of 22 consecutive patients (10 male-12 female). Mean age was 59.2 years (range 32-80 years). Encountered lesions were: rheumatoid arthritis with pannus (12), 4 of which with associated cranial settling, ankylosing spondylitis (2), tumors (3: 2 extradural cordomas and 1 metastasis), odontoid fractures with hypoplasia and rotational instability (3). Patients presented with a variety of symptoms: high cervical pain (82%), varying degrees of quadriplegia (64%), lower cranial nerve deficits (23%), central cord syndrome with neurogenic bladder (14%). All patients underwent one stage transoral decompression and consecutive posterior atlanto-axial axialization (C1-C2 either Harms or Magerl technique-modified Sonntag) of the CVJ. Clinical evaluation was made pre- and post-operatively using the Ranawat score. Follow up period ranged between 6 and 48 months (average 22 months).

Results: According to the Ranawat score, we had 10 grade I patients, in all of which pain was eradicated, 5 grade II patients, 4 of which passed to grade I, 5 grade IIIA patients, of which 3 passed to grade I and 2 to grade II, and 2 grade IIIB patients that passed to grade IIIA. In 3 patients the transarticular screws crossed the anterior cortex of the atlas, without clinical manifestations. In 2 patients, complete reduction of the C1-C2 rotation was not possible, due to the chronic nature of the defect. Surgical morbidity occurred in 3 cases (1 dural tear, 2 occipital wound infections). There was 1 perioperative exitus (dural rupture, pneumoencephaly, meningitis, massive pulmonary embolism).

Conclusions: Successful and stable decompression of the CVJ requires extensive preoperative evaluation, appropriate tailoring and adequate expertise. The transarticular C1-C2 fixation is a safe and effective stabilization method. Complications appear mostly in patients with rotational deformity of the C1-C2 complex. Patients with clinical and radiological findings of myelopathy improve less even if surgery is successful.
Anterior reconstruction of cervical kyphotic deformity in patients with multiple discogenic disease

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Objective: Subaxial cervical deformities most often occur in the sagittal plane, primarily as kyphosis. In the current study we address the issue of multilevel discogenic disease as a cause of kyphotic deformity, as well as its management by means of ventral approach.

Materials & Methods: Retrospective (1998-2009) outcome analysis regarding 45 consecutive patients with multiple cervical discogenic disease (>2 levels) and associated kyphotic deformity. Male to female ratio was 21/24. Mean age was 52 years (range 35-72 years). 15 patients had already undergone a previous operation (mainly Cloward discectomies) in the past. All patients presented radicular signs, and the vast majority (33/45) also presented myelopathic signs. 82% complained of chronic mechanical pain. All patients underwent anterior cervical discectomies with removal of posterior longitudinal ligament (PLL) and osteophytes and fusion with PEEK cages (ACD-F). A dynamic plate and screw system strengthened the construct and helped restore the lordotic curvature. In 12 cases of severe spondylotic myelopathy, ossified PLL (OPLL) or failed previous ACD-F a corpectomy had to be performed as well (single level in 8 cases, 2-level in 4). The follow up period ranged from 8 to 36 months.

Results: 38 patients (84.4%) showed a good or excellent outcome, 4 fair (8.8%), and 3 poor (6.6%). The final plain radiographs showed improved cervical lordosis in all but 3 cases. Preoperative lordosis C2-7 was 6.7 degrees in average, postoperative 14.4 degrees in average. Fusion was achieved in all cases (delayed in 3). 2 screws broke and 1 plate was misplaced obliquely (excessive anterior osteophytes). The complications included temporary hoarseness in 2 cases, CSF leakage in 1 case, and temporary nerve root palsy in 1 case.

Conclusions: In flexible c-spines (no ankylosed or fused facets), anterior-only instrumentations following segmental decompressions or use of the hybrid technique with discontinuous corpectomies can avoid the need for posterior supplemental surgery in multiple level surgeries.

Recruitment pattern of dorsal neck muscles investigated by tissue velocity ultrasonography imaging

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More knowledge about activation patterns in the dorsal neck muscles in different clinical situations is needed. This study investigated the recruitment pattern of the dorsal neck muscles at C4 segmental level in seated position in healthy people during manual resistance of the head in extension. Fifteen healthy young adults were included. Doppler based tissue velocity imaging (TVI) ultrasonography makes it possible to investigate regional tissue activity and thus, inter-muscular coordination. Semispinalis muscles and especially Capitis have high strain and strain rate (SR) during the exercise. Trapezius was the muscle with the lowest strain and SR. The SR in all muscles, except for Trapezius decreases from the initial contraction phase to the plateau phase. For strain the relationship were inversely with higher muscular deformation in the plateau phase. The deep muscles, Semispinalis Cervicis followed by Multifidus and Semispinalis Capitis was first to be recruited when exercise started. TVI provides detailed information of regional tissue activities and coordination patterns among dorsal neck muscles which can be scrutinized. In future studies it will be necessary to match data from patients with neck disorders to data from healthy volunteers in different situations and activities. Key words: Neck muscles, Tissue velocity imaging, Ultrasonography, Recruitment pattern.

Recruitment pattern of ventral neck muscles investigated by tissue velocity ultrasonography imaging

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Study design: Experimental study.

Objective: To investigate the recruitment pattern of the ventral neck muscles; sternocleidomastoid (SCM), longus capitis (Lca) and longus colli (Lco) at C4-C5 level in healthy volunteers, during isometric manual resistance of the head in flexion in seated position.

Summary of background data: The exercise is used in the
physiotherapeutic treatment of neck pain and is assumed to activate the deep ventral muscles. Today there is no knowledge if that assumption is true.

Methods: Neck flexors of 16 healthy volunteers (mean age 24 years, SD 3.7) were measured with ultrasonography (US) with strain and strain rate (SR) tissue velocity imaging (TVI) during isometric contraction of flexor muscles. TVI uses the Doppler method to study tissue dynamics.

Results: All three muscles show a deformation compared to rest. Except for the initial contraction phase, Lco had lower strain than Lca and SCM, but was the only muscle with significant change in SR between the phases. When the beginning of the contraction phase was analyzed, Lco was the first to be activated among most volunteers, followed by Lca and thereafter SCM.

Conclusion: The exercise investigated seems to be useful as a “stabilising” exercise for Lco. Our suggestion is that Lco and Lca in further research should be investigated as separate muscles. TVI could be used to study coordination between the neck flexors with the possibility to separate Lco and Lca.

Keywords: Neck muscles, Ultrasonography, Coordination, Recruitment pattern

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Single Use of Antimicrobial Prophylaxis and Postoperative Longitudinal Glucose Level in Cervical Laminoplasty
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Introduction: The administration method of antimicrobial prophylaxis (AMP) is controversial in spine surgery. We started a protocol of single use of AMP from 2004. On the other hand, diabetes and postoperative hyperglycemia were pointed out as high independent risk factors. However little is known about time course changes of postoperative glucose levels. The purposes of this study were to report the effectiveness of our AMP protocol and the longitudinal postoperative glucose levels in cervical laminoplasty.

Methods: From 2004 to 2008, 78 patients underwent cervical laminoplasty, 61 male and 17 female, for CSM in 63 patients, ossification of posterior longitudinal ligament in 15 patients, and RA in 3 patients. The average age was 62.7 years old (36 to 82), and 30 diabetic patients were included. Our AMP protocol was used in all patients regardless of health status. In our protocol, 1g cefazolin sodium was given in the half-hour before the incision. We monitored fasting plasma glucose (FPG), C-reactive protein (CRP) and creatine phosphokinase (CPK) for two weeks postoperatively. Sliding scale managements were performed to hyperglycemia patients. Non-diabetic patients were divided according to the maximum postoperative FPG value into two groups, over 126 mg/dL (group A) or less than 126mg/dL (group B), in order to detect a related factor for hyperglycemia (FPG value of 126mg/dL is defined as diabetes border line by WHO).

Results:SSI occurred in one patient (1.3%), and no other patients had infections. FPG of diabetic and non-diabetic patients peaked during first postoperative 3 days and decreased gradually. Group A was consist of 12 patients (25%). The age and maximum CRP value of group A (n=12) were significantly higher than those of group B (n=36). There were no significant differences in CPK and gender between group A and B.

Conclusions: Our protocol of a single use of AMP was acceptable in cervical laminoplasty. We should pay attention to glucose level during first 3 days. This study also revealed that a quarter of non-diabetics patients (group A) became postoperative hyperglycemia. They were older, and they showed stronger inflammation reaction than non-hyperglycemia patients (group B).

POSTER PRESENTATIONS 76
Effect of Gender on Neck Muscle Locations
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Introduction: Females demonstrate higher susceptibility to traumatic cervical spine injuries in automotive collisions. Although the mechanism for this disparity remains ambiguous, anatomical characteristics may play a role. In particular, differences in neck muscle size and orientation may lead to males being more capable of actively resisting inertial loading of the head-neck complex.

Methods: MRI scans were obtained for the neck region in six male and three female volunteers seated in an upright position to ensure proper spinal orientation allowing gravity to load the head-neck complex. Three-millimeter scans obtained at the mid-intervertebral disc height were oriented parallel to the disc space at C4-C7 levels. Cross-sectional area and centroid position in polar coordinates of the sternocleidomastoid, longus colli, levator scapulae, and trapezius muscles were computed. Radius was measured from the disc center to the muscle centroid. Angle was measured from zero degrees, defined by a line extending anteriorly from the center of the disc. ANOVA determined significant differences (p<0.10) in cross-sectional area, radius, and angle based on gender.

Results: Cross-sectional areas for sternocleidomastoid, levator scapulae, and trapezius were significantly larger in males. Centroid radius was significantly longer in males (Figure 1). Centroid angle was not significantly dependent on gender.

Discussion: Because cross-sectional area is associated with maximum contractile force, increased muscle areas are indicative of an increased ability to stabilize the head-neck complex during static and dynamic events. It is generally accepted that deep neck muscles are responsible for static stabilization, whereas superficial muscles dynamically stabilize the head-neck complex. Therefore, greater cross-sectional areas in superficial muscles for male subjects may be particularly important for occupants in automotive environments subjected to head-neck inertial loading during collision. Additionally, greater centroid radii in male subjects results in a greater moment-generating capacity, a greater ability to stabilize the head-neck complex, and a decreased likelihood of longitudinal dysfunction. Figure 1.

Table 1: Mean neck muscle cross-sectional areas (mm2) for males (M) and females (F).

POSTER PRESENTATIONS 77
Delayed diagnosis of a disrupted persistent anterior synchondrosis of the atlas ring in an adolescent. A case report and review of literature
C1 exhibits 3-synchondroses synostosing at age 7-10. Few adolescents reveal delayed/ no closure of the synchondroses (congenital atlas clefts, CAC). After trauma these clefts can mimic fractures causing difficulties with correct interpretation of the injury severity, determination of stability and treatment. Therefore, in light of a case report and review of literature we highlight a diagnostic and treatment strategy used for patients with CAC. A 16-years-old boy complained about slight neck pain & stiffness after falling onto his head during judoka. Biplanar cervical radiographs revealed no instability C1-2, incongruence or fracture. The patient showed minor reduction of ROM but no neurologic deficit. He was given analgesics for neck pain. Because of persistent pain at 4 days (increasing with compression) he introduced at the spinal clinic. Subsequent MRI-scans revealed signaling comparable to sprain/disruption of a persisting anterior atlas synchondrosis with prevertebral haematoma along the longus colli muscle. Flexion-extension views showed sagittal stability C1-2 while review of trauma radiographs revealed a posterior arch cleft. The subsequent CT-scans showed a gapping anterior C1-cleft of 6mm and a non-displaced posterior midline cleft. There were no signs of acute or old fractures. Due to anterior widening with injury positive MRI-signaling, isolated disruption of the anterior synchondrosis was diagnosed. With congruent alignment in coronal and sagittal plane and no signs of translational instability C1-2 the patient was treated with semi-rigid collar for 4 weeks. Follow-up MRI- & CT-scans at 3 months documented decreased T2-signals at the anterior synchondrosis, no calcification at or further gapping of the anterior. Patient resumed athletic sports at 4 months. At 1-year follow-up revealing further decreased MRI-signal intensity at the C1-cleft with patchy signal voids. Flexion-extension views showed stable, congruent C1-2 complex, patient was pain-free. Anterior CAC are rare, differentiation of varying grades of ligamentous injury (sprain-disruption) remain difficult. Identification of vertebral anomalies, e.g. posterior CAC, in a symptomatic trauma patient but with frank radiographs should prompt extended diagnostics. Stability with rupture of an persisting C1-synchondrosis depends on congruence C1-2 in sagittal and coronal plane provided by the remaining ligamentous stabilizers at C0-2 that serve for vertical & sagittal stability. Non-surgical treatment was sufficient in the current case.

POSTER PRESENTATIONS 78

Significant explained variance in cervical spine surgery outcomes by novel behavioral and attitudinal factors
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Background Context: It is generally expected that patient demographic and negative behavioral indicators influence the well-being of cervical spine surgery patients in the years after surgery. In addition to factors such as smoking status, body mass index, and worker's compensation (WC) status, it may be worthwhile to evaluate other lifestyle and attitudinal factors.

Design and Purpose: This cross-sectional observational study of 63 patients from an active spine surgery practice sought to compare explained variance in quality-of-life (QOL) outcomes in cervical spine surgery patients in standard versus heretofore-unexplored lifestyle and attitudinal factors. Lifestyle factors included exercise and commuting practices, and attitudinal factors included altruistic social interest behaviors. Patients (stenosis n=36 and spondylosis n=47) had undergone surgery on average 2.3 years ago (range 0.21 to 4.6 years) with a mean age of 59 years; over half were working and female.

Measures: Neck Disability Index (NDI); Physical Component Scores (PCS) and Mental Component Scores (MCS) from Rand-36; PROMIS Pain Impact Scale; NRS Pain Scale; Katz Co-Morbidity Index; and the Schwartz Altruism Measure. Methods: Internet study using Dillmans Tailored Design Method. Univariate regressions were used to estimate explained variance.

Results: Mean plots suggested that cervical spine surgery patients improved substantially over time, but were still functioning below the population mean PCS at 3+ years post-surgery (mn PCS=40.9). Among the standard factors examined, significant variance in QOL outcomes was explained by age, smoking, WC status, being employed, and presence of co-morbidities (R2 range 0.05 to 0.23). Among the hypothesized lifestyle and attitudinal factors examined, significant variance in all QOL outcomes was explained by hours spent commuting and engaging in regular aerobic exercise practice (R2 range 0.09 to 0.23). Significant variance in mental health was explained by attitudes and behaviors related to engaging in regular altruistic practice (R2 range 0.06 to 0.09).

Conclusion: We conclude that cervical spine surgery outcome research should include other lifestyle and attitudinal factors in the study design to enhance the personal and salutogenic relevance of the research. Time spent commuting, exercise practice, and altruistic practice appear to be relevant factors.

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Translational Cervical Plate Fixation: An Evaluation of Compression Rate and Timing
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Design: Retrospective review of a single surgeon patient population operated with translational anterior cervical plate fixation.

Objective: To evaluate the adequacy and timing of cervical plate compression using radiographic data from plates extending 2 or 3 levels.

Background: Developments in anterior cervical spine plating have supported the use of translation plates which allow for axial motion of the plating system and utilize Wolff's law by compressing the graft as healing occurs, thereby promoting bone healing.

Methods: The superior and inferior articulations of 21 unidirectional translation plates spanning a distance of 2 or 3 cervical levels were examined to determine compression of plating as related to the following variables: sex, age, radiographic measurement of closure from surgical intervention, and surgical correction performed.

Results: This sequential series of a 17 month interval consisted of 14 females (66.6%) and 7 males (33.3%) with an average age of 54.05 years ± 10.49 [34, 75]. The mean length of plating was 44.74 mm ±
World Spinal Column Journal, Volume 1 / No: 3 / September 2010

8.69 [35, 65]. Plating was performed from C3-C7 and averaged 2.28 levels. Surgical interventions included corpectomy only (C) (n = 3), interbody device (I) (n = 12), or corpectomy + interbody device (C+I) (n = 6). There was a significant difference between the surgical groups (p < 0.0131, Fisher's exact test) with C + 1 plates compressing 83.33% overall at the superior end. Inferior compression in all plating systems occurred more frequently in males (p < 0.0237, Fisher's exact test) than females. Superior ends closed 42.9% of the time (9 of 21) and inferior 47.6% (10 of 22). All of the construct closures were visualized at or before 12 weeks post op.

Conclusions: Compression rates were higher in corpectomy + interbody surgical interventions. Overall men closed inferiorly more frequently than women and all translations occurred at or before 12 weeks post op.

POSTER PRESENTATIONS 80
Prognosis after occipito-thoracic fusion for patients with mutilating-type rheumatoid arthritis
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Objectives: To evaluate the prognosis after occipito-thoracic fusion for patients with mutilating-type rheumatoid arthritis (RA).

Summary of Background Data: Mutilating type RA patients have the most destructive cervical spine lesions and the severe general condition. For such cases, we have performed occipito-thoracic fusion since 1991. Few studies have reported the prognosis of those patients treated by occipitothoracotomic fusion.

Methods: The subjects were 50 RA patients with myelopathy (47 female, 3 male; mean age 62.5 years). The mean history of RA was 24 years (range 3 to 51). All patients had preoperative neck-occipital pain and myelopathy. Neurologic status was assessed by Ranawat's classification. The mean follow-up period was 44 months (range 9 to 74), except two cases that died within postoperative six months. In these cases, the change of neurologic status and prognosis were investigated.

Results: The neurologic status before surgery assessed as IIIB in 36 patients, and non-IIIB (II+IIIA) in 14 patients, and improved after surgery: IIIB in 19 patients, and non-IIIB in 31 patients. Of 36 patients with class IIIB, 17 patients improved to be able to walk (47%). 24 of 50 patients died one month to 10 years (average, 3.5 years) after surgery. The average age at death was 64 years (range, 51-83 years). The survival rate was 62% 5 years after surgery, and 35% in the 10 years. The survival rate of the patients who were assessed as non-IIIB (II+IIIA) after surgery was 73% 5 years, and 63% in the 10 years, and who were assessed IIIB was 47% 5 years, and 11% in the 10 years. The causes of death among the patients were respiratory failure in 7 cases, sepsis in 4 cases, digestive tract hemorrhage in two cases, heart disease in three cases, a cerebral infarction in one case, a lung cancer in one case, and sudden death of an unknown cause in 6 cases.

Conclusion: The findings lead to the conclusion that occipito-thoracic fusion for such severe patients is useful for improving prognosis. It is necessary to undergo surgery while patients can still walk for a better chance of survival.

POSTER PRESENTATIONS 81
Impact of titanium box cage dimensions for postoperative subsidence after anterior cervical interbody fusion
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Background: Subsidence is a problem after cervical anterior fusion surgery using titanium cage, since it leads to deterioration of sagittal balance. In our previous study, the facts as below were clarified: subsidence rapidly proceed within one month; local kyphosis also proceed within one month in subsidence cases; anterior lower aspect of cage is significantly frequent of subsidence; and significantly frequent at C6/7 level. Although the cause of significance at C6/7 is not clear, due to relative small squares of cage, i.e. large squares of vertebra. In this study, influence of cage dimensions is assessed.

Materials & Methods: Large dimensions titanium box cage (McageSR wide, Amtec, Japan; prototype) has been available since January 2008. It has 15% larger area than traditional Mcake SR cage. Until June 2009, 12 cases fusions including C6/7 were performed. Traditional size cages were used for 5 cases, and large dimensions cages for 7 cases. The selection depends on width of C6/7 space. Control group was 15 cases of C6/7 fusion treated in 2006 and 2007. Lateral cervical radiograph of pre-operation, immediately, 1month, 3months and 6months postoperation were evaluated for depth of subsidence. Subsidence greater than 2mm was considered as significant (SS(+)), less- and more than 4mm was determined as moderate and severe, respectively.

Results: Subsidence observed in 6/12 and 10/15 cases in study and control group, respectively. Serial depth of subsidence was 0.17±0.49mm, 1.51±1.47mm, 1.82±1.65mm and 2.27±1.83mm in study group, and 0.27±0.67mm, 1.94±1.35mm, 2.34±1.61mm and 2.89±1.53mm in control group. There was no significant difference in both groups.

Conclusion: Cage dimensions didn't alter the course of postoperative subsidence. Our study does not support the hypothesis relative small dimensions is responsible for frequent subsidence at C6/7 level. C6/7 is border between cervical lordosis and thoracic kyphosis. Steep angle to horizontal plane is one of possible reason for this significance.

POSTER PRESENTATIONS 82
Intraoperative TcMEP and EMG changes of the adjacent level in anterior cervical discectomy. Analysis of 38 patients.
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Objective: To determine if at the cervical disc disease, the early correlation between intraoperative transcranial motor evoked potentials (TcMEP) or continuous electromyography (EMG) changes during anterior cervical approach and clinical outcome using the VAS and ODOM scale, associated with the adjacent level.

Methods: In this study were evaluated 38/51 patients (in 13 cases the intraoperative monitoring had not any diagnostic value because of inappropriate anaesthesia) that underwent microdiscectomy and fusion with cages for cervical disc herniation. We prospectively evaluated TcMEP s/EMG for preservation of the descending motor
pathways not only at the levels with defect but also at the adjacent levels (level below and level above). Preoperatively the neurological deficits were scored. Clinical function after surgery was evaluated. The first intraoperative TcMEP recording was stored as baseline and was compared to the postoperative value. Continuous EMG monitoring was performed during operation. TcMEP/EMG changes were correlated with clinical findings. All patients had a regular follow-up examination (MRI-imaging, VAS and ODOM scale) for 1.5-2 years. The correlation between intraoperative TcMEP/EMG, neurological findings before surgery and surgical outcome in the adjacent level were analyzed

Results: We studied 38 patients (13 male,25 female, mean age 45.6 years) at last 3 years. The intraoperative TcMEPs/EMG and clinical outcome using the VAS and ODOM scale were statistically significant (P<0.05) at the level above.

Conclusion: The neurological improvement at the level below or clinical findings before and after surgery using intraoperative TcMEPs/EMG monitoring, VAS and ODOM scale during anterior cervical microdiscectomy and fusion with cages, may be associated with better stabilization, the reducing of the pathological micro movements at cervical spine and more effective blood supply in this area.

POSTER PRESENTATIONS 83
Dysphagia and respiratory discomfort secondary to retropharyngeal mass caused by Diffuse Idiopathic Skeletal Hyperostosis relieved by retropharyngeal osteophytectomy.
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Back Ground Data: There have been a few reports of dysphagia secondary to DISH, while reports of respiratory discomfort in this disease is rarely discussed. Combination of dysphagia and respiratory discomfort only occurs when the big osteophytes are mainly located at C2-C3 region. Difficult endotracheal intubation, and possibility of immediate post operative respiratory complications necessitates preoperative tracheostomy. Surgeons familiar to retropharyngeal approach can expose the osteophytes of the upper cervical region easily.

Study Design: We report a 55 year old man with respiratory discomfort and dysphagia for a year worsening in the last two months with Diffuse Idiopathic Skeletal Hyperostosis.

Method: Plain radiographs showed osteophytes from C6 up to C1, being most prominent at C2 C3 area. CT reconstruction MRI demonstrated a retropharyngeal mass obstructing the pharynolaryngeal pathways and barium swallow showed marked deviation and shift. Preoperative tracheostomy was done on operating table and after induction of general anesthesia, through a longitudinal incision along the sternocleidomastoid muscule combining standard anterior cervical and retropharyngeal approach all the osteophytes including the most prominent ones from C1 to C3 were removed with high-speed drill. Liquids were started in the first post operative day with no difficulty and the patient could breathe normally with tracheostomy tube capping in the third day.

Conclusion: DISH should be included in the differential diagnosis of both dysphagia and respiratory discomfort. Difficult or dangerous intubation makes preoperative tracheostomy mandatory specially in the patients with high cervical Forestier’s disease. Tracheostomy also prevents untoward postoperative respiratory complications, specially in more generalized form of the disease with affection of the costovertebral joints resulting in restricted thoracic cage compliance and ventilation impairment. Spine surgeons should be familiar with retropharyngeal access surgery in the surgeries of high cervical spine region.

POSTER PRESENTATIONS 84
Qualitative motion analysis in arthroplasty versus simple discectomy in the surgical management of cervical disc degeneration.
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Introduction: In the surgical care of symptomatic single level cervical disc degeneration discussion exists about whether fusion at the operated level should be a goal of surgery. Fusion may be a contributing factor to adjacent disc disease (ADD) and therefore should possibly be avoided. ADD may be avoided by movable arthroplasty devices. Many types were developed in the past decade. To date, the effectiveness of these devices in preserving segmental motion is usually evaluated by quantitative motion analysis by means of two function radiographs in the sagittal plane or, occasionally, by radiostereometric analysis. We hypothesize that qualitative motion analysis, in a better way than quantitative motion analysis, can be used to assess whether physiological movement is successfully restored. To this end, a prospective, randomized trial was started at our institution.

Objectives: To evaluate the ability of cervical disc arthroplasty to restore physiological motion in the cervical spine by qualitative motion analysis, i.e. the order of segmental contributions to flexion and extension from C0-C1 up to C6-C7.

Methods: 24 patients with symptomatic cervical disc degeneration will be randomized to two groups, one group undergoing simple anterior cervical discectomy (ACD), and one undergoing ACD with arthroplasty (Activ-C disc prosthesis Braun Aesculap). Patients in both groups are radiologically evaluated at 2 days prior to surgery, and at 3 and 12 months after surgery. A complete flexion and extension movement is captured by digital fluoroscopic cinematography. These videos are analyzed by means of image recognition software that the authors RR and BP have developed to establish not only the segmental ranges of motion of all cervical motion segments, but also their respective order of movement. These data will be compared to similarly analyzed videos of 10 healthy volunteers.

Results: Both qualitative and quantitative data on cervical spine movement in healthy volunteers and patients will be presented.

POSTER PRESENTATIONS 85
Clinical and Radiographic Outcome of the NeoDisc Cervical Total Disc Replacement (TDR) at One-Year Follow-up
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Background: The NeoDisc cervical TDR consists of a compliant elastomeric core encased in an embroidered polyester jacket with anterior fixation phalanges attached via screw fixation. This data is
Objective: The purpose of this study was to evaluate the time-course of radiologic findings and clinical outcomes in 3 or 4 levels double door laminoplasty using hydroxyapatite (HA) spacer by follow-up over 30 months after surgery.

Method: We followed-up 29 patients (male to female ratio 24:5; mean age 53.1; total 103 laminoplasty levels) who had double door cervical laminoplasty from 2004 to 2007. Preoperative diagnosis was 21 cases of OPLL and 8 cases of degenerative spondylosis. Patients were divided into 3 groups according to the followup periods; early (12-<18 months), middle (18-30 months), late (>30 months). Neutral and flexion-extension cervical lateral radiographs and CT scans were taken at the last follow-up. Stability of HA spacers, C2-7 ROM and kyphosis were evaluated. Bone fusion status between HA spacer and laminae were estimated using 3-types classification from A to E. Type C, D and E was accepted as successful HA-laminae fusion. Bone fusion on the bilateral gutters was also evaluated. Nurick grade and JOA score to evaluate neurological improvement were checked at the preoperative moment and last follow up moment. Visual analogue scale (VAS, 0-10) to measure post-operative neck pain and radiating pain were used for all patients.

Results: The number of patients was 9, 11 and 9 in early, middle and late followup groups, respectively. Successful HA-laminae fusion rate was 24%, 42% and 69% in early, middle and late groups, respectively. Bilateral gutter fusion was 93% in early group and 100% in both middle and late groups. ROM of C2-C7 was significantly decreased after surgery: 10, 11 and 13 degrees reduction compared to preoperative ROM in early, middle and late groups, respectively. Kyphotic change was slightly increased after surgery without significance. Nurick grade, JOA scales and VAS of radiating pain were significantly improved after surgery but there was no difference between 3-groups. There was no direct clinical correlation between HA-laminae fusion rate and clinical improvement (p<0.005).

Conclusion: HA-laminae fusion progressed very slowly; however, HA spacers showed stable positions and clinical outcomes were improved regardless fusion status.

POSTER PRESENTATIONS 87
The strategy of surgical treatment for cervical osteomyelitis
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Background: Osteomyelitis of the spine is a rare disease that accounts for approximately 1 to 7% of all bone infections, and only 3 to 6% of spinal osteomyelitis are confined to occur in the cervical spine. Because of the large diameter of the cervical cord in relation to the spinal canal and the significant range of motion, even a small epidural abscess can cause devastating results. It is difficult to choose surgical treatment in these cases, especially in cervical osteomyelitis because of numerous factors such as degree of the infectious process, spinal cord compression, and expected kyphotic deformity due to bony destruction or disc space involvement.

Methods: We retrospectively reviewed 14 patients who had been treated for cervical osteomyelitis from May 2000 to July 2008. We investigated their clinical course, antibiotic regimen, surgical methods, and laboratory and radiologic findings including X-ray, CT, and MRI.

Results: This study included ten men and four women, whose mean age was 48.8 (range, 21-69) years old. 5 patients had primary spontaneous spondylodiscitis, 5 patients had post operative spondylodiscitis and 4 patients had tuberculosis in the cervical spine. The average hospital stay was 62 (range, 17-349) days. Patients were treated 13.8 weeks (range, 5.4-25.8) with IV antibiotics and then treated for 58.2 days (range, 13-106) with oral antibiotics. For tuberculotic infections, we used antituberculotic medication for a mean of 383.8 days. 11 patients were treated with anterior debridement and fusion (3), irrigation and debridement (3), and we simultaneous performed cervical anterior interbody and transthoracic thoracic interbody fusions (1). 3 patients underwent the planned 2-staged operation, which included an anterior debridement with or without fusion for the 1st operation and posterior instrumentation for 2nd operation. 10 patients (71.4%) had neurologic deficits at the time of diagnosis and 7 patients (70%) among them improved postoperatively.

Conclusions: Anterior cervical spine surgery is the preferable treatment option in patients with neurological deterioration, extensive bony destruction with expected kyphotic deformity, and uncontrolled infection being managed only with antibiotics. Postoperative infections have the tendency to
have worse clinical courses compared with primary spontaneous spondylodiscitis.

**POSTER PRESENTATIONS 88**  
Comparative analysis of Total cervical disc replacement with Discocerv® (Scient'X Prosthesis) with Anterior cervical decompression and fusion: Preliminary report on radiological change of sagittal alignment and heterotopic ossification over 1.5 year after surgery.  
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**Introduction:** Preliminary study over one and half years’ experience in total cervical disc replacement with Discocerv® (Scient’X Prosthesis) in regard to clinical and radiological outcome compared with Anterior cervical interbody fusion (cage using bone graft).

**Method:** Cervical arthroplasty using Discocerv® (Scient’X Prosthesis) were performed in total 24 patients between Nov 2007 and Sep 2009 by single surgeon. To make the result clear, 15 of 24 patients with single level arthroplasty or fusion at C5/6 level with more than 18 months follow-up period were enrolled in this study. We compared these patients with 20 patients who underwent cervical anterior interbody fusion (cage using bone graft) at C5/6 level between Apr 2003 and June 2006, and the mean follow up duration was 24 months (12-51 months). Preoperative and postoperative radiographs (immediate, 1 month, 6 months, 12 months, 18months after surgery) were analysed by PACS system (CentricityTM PACS 1.0 GE) to quantify the segmental range of motion (ROM) at functional segment, upper adjacent segment (C4/5), the lower adjacent segment (C6/7) and overall (C2-7) segment. We also reviewed heterotopic ossifications (HOs) according to the McAffee’s criteria.

**Results:** Pre- and post-operative ROM at functional segment (C3/6) was 21.4% and 6.5% for interbody fusion, 25.3% and 26.7% for Discocerv® disc, respectively. Pre- and post-operative ROM at upper adjacent segment (C4/5) was 24.3% and 23.9% for interbody fusion, 20.9% and 27.7% for Discocerv® disc, respectively. Pre- and post-operative ROM at lower adjacent segment (C6/7) was 15.1% and 23.3% (p < 0.05) for interbody fusion, 19.1% and 20.9% for Discocerv® disc, respectively. Heterotopic ossifications (HOs) was developed in four patients (26.9%). 3 patients had class I HO and 1 patients had class III HO.

**Conclusion:** Discocerv® disc has the superior result to interbody fusion in relative segmental ROM at functional segment. There were no significant differences in overall segment ROM and adjacent segment below and above ROM between two groups. There was 26.9% of prevalence of HOs. Most frequent location of HOs was the posterior margin of the inferior device. Long-term follow up study should be needed for heterotopic ossifications and it’s incidence might be increased.

**POSTER PRESENTATIONS 89**  
In-vivo kinematics of cervical disc replacement: Analysis of reconstruction of Center of Rotation (COR) with non-constrained balland-socket type.

Informations on in-vivo kinematics after cervical disc replacement (CDR) are scant. For better understanding of success/failure the in-vivo behavior of CDR must be assessed. Radiographic analysis of 19pat undergoing 1-level CDR (Discover,Depuy) focusing on kinematics. Neutral and flexion-extension radiographs(FE) preoperatively, postoperatively and at follow-up were analyzed for segmental rotation angle(SRA) and absolute rotation angle(ARA-C2-7).The FE-images were processed with quantitative motion analysis (QMA, Medical-Metrics, Houston, Texas/US) to calculate the functional spinal unit motion parameters of surgery and adjacent levels:Range of motion(ROM),translation and COR.With COR-analysis,positive-X-values defined anterior COR-position and positive-Y downward COR-position compared to endplate mid-point. Patients’ age was 43.3±7.3years(27-58), follow-up 15.3±7.2mo(6-26), CDRheight 6.7±0.7cm(6-8). CDRs were implanted at C4-5(1x),C5-6(12x),C6-7(6x). Preoperatively, ROM at CDR-level was 5.9±5.1 and 11.5±6.3 at follow-up (difference:8.4±5.9,p=0.006). Preoperatively ROM-ARA-C2-7 was 35.9±13.7 and 45.4±13.6 at follow-up (Difference:18.1±1.7,p<0.01). Postoperative shell-angle was -5.5±4.9 and -7.1±6.8 at follow-up (difference:1.3±5.3). With QMA follow-up-sRA-CDR was 9.8±5.9,translation was 10.1±7.8 vertebral body antero-posterior diameter.Compared to normals, COR-X was located at 3.3±6.8 and COR-Y at 23±11.6. At CDR-level, COR-X was within normal bounds in 9pat (47.4%) and COR-Y in 16pat (84.2%). COR-X&COR-Y were within normal bounds in 8pat (42.1%). At supra-adjacent levels the SRA was 10.9±4.6,translation was 12.1±5.3. Compared to normals, the COR-X was located at -4.6±4.7 and COR-Y at 35.1±13.3. At caudal-adjacent levels SRA measured 5.9±3.2,translation was 3.3±2.6. The COR-X was at -6.2±3.8 and COR-Y at 4.8±11.5. Statistics showed preoperative CDR-ROM and ARA-C2-7 had no impact on follow-up- CDR-ROM and -ARA-C2-7. Individuals with higher CDR-ROM had increased CDR-tr anslation(p<0.001,r=0.97),supra-adjacent-translation (p<0.01,r=0.79),supraadjacent- ROM(p=0.003,r=0.61) and ROM-ARA-C2-7 (p=0.01,r=0.56). Supra-adjacent-ROM influenced supra-adjacent-translation (p<0.001,r=0.9), caudal-adjacent-ROM influenced caudal-adjacent-translation(p<0.001,r=0.9). Supra-adjacent-translation was influenced by CDR-translation(p=0.001,r=0.71). Notably, the position of the CDR-COR on y-axis (COR-Y) had impact on the extend of CDR-translation(p=0.02,r=0.6). The shell-angle had no impact on CDR-ROM but on COR-X(p=0.046,r=-0.36) and COR-Y(p=0.044,r=0.51). COR is one of the key-parameters when assessing the ability of non-constrained CDRs to replicate the kinematics of a functional spinal unit. COR is influenced by CDR-position and -size. In reverse, besides articulating surface designs the artificial-COR after CDR-implantation influences translation. It’s yet unknown how much translation is beneficial concerning clinical outcomes and facet loading indicating further research.

**POSTER PRESENTATIONS 90**  
Epidural Abscesses of the Cervical Spine: Operative Treatment  
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Abstracts of 26th Annual Meeting of CSRS-ES Meeting
**Introduction:** Purpose of the study is to present the treatment of epidural abscess of the cervical spine that caused severe neurological deficit.

**Material & Method:** 4 patients, 3 men and 1 woman age from 56 to 70, admitted urgently to the Orthopaedic Department complaining for neck pain and weakness of the upper and lower limbs. The investigations revealed a) the existence of epidural abscess into the spinal canal and b) staphylococcus in 3 cases & borderella in the fourth. The Operative treatment consisted in urgent evacuation of the abscess and stabilization of the involved area of the spine in three cases in two cases the evacuation and stabilization performed through anterior and posterior procedure. Postoperatively they received antibiotic treatment for six months.

**Results:** Complete recovery of the neurologic function was succeeded in four cases. There was no observation of recurrence of the infection at the long term follow up (on average 3 years), neither failure of implants and destabilization of the involved area of the spine.

**Conclusions:** The rapid development of neurologic deficit in spine of the absence of the classic signs of infection must arise the suspicion of existence of an epidural abscess. The appropriate treatment is the evacuation of the abscess. The stabilization of the affected area of the spine is not contra-indicated. The complimentary antibiotic treatment for a long time is compulsory.

**POSTER PRESENTATIONS 91**

Streptococcus fecalis cervical spondylodiscitis in a patient with end-stage renal disease undergoing hemodialysis therapy. Case report

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Study Design: A case report and clinical discussion.

Objective: To present a case of Streptococcus fecalis cervical spondylodiscitis in a patient undergoing chronic hemodialysis therapy.

**Background Data:** Infections can be frequent in patients with renal disease undergoing hemodialysis therapy and spinal treatment can be difficult and dangerous due to many factors such as osteopenia and secondary immune deficiency.

**Methods:** A 64 old woman undergoing hemodialysis therapy for more than 20 years came to our hospital complaining of cervical spine pain and left upper limb monoparesis. Previously she had undergone surgery for an arteriovenous fistula abscess caused by streptococcus fecalis. X-ray and MRI were carried on. C4-C5 vertebral collapse suggestive for spondylodiscitis was seen on the examinations. WCC, ESR and CRP were significantly high. Blood culture and percutaneous local biopsy were positive for streptococcus fecalis. Conservative treatment- consisting in halo–vest combined to antibioticotherapy- was undertaken.

**Results:** Cervical pain relief and left upper limb monoparesis recovered in a few days. Bony fusion was completely reached in six months. The patient was always ambulant.

**Conclusion:** The use of metal implants in large defects caused by spinal infection is controversial, and relatively few results have been published to date. In patients with renal disease undergoing hemodialysis therapy the complication rates and mortality rates for surgery can be relatively high and the fusion rate can often be low due to multiple factors such as comorbid medical diseases, laboratory abnormalities, and osteoporosis. In such a condition conservative treatment can be satisfactory undertaken.

**POSTER PRESENTATIONS 92**

Cervical lordosis: Standard measurements using the EOS® system

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Objective: Assessment of standard cervical lordosis using a standardized acquisition procedure and digital measurement in the normal population.

**Study Design:** The literature review is sparse and provided very large ranges, different standards and variable methods for assessing standard cervical lordosis. We used three independent reviewers, two surgeons and one radiologist to measure static lordosis and determine original angle values in a reproducible manner. The EOS® system uses low dose radiation and provides reliable standardized digital 2D acquisition with 3D reconstruction.

**Subjects:** We used a cohort of the general public of over 180 subjects divided in 4 groups respectively: two female groups below 40 years and above 50 years and the same groups for males. They all had no previous surgical spine history and no frontal or sagittal imbalance. We assessed general cervical lordosis (C2 to C7) as well as upper and lower cervical lordosis separately.

**Outcome Measures:** The measurements were carried out twice by every examiner on two different occasions and yielded standard sagittal cervical angle measurements.

**Results:** We found that the cervical lordosis in the general population has a very wide range in both sexes but that as a general rule of thumb, the upper and lower cervical lordosis have approximately a 60 to 40 respectively ratio.

**Conclusions:** The aim of this study was to provide sagittal cervical balance or lordosis in order to assess a standardized and applicable value, especially in the case of multilevel corpectomy and the subsequent need for a curved implant and its most appropriate angulation.

**POSTER PRESENTATIONS 93**

Congenital defects of atlantal arch: The clinical implications

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Atlantal arch defects are rare. Few cadaveric and imaging studies have been reported on the variations of such anomalies. Our study examines the incidence and review the clinical implications of this anomaly. A review of all bibliographical data was performed to identify patients with atlantal arch defects. Posterior arch defects of the atlas were grouped in accordance with the classification of Currraino et al. In patients exhibiting this anomaly, special attention was given to defining associated anomalies and neurological findings.

**Results:** Atlantal arch defects were found in 0.95% of the patients. The type A and the type B posterior arch defects were found. No type C, D, or E defects were observed. A case-report with a type A posterior arch defect had an anterior atlantal-arch midline cleft. Associated cervical spine anomalies observed included one C (6-7) fusion and two atlantal assimilations. None of the reviewed cases had neurological deficits because of atlantal arch anomalies. Conclusion:
Most congenital anomalies of the atlantal arch are found incidentally during investigation of neck mass, neck pain, radiculopathy, and after trauma.

**POSTER PRESENTATIONS 94**

Ossification of the posterior longitudinal ligament of the cervical spine: a review of the literature

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Ossification of the posterior longitudinal ligament (OPLL) is a pathological ossification of the ligament that causes slowly progressive myelo-radiculoapathy in adults. Because of long-standing compression of the spinal cord by OPLL, functional prognosis may not always be favourable. This study is a review of the literature on the diagnosis and management of the ossification of the posterior longitudinal ligament of the cervical spine. The symptoms of OPLL include numbness in the hands and/or legs, neck pain, awkward hand movements, and/or gait disturbance. Apparent neurological deficit may be an indication of surgery in patients with cervical OPLL because of the low efficacy of conservative treatment and the unfavorable surgical outcomes in patients with established neurological deficits. The two major surgical strategies used for the treatment of cervical OPLL are anterior decompression with fusion and posterior decompression via techniques such as laminoplasty and laminectomy. The indications of anterior surgery include ossification of a small length of the posterior longitudinal ligament (< 7 cm). During the removal of the ossified ligament through the corpectomy site, care should be taken to not compress the spinal cord or to injure the dura mater. If the dura mater is adherent to the ossified ligament, further removal of the ligament should be discontinued, and the floating technique may be used for the removal of the remaining ligament. Cylindrical cages may be safely used instead of anterior surgical plates for fixing bone struts harvested from the iliac crest. The indications of posterior decompression include multi-segment pathology and/or developmental canal stenosis. Open-door laminoplasty via the unilateral approach has been introduced for posterior decompression. Both methods are associated with symptomatic improvement in 50-70% of patients and with the development of complications such as deterioration of myelopathy and C5 palsy in 0-10% of patients. After anterior decompression surgery, 5-15% of patients develop complications related to the bone strut, whereas after posterior decompression surgery, 9% of patients develop postoperative kyphotic deformity.

**POSTER PRESENTATIONS 95**

Imaging of Craniovertebral Junction: the normal and variable anatomy, the anomalies, fractures, inflammatory and degenerative diseases and the neoplasms

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The craniovertebral junction comprises the occiput, atlas, and axis and is visible in most magnetic resonance imaging studies of the brain. Most anomalies of the occiput are associated with decreased skull base height and basilar invagination, the latter being a primary developmental anomaly in which the vertebral column is abnormally high and prolapsed into the skull base. Occiput anomalies include condylus tertius, condylar hypoplasia, basiocciput hypoplasia, and atlanto-occipital assimilation. Most atlas anomalies produce no abnormal CVJ relationships and are not associated with basilar invagination. These anomalies include aplasias, hypoplasias, and clefts of the atlas arches and “split atlas”. Except for fusion anomalies, abnormalities of the axis are primarily confined to the odontoid process and are not associated with basilar invagination. These anomalies include persistent ossiculum terminale, odontoid aplasia, and os odontoideum. With the widespread availability of MR imaging, which is well suited for evaluating the CVJ because of its direct sagittal imaging capabilities, renewed understanding of CVJ anatomy and anomalies is important for all radiologists. This study reviews the embryology, anatomy, congenital anomaly, acquired disorders, degenerative diseases, neoplasms, and inflammatory and infectious disorders in the craniovertebral junction. The imaging characteristics and differential diagnoses of these lesions are provided. Also we focus on the complimentary roles of different imaging modalities.