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3 **abstract collection**  
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6 **The tips and pitfall of craniocervical junction surgery using**  
7 **O-arm**

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10 *Introduction* Recently the image guided surgery (IGS) has been more  
11 feasible and available for craniocervical junction (CCJ) surgery.  
12 However, there are many problems in CCJ concerning how to use  
13 navigation system well, and how to expose bony structures meticu-  
14 lously and so on. The purpose of this paper is to present the tips and  
15 pitfall of CCJ using O-arm.

16 *Materials and methods* Since 2005, consecutive 54 cases underwent  
17 posterior (occipito-)cervical fixation using occipital screw (OS) or  
18 occipital condyle screw (OCS) or C1 lateral mass screw (C1LMS) and  
19 C2 pedicle/laminar screw (C2PS/LS), 28 were male and 26 were  
20 female; their age ranged from 27 to 92 years old, mean 67.1. We have  
21 used to perform subperiosteal dissection to expose meticulous bony  
22 structure. We have set the reference arc on the Mayfield's head ring to  
23 obtain the light operative field preventing the shadow of the hand at  
24 deep operative field. And if using fluoroscopic 2D image using O-arm  
25 during insertion of the screw, we used to decline the O-arm's axis to  
26 secure the space for the operator.

27 *Results* 18 OS and 1 OCS and 96 C1LMS and 108 C2PS/LS were  
28 inserted. Of the 223 screws, 221 (99.1 %) were inserted correctly, and  
29 2 (0.9 %) were incorrectly, complete deviation were zero. No neuro-  
30 vascular complication associated with surgery occurred. All  
31 patients obtained bony fusion except for one fibrous union case.

32 *Discussion and conclusion* We are convinced that firstly we should  
33 make hemostatic and meticulous exposure, subsequently we should  
34 perform the correct and safe insertion of the screw using navigation  
35 system.

36 **Surgical stabilisation improves survival of spinal fractures related**  
37 **to ankylosing spondylitis**

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*Study design:* National registry cohort study.

*Objective* To investigate the effect of surgical stabilisation on survival  
of spinal fractures related to ankylosing spondylitis (AS).

*Summary of background data* Spinal fractures related to AS are  
associated with considerable morbidity and mortality. Still hard data  
on treatment modalities and survival is missing and limited to retro-  
spective studies.

*Methods* In the Swedish patient registry of (SPR) all patients treated  
in an inpatient facility are registered prospectively with diagnosis and  
treatment codes. The mortality registry collects date and cause of  
death for all fatalities. Registry extracts of all patients with AS and  
spinal fractures including date of death and treatment were prepared  
and analysed for epidemiological purposes.

*Results* 11008 individual patients with AS were admitted to treatment  
facilities in Sweden between 1987 and 2011. 943 patients with AS  
(age 66 ± 14 years) had 1031 spinal fractures, of which 466 affected  
cervical, 333 thoracic, and 232 lumbar vertebrae. 9.3 % had multiple  
levels of injuries during the observed period. Surgically treated  
patients had a greater survival than those treated non-surgically  
(HR = 0.80, p = 0.0429). Spinal cord injury was the major factor  
contributing to mortality in this cohort (HR = 2.53, p < 0.0001). The  
survival of spinal fractures related to AS showed an annual  
improvement of 3 % over the observed time period (p < 0.001). The  
proportion of surgically treated spinal fractures increased linearly  
during the last decades (r = 0.90, p < 0.001) and has been about  
53 % through the observed years.

*Conclusions* Spinal cord injury threatens the survival of patients with  
spinal fractures related to AS. Despite the complications related to  
surgical treatment, the survival of spinal fractures related to AS was  
improved by surgical stabilisation. Therefore surgical treatment can  
be recommended.

**Recovery of sensory impairment in the upper extremity due**  
**to cervical myelopathy by surgical intervention: Prospective**  
**Cohort Study**

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83 **Introduction** Motor deficits, such as clumsiness of the hand and gait  
84 disturbance, are commonly recognized as prime symptoms of cervical  
85 myelopathy. On the other hand, sensory impairment; neither subjective  
86 nor objective, has been fully evaluated, although it may have a  
87 considerable effect on the everyday activities. The purpose of this  
88 study was to clarify the recovery of objective and subjective sensory  
89 impairments in the upper extremity due to cervical myelopathy after  
90 surgery in prospective cohort fashion.

91 **Materials and methods** Fifty-two patients who required surgical  
92 intervention due to cervical myelopathy were enrolled (33 male, 19  
93 female, 65.2 years old). For evaluating objective sensory impairment,  
94 the Semmes-Weinstein monofilament test was used: five different  
95 thickness monofilaments, from 1.65 to 6.65, were placed on the  
96 palmar side, with a pressure adequate to bend them, and the lowest  
97 filament number were recorded. The severity and the area were  
98 multiplied to give the score. For subjective sensory impairment, a  
99 visual analog scale for numbness of the upper limb was recorded.  
100 These examinations were prospectively performed at pre-operation,  
101 discharge, 6, and 12-months after surgery. The recovery rates of these  
102 sensory impairments were statistically analyzed using multivariate  
103 analysis with the JOA score, SF-36v2 scores and depression scale  
104 using Quick Inventory of Depressive Symptomatology.

105 **Results** The recovery rate of objective sensory deficit was statistically  
106 improved along the time course (37.4 % at discharge, 59.0 % at  
107 6-months, and 67.6 % at 1-year after surgery). On the other hand,  
108 the recovery rate of subjective symptom was not improved along the  
109 timeline (31.8 % at discharge, 31.6 % at 6-months, and 35.3 % at  
110 1-year after surgery). The recovery rates of subjective sensory  
111 impairments were well correlated with the JOA score at each time  
112 point, but objective sensory impairments did not. Several parameters  
113 of SF-36 and the depression scale had correlation with the recovery of  
114 either subjective or objective sensory impairments.

115 **Discussion and conclusion** This study has indicated that there was a  
116 dissociation between objective and subjective recovery of sensory  
117 impairments after surgery. It has also speculated that the recovery of  
118 objective/subjective sensory impairments might occasionally have  
119 several relations with the activities of daily life and mental status.

## 120 **Cervical intervertebral disc degeneration: assessment** 121 **by quantitative magnetic resonance imaging and histology**

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134 **Introduction/aim** Understanding Intervertebral Disc (IVD) degeneration  
135 is fundamental to the development of new therapies and  
136 technologies aimed at treating spinal pathology. Magnetic resonance  
137 (MR) imaging can non-invasively assess IVD changes, but current  
138 clinical MR-based classification systems for IVD degeneration are  
139 qualitative and susceptible to observer variability. This study

introduces an MR-based method for the quantification of intervertebral  
disc degeneration, exploiting textural and morphological image  
information. The authors hypothesize that texture and morphology  
can capture the biochemical and structural alterations described in  
IVD degeneration. The aim here is to provide a quantitative tool for  
non-invasive assessment of IVD degeneration severity. The proposed  
method is validated against a published and standard histological  
grading of disc samples.

**Methods** This study comprised data on 84 patient datasets. All  
patients had preoperative MRI scans followed by cervical spine  
discectomy at Salford Royal NHS Foundation Trust (SRFT). The  
excised IVD samples form part of the Human Intervertebral Disc  
Tissue Bank of the SRFT held by the University of Manchester. The  
tissue samples were graded histologically according to established  
criteria developed at the University of Manchester.

The MR quantification method included the segmentation of the IVD  
region from T2-weighted images of the cervical spine, followed by  
the extraction of textural and morphological features from the disc  
region (histogram features, grey-level-co-occurrence-matrix features  
and region property descriptors).

**Results** Linear discriminant analysis identified two quantitative features  
extracted from MR images, the disc “extent” and the  
“information-measure-of-correlation”, as the most descriptive features  
of IVD degeneration. Non-parametric correlation analysis  
(Spearman) indicated significant association between these quantitative  
IVD parameters values and the histological grading of disc  
degeneration ( $p < 0.01$ ). The Mann-Whitney-U test showed significant  
differentiation in IVD texture and shape between disc samples  
with histologically defined early vs advanced degeneration  
( $p < 0.01$ ).

**Conclusion** Due to their ability to capture small changes in MR  
images, IVD texture and morphology provide novel biomarkers for  
quantitative non-invasive characterisation of IVD degeneration, as  
defined by histological grading. The proposed quantitative tool could  
potentially support targeting patients with appropriate types of therapy;  
conservative versus surgical treatment, or evaluating the effectiveness  
of new treatment methods such as biological or cell  
therapy.

## 178 **Compensatory mechanism of the spine for cervical kyphosis:** 179 **the role of clivo-axial angle**

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**Introduction** Progression of cervical kyphosis can cause difficulty of  
horizontal gaze, therefore other spinopelvic part may compensate the  
alignment. However, its precise mechanism remains unclear. The  
purpose of the present study was to investigate the compensatory  
mechanism of the spine for cervical kyphosis.

**Materials and methods** Forty-four patients (male 21, female 23, a  
mean of 71.8 years old) having cervical diseases were enrolled.  
Disease types were; 29 cervical spondylotic myelopathy, 5 ossifica-  
tion of the posterior longitudinal ligament, and 10 dropped head  
syndrome. Spinopelvic lateral radiographs in the standing position  
were taken. Clivo-axial angle (CAA), atlanto-axial angle (AAA),  
C2-7 angle, thoracic kyphosis (TK), lumbar lordosis (LL), pelvic tilt  
(PT), and sacral slope (SS) were measured on the radiographs, and  
correlation between C2-7 angle and other radiologic parameters were  
statistically evaluated. Twelve patients underwent correction surgery  
for cervical kyphosis, and correlation between the correction angle  
and other radiologic parameters were also calculated.

200	<i>Results</i> The mean values of CAA, AAA and C2-7 angle on the lateral radiographs in standing position were $167 \pm 18^\circ$ , $31 \pm 7.9^\circ$ and $-1.3 \pm 22^\circ$ , respectively. The C2-7 angle was negatively correlated with CAA, AAA, i.e., CAA, AAA, increased along the progression of cervical kyphosis. Moreover, there found correlation between CAA and PT and SS. The patients having dropped head syndrome exhibited bigger CAA ( $195^\circ$ ) and AAA ( $39^\circ$ ) compared to other diseases with statistical significance. In 12 patients who underwent correction surgery for cervical kyphosis, CAA decreased along the increase of correction angle although no correlation was found between the correction angle and other spinopelvic parameters.	260
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211	<i>Discussion and conclusion</i> The present study has indicated the compensatory mechanism for cervical kyphosis which occurs at other parts of the whole spine. That is, progression of cervical kyphosis is compensated by gaining lordosis at the upper cervical spine (which is created by increasing CAA and AAA), and retroverting the pelvis. In cases with more severe kyphosis such as dropped head syndrome, CAA, not other parameters, is found to be related to more compensation. That is, CAA plays one of the most important roles in compensating cervical kyphosis.	
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220	<b>Characteristic findings in imaging of cervical spondylolisthesis: analysis of CT and X-ray photography in 101 spondylolisthesis patients</b>	
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226	<i>Background</i> The purpose of this study was to elucidate characteristic findings in imaging of cervical spondylolisthesis.	
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228	<i>Materials and method</i> Between 2008 and 2013, we performed 731 cervical spine surgeries in our hospital. We defined the cervical spondylolisthesis as more than 2 mm slippage with lateral X-ray in neutral position. Considered radiological parameters were C2-7 angle, ROM, C2-7SVA, facet inclination angle, cervical alignment, narrowing of disc space in sagittal CT image, subchondral bone cyst formation in CT and direction of facet joint in axial CT image.	
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236	<i>Results</i> Cervical slippage was recognized in total 101 cases and 124 levels. There were 68 males and 33 females whose average age was 70 years. Eighty nine patients suffered cervical spondylotic myelopathy or amyotrophy. Anterior spondylolisthesis was detected in 68 cases and 81 disc levels. Slipped vertebra was C2 in 6 cases, C3 in 18 cases, C4 in 30 cases, C5 in 4, C6 in 1 and C7 in 22 cases. Averaged SVA was 30.2 mm, this is higher than control data. Disc height at slipped level was preserved, while significantly decreased at adjacent caudal level. At slipped level, the direction of facet joint in axial image tended to be posteromedial. Posterior spondylolisthesis was detected in 40 cases and 43 levels. Slipped vertebra was C3 in 15 cases, C4 in 6 cases, C5 in 19 and C6 in 3 cases. Cervical curvature was relatively maintained as compared to anterior spondylolisthesis. Disc height at slipped level was greatly decreased. Cyst formation at slipped level was detected in 86 % of total 43 levels.	
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251	<i>Conclusion</i> Anterior spondylolisthesis tends to occur at the level adjacent to the stabilized level where disc space is narrowed for aging process or naturally stabilized for cervicothoracic junction. The disc height of slipped level was usually preserved, thus left the ability for the vertebra to slip down in flexion. Direction of facet joint may have influence on anterior slippage. Posterior spondylolisthesis tends to occur at the level where the disc space was significantly narrowed and the cyst formation was well detected. This suggests that posterior spondylolisthesis is strongly related to the intervertebral disc factor.	
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	<b>Revision surgery after incomplete resection of chordoma of the cervical spine</b>	260
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	<i>Introduction/aim</i> Chordomas rarely metastasize but due to the high local recurrence rate, despite surgical resection and/or radiation therapy, prognosis is poor. There is a paucity of literature regarding the outcome after treatment of recurrent chordomas. This study reports on survival rate and complications in patients treated with chordoma remnants with/without tumor recurrence at the cranio-cervical junction or in the cervical spine.	265
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	<i>Materials and methods</i> 24 patients with cervical spine chordoma remnant (Rc) or remnant-recurrence (RRc), treated at our department between 1999 and 2012, were reviewed retrospectively at an average 37.5 months (range, 4 to 102 months) follow-up. All patients had undergone at least one previous surgery including intralaminar or partial resection with/without stabilization of spine. The average time between the latest surgery and admittance to our department was 4 months (range, 2 to 6 months) in Rc-group and 12.1 months (range 4 to 21 months) in RRc-group. Average age was 44.3 years (range, 5 to 86 years). The chordomas were located at the cranio-cervical junction (N = 13), mid-cervical level (N = 9) and the low-cervical spine (N = 2). Preoperative X-ray, CT, MRI and angiography were performed to determine the extent of the tumor, signs of instability and encasement/displacement of vertebral arteries. All patients underwent single- or multi-staged tumor removal combined with revision of or first-time instrumentation. Postoperatively, 4 patients received adjuvant proton beam radiation therapy (mean dose: 69.2 CGE) and 12 patients had additional combined photon- and proton beam radiation therapy (mean dose: 74.19 CGE). We analyzed the surgical margins, spinal stability, short- and long-term complications, local tumor recurrence rate, morbidity rate and contributing factors for tumor recurrence.	272
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	<i>Results</i> Based on postoperative MRI scans and histopathological findings R0 resection was achieved in 17 cases. Dehiscence of the pharyngeal wall at the sight of incision was the most common long-term complication (7 cases). No instability was observed. The 5-year progression-free survival rate was 72.6 %.	293
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	<b>The progression of cervical instabilities after atlantoaxial fusion surgeries for RA-comparative analysis with cases that followed a natural course</b>	302
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	<i>Introduction</i> The objective of this study was to elucidate the progression of cervical spine instabilities and its predictable risk factors after atlantoaxial fixation (AAF) in RA patients.	314
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- 317 **Materials and methods** Seventy-five RA patients with atlantoaxial  
318 subluxation (AAS: ADI >3 mm) without vertical subluxation (VS:  
319 Ranawat value <13 mm) were included in this study. Twenty-seven  
320 patients performed AAF were classified as group S and 48 patients  
321 followed on an outpatient basis were classified as group N. The mean  
322 follow-up periods were 5.3–6.1 years, respectively. In group S, 16  
323 patients underwent transarticular fixation with Magerl and Brooks  
324 techniques (MB) and 11 patients underwent C1 lateral mass–C2 pedicle  
325 screw and rod fixation (SR). The progressions of VS and subaxial  
326 subluxation (SAS: irreducible translation  $\geq 2$  mm) were investigated.  
327 **Results** Only one case (3.7 %) with pseudoarthrosis of C1-2 joint  
328 developed VS in group S, while 14 cases (29.2 %) developed VS in  
329 group N ( $p < 0.01$ ). There was no significant difference between  
330 group S (33.3 %) and group N (25.0 %) in the incidence of SAS at the  
331 final follow-up. However, in group S, patients who had “over 25° of  
332 postoperative C1-2 angle” and “decrease of C2-7 angle during fol-  
333 low-up period” showed higher incidence of SAS (77.8 %) than group  
334 N ( $p < 0.01$ ), whereas the other patients in group S did not show the  
335 significant difference in the incidence of SAS compared to group N  
336 (11.8 %,  $p = 0.217$ ). Patients performed MB showed a higher incidence  
337 of “over 25° of postoperative C1-2 angle” and “decrease of  
338 C2-7 angle during follow-up period” than those performed SR  
339 (60.0 % vs. 0 %,  $p < 0.01$ ), and the development of SAS was  
340 detected in 8 cases (53.3 %) after MB, which was higher than in one  
341 case (9.1 %) after SR ( $p = 0.02$ ).  
342 **Discussion** AAF for patients with AAS prevented the occurrence of  
343 VS if C1-2 joint successfully fused following the operation. However,  
344 SAS was not prevented by this procedure. Furthermore, hyperlordosis  
345 of C1-2 angle in AAF may lead to the decrease of C2-7 angle and  
346 cause postoperative SAS, particularly prominent in patients per-  
347 formed MB.  
348 **Conclusion** C1-2 angle should be set less than 25° when AAF is  
349 performed in RA patients.
- 350 **Surgical versus conservative treatment strategies for odontoid**  
351 **fractures in the elderly: review of cases from three tertiary**  
352 **referral centres in The Netherlands**
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- 363 **Introduction/aim** Odontoid fractures (OF) are the most common  
364 traumatic fractures of the geriatric spine. The optimal treatment is still  
365 subject to controversy. The aim of this study was to compare out-  
366 comes of surgical and conservative treatments for OF in the elderly.  
367 **Materials and methods** Patient records were screened for patients who  
368 met the selection criteria (type II/III OF,  $\geq 55$  years old, <2 weeks  
369 after trauma, no rheumatoid arthritis/ankylosing spondylitis). Treat-  
370 ment strategies differed between centres (‘low threshold for surgery’  
371 in two centres, ‘primarily conservative’ in one centre). Radiological  
372 (union/stability) and clinical outcomes were assessed. The influence  
373 of age ( $\geq 55$ –80 versus  $\geq 80$  years) and potential prognostic factors  
374 were studied.  
375 **Results** Included were 105 patients (18 treated surgically, 87 con-  
376 servatively). No difference was found in fracture union (68 % overall,
- $p = .778$ ) or -stability (88 % overall,  $p = .379$ ) between treatment  
groups. Unfortunately, clinical outcome was reported in only 41  
patients and was therefore not subjected to statistical analysis. Out-  
come between centres was similar. Patients  $\geq 80$  years had worse  
outcomes in both arms. Baseline functioning did not influence out-  
come. Type-III fractures yielded better results than type-II fractures.  
Treatment/follow-up duration did not differ between treatments. The  
most common complication was failure of initial treatment (2/18 in  
surgical, 18/87 in conservative group). Two surgically treated patients  
died (both  $>80$ ). Eleven conservatively treated patients died (eight  
 $>80$ ).
- Discussion** The patient cohort in this review is one of the largest in  
literature. However, still no extensive data analyses were possible.  
Group heterogeneity may have flattened the findings (e.g. surgery for  
severest cases). The correlation between radiological and clinical  
outcome could not be studied. Prospective studies are needed, which  
will also provide better understanding of what the exact treatment  
goal should be (to achieve union, stability, favourable clinical out-  
come, or a combination).  
**Conclusion** No differences in radiological outcome between surgi-  
cally and conservatively treated patients were observed. The majority  
of patients achieved fracture healing. Advanced age and type II  
fractures are associated with worse radiological outcomes, irrespec-  
tive of the applied treatment.
- Predictors of two-year surgical outcomes of patients with cervical  
myelopathy: an analysis of 203 patients**
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- Introduction/aim** This study investigated whether baseline patient  
characteristics, pre-operative non-operative treatment modalities,  
operative data, and surgical procedures predicted surgical outcomes  
for cervical myelopathy patients.  
**Materials and methods** A retrospective review of a prospectively-  
collected database was performed. Cervical myelopathy patients with  
 $\leq$ Grade 1 Spondylolisthesis requiring 1–2 level surgery were inclu-  
ded. Data collected included baseline patient demographics,  
comorbidities, clinical information, non-operative treatment modal-  
ities, operative data, and surgical procedures. Primary outcomes  
measures were HRQOL (NDI, SF-36 PCS and MCS) changes from  
baseline to 2 years post-operatively. Univariate linear regression was  
utilized to identify predictors of HRQL changes. SF-36 changes were  
calculated as 2 yr–baseline, while NDI changes were calculated as  
baseline–2 yr to standardize for scoring technique differences. Posi-  
tive coefficients corresponded to improvement. Negative coefficients  
corresponded to worsening.  
**Results** 203 patients were included. Patient demographics, comor-  
bidities, clinical information, and types of pre-operative non-  
operative treatment did not predict HRQL changes. Previous cervical  
spine surgeries ( $-6.80 \pm 3.150$ ,  $p = 0.034$ ), surgery length  
( $-0.031 \pm 0.012$ ,  $p = 0.010$ ), and EBL ( $-0.008 \pm 0.004$ ,  
 $p = 0.020$ ) predicted PCS worsening. EBL predicted MCS worsening

- 437 (−0.010 ± 0.004, p = 0.026). Number of levels of decompression  
438 with corpectomy predicted MCS worsening (−8.861 ± 2.217,  
439 p = 0.001). C2-3 discectomy predicted NDI worsening (−29.989 ±  
440 12.489, p = 0.019). C6-7 discectomy predicted NDI improvement  
441 (8.252 ± 3.024, p = 0.008).  
442 **Discussion** It is important to consider the impact of baseline and  
443 treatment variables in outcomes in cervical myelopathy patients. Prior  
444 cervical spine surgeries, longer surgery, higher EBL, and decom-  
445 pression with corpectomy correlated with worse outcomes. The effect  
446 of discectomy on outcomes differed between levels operated on.  
447 Surgical factors may be more important than baseline patient char-  
448 acteristics or pre-operative use of non-operative treatment in  
449 optimizing outcomes.  
450 **Conclusion** Past medical history and surgical factors (op time, blood  
451 loss, approach) are important factors to consider in myelopathic  
452 treatment outcomes; surgical factors in particular may be more  
453 important in optimizing patient outcomes.
- 454 **Laminoplasty vs laminectomy and fusion to treat cervical**  
455 **spondylotic myelopathy: outcomes of the prospective multicenter**  
456 **AOSpine International CSM Study**
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472 University, Chiba, Japan, <sup>17</sup>Beaumont Hospital, Dublin, Ireland
- 473 **Introduction/aim** Recent studies conducted in North America have  
474 demonstrated benefits of surgical treatment for symptomatic CSM.  
475 However, differences in pathology, comorbidities, treatment appro-  
476 aches and cultural response to treatment may affect the generalizability  
477 of these findings at the global level.  
478 **Methods and materials** Patients receiving surgery for clinically  
479 symptomatic CSM were enrolled in a prospective multicenter,  
480 cohort study which is continuing to accrue subjects at 16 sites in  
481 Europe, Asia, North and South America. Subjects included were a  
482 part of a larger ongoing prospective observational study that has  
483 enrolled 492 subjects with CSM involving 16 clinical sites in Euro-  
484 pe, Asia, North and South America. Of those, 108 received  
485 laminectomy and fusion; 66 received laminoplasty. The choice of  
486 surgical approach was at the discretion of the surgeon. Outcome  
487 measures were mJOA, the Nurick scale, NDI and the SF36 PCS and  
488 MCS Component Scores.  
489 **Results** Average age was 60.2 years (SD 10.8), 29.8 % were female.  
490 Subjects treated with laminectomy and fusion had more levels  
491 operated (5.0 vs. 4.4, P < .01), shorter length of stay (7.7 vs.  
492 15.7 days, P < .01) and, less severe neurologic impairment measured  
493 by mJOA (12.6 vs. 11.2, P < .01). There were no differences in age,  
494 and baseline NDI, SF36v2 PCS and SF36v2 MCS. At 12 month  
495 follow-up, there were no differences in neurologic and functional  
496 outcomes for laminoplasty compared to laminectomy and fusion;  
mJOA (3.0 and 2.3, respectively, P = 0.15). Moreover, there were no  
differences in NDI (13.3 and 12.0, respectively, P = 0.71), SF-36v2  
PCS (8.5 and 7.7, respectively, P = 0.66) and SF-36v2 MCS (7.9 and  
6.9, respectively, P = 0.56).  
**Conclusion/discussion** Patients undergoing laminectomy and fusion  
and laminoplasty surgery for CSM show similar improvements in  
generic and disease specific outcome measures allowing for baseline  
differences in clinical presentation between the two groups of  
patients. Longer term follow-up will be required to determine whether  
any differences in outcome between the two forms of treatment  
emerge.
- Geographical variations in degenerative cervical myelopathy  
presentation and surgical treatment outcomes: results  
of a prospective international, multicenter AOSpine International  
study (CSM-I)**
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Ismir, Turkey
- Introduction/aim** Significant global variation in the presentation, eti-  
ology and management of cervical spondylotic myelopathy (CSM) is  
expected but has not been studied to date. Here, we report results of a  
large prospective international multicenter study (AOSpine CSM-  
International).  
**Methods and materials** Between 2007 and 2011, all adult patients  
with imaging confirmed CSM were enrolled at 16 international high  
volume centers. Detailed data on presentation, treatment and func-  
tional outcomes were collected prospectively. Participating surgeons  
were free to choose the type and extent of surgery. Those with  
inflammatory, infective, neoplastic etiology were excluded. Patients  
were followed up for up to 24 months.  
**Results** Participating centers were based in Asia (AP n = 150),  
Europe (E n = 126) Latin (LA n = 80) and North America (NA  
n = 123). The mean age of the cohort was 56.4 (range 22–87 yrs)  
years and the majority were males. Patients from AP and LA were  
significantly younger (53.9 and 54.2 respectively) than those from  
NA and E (p < 0.0003). The presenting underlying CSM pathology  
varied between regions (p < 0.001). Posterior ligamentum flavum  
hypertrophy was most frequently in LA and OPLL was prevalent  
in AP patients (35 %) and E (32 %). Despite etiological variations,  
there were no differences in baseline mJOA, Nurick and NDI  
scores (p < 0.1). However, patients in AP scored the highest and  
those in LA scored the lowest on SF36PCS and LA patients had  
highest SF36 MCS scores p < 0.008). Anterior surgical decom-  
pression was performed on the majority in Europe (71.43 %), AP  
(61.07 %) and NA (56 %) but not in LA (33 %). Circumferential

- 557 decompression surgery was rarely performed in NA (4.88 %) and E  
558 (3.17 %).  
559 At 24 months there was significant improvement in overall outcome  
560 measures ( $P < 0.001$ ) in all regions. AP patients demonstrated the  
561 greatest improvement in NDI and SF-36 PCS/MCS and E the least.  
562 Patients from Europe had lower SF-36 QOL scores and showed less  
563 functional improvement in mJOA. NDI score was highest in AP  
564 region.  
565 *Conclusions/discussion* There were significant regional variations in  
566 etiology of CSM but not at presenting functional status. Anterior  
567 cervical approach for CSM was the most common surgical approach  
568 worldwide. Surgical decompression achieved statistically significant  
569 improvements in mJOA, NDI, Nurick score and SF36v2 across centers.  
570 However, there were variations in the degree of functional  
571 improvements gained across the regions.
- 572 **Results of a Prospective, Multicenter, AOSpine International**  
573 **Study on the Surgical Management of Cervical Spondylotic**  
574 **Myelopathy**
- 575 M. Fehlings<sup>1</sup>, A. Ibrahim<sup>1</sup>  
576 <sup>1</sup>University of Toronto, Toronto, Canada
- 577 *Introduction/aim* Cervical spondylotic myelopathy (CSM) is a  
578 degenerative condition common in those over the age of 50 from all  
579 racial or ethnic backgrounds. Surgery to treat CSM has been  
580 increasingly shown to be effective, including in a recent the AOSpine  
581 North America study. However, this study was an exclusively North  
582 American and such functional improvement after CSM surgery in a  
583 global setting has not been studied. Here, we present results of a  
584 prospective, international multicenter study on the surgical manage-  
585 ment of CSM.  
586 *Methods and materials* This study was multicenter, prospective  
587 observational representing the largest study on CSM to date. Between  
588 2007 and 2011, 479 patients with CSM were prospectively enrolled in  
589 a 16 sites based in Asia Pacific (AP)  $n = 150$ , Europe (E)  $n = 126$ ,  
590 Latin America (LA)  $n = 80$  and North America (NA)  $n = 123$ .  
591 Demographic information, surgical technique and functional outcome  
592 parameters including the modified Japanese Orthopaedic Assessment  
593 scale (mJOA), Nurick Score, Neck Disability Index (NDI), Short  
594 Form (SF36v2) were collected.  
595 *Results* The study cohort consisted of 310 males and 169 females with  
596 a mean age of  $56.4 \pm 11.91$  years. The majority of patients had  
597 anterior surgery (57.7 %). Consistently, at 24 months follow up there  
598 was significant improvements on all outcome measures (mJOA,  
599 Nurick, NDI and SF36v2) ( $P < 0.001$ ). The mean mJOA score  
600 improved from 12.50 (95 % C.I., 12.24–12.76) to 14.90 (95 % C.I.,  
601 14.64–15.16); the NDI improved from 36.38 (95 % C.I., 34.33–38.43)  
602 preoperatively to 23.20 (95 % C.I., 21.24–25.15); and the SF36v2  
603 PCS and SF36v2 MCS improved from 34.28 (95 % C.I.,  
604 33.46–35.10) to 40.76 (95 % C.I., 39.71–41.81) and 39.45 (95 % C.I.,  
605 38.25–40.64) to 46.24 (95 % C.I., 44.94–47.55), respectively  
606 ( $p < 0.0001$ ). Of the cohort 22.34 % of patients experienced complica-  
607 tions, most of which were transient. Fourteen (14) patients had  
608 new postoperative neurological complications in the form of  
609 radiculomyelopathy.  
610 *Conclusion/discussion* This large multicenter prospective study has  
611 demonstrated that Surgery for degenerative CSM is effective at  
612 improving function in patients from around the globe despite the  
613 heterogeneity of the patient population, variations in treatment  
614 approaches and the diversity of global healthcare systems. It also  
615 shows that surgery to decompress the cervical spinal cord is safe with  
616 low perioperative morbidity.
- Non-operative treatment modalities prior to cervical surgery  
affect patient outcomes: an analysis of 1818 patients**
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- Introduction/aim* Effects of non-operative treatment prior to surgery  
on operative data, patient reported outcomes, and complication rates  
were investigated.  
*Materials and methods* A retrospective review of a prospectively-  
collected database, for 1–2 level surgical cervical pathology patients  
with  $\leq$ Grade 1 Spondylolisthesis, was performed. Baseline demo-  
graphics, comorbidities, and non-operative modalities were collected.  
Patients were grouped based on pre-operative conservative treatment  
use (NoT vs PrT). Pre-operative epidural steroid injections, physical  
therapy, and narcotics use was sub-analyzed. Primary outcomes  
measures were baseline and 2-year post-operative HRQOL scores  
(SF-36 and NDI), operative data, and complication rates.  
*Results* A total of 1818 patients (757 NoT vs 1061 PrT) were identified.  
Common non-operative modalities included narcotics (36 %) physical  
therapy (35 %), and NSAIDs (35 %). PrT patients were younger (52.3  
vs 50.6 years,  $p < 0.01$ ) with fewer previous cervical surgeries (21.7 vs  
13.2 %,  $p < 0.01$ ). PrT had higher baseline SF36 PCS scores (33.2 vs  
35.8,  $p < 0.01$ ), shorter surgeries (135 vs 122 min,  $p < 0.01$ ) and  
hospitalization (49 vs 37 hr,  $p < 0.01$ ), and lower CSF leak rates (1.4 vs  
0.2 %,  $p < 0.01$ ). At 2 years, PrT has significantly higher SF36 PCS  
(36.6 vs 39.1,  $p < 0.01$ ) and MCS (40.2 vs 42.7,  $p = 0.03$ ) scores.  
Epidural injections were associated with a mean decrease in SF36 MCS  
score ( $-2.54$ ,  $p = 0.042$ ) in the sub-analysis.  
*Discussion* Preoperative conservative treatments were associated with  
shorter surgical and hospitalization length, less CSF leaks, and  
improved 2-year SF36 scores. Only epidural steroid injections were  
associated with improved SF36 MCS scores. These factors should be  
considered in patient counseling efforts and warrant further research.  
*Conclusion* Patients who underwent conservative treatment prior to  
cervical surgery experienced better outcomes with regard to length of  
hospital stay, complications, and patient-reported HRQL measures at  
2-years post-operatively compared to patients who did not undergo  
conservative treatment.
- Clinical and radiological results of bryan cervical disc  
arthroplasty after follow-up of ten years**
- R. Assietti<sup>1</sup>, C. Liberati<sup>1</sup>
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- Introduction* Cervical arthroplasty potentially offers several advan-  
tages such as preservation of segmental motion and reduction of  
adjacent segment degeneration, compared to anterior cervical fusion.  
The aim of this study was to evaluate clinical and radiological out-  
comes of Bryan cervical disc arthroplasty at ten years follow-up.  
*Materials and methods* Sixty patients with radiculopathy and  
myelopathy secondary to degenerative disc disease were followed  
after Bryan cervical disc arthroplasty. We collected radiographic  
parameters, including range of motion anterior and posterior disc  
heights, and clinical parameters, such as Odum, VAS, NDI, SF-36 at  
ten years.



674 **Results** Forty patients (22 males, 18 females) had single-level cervical  
 675 arthroplasty and twenty patients (12 males, 8 females) double-level  
 676 cervical arthroplasty. Single-level Bryan arthroplasty had a clinical  
 677 success in 100, 95, 85 and 90 % of patients after 6 months, 2, 5 and  
 678 10 years, respectively. Double-level Bryan arthroplasty clinical suc-  
 679 cess was observed in 100, 95, 80 and 90 % of patients at the same time  
 680 intervals. After 2 years 95 % of single-level and 85 % of double-level  
 681 Bryan prosthesis had motion; after 5 years 85 % of single-level and  
 682 80 % of double-level Bryan prosthesis had motion with an average of  
 683 9°. At 10 years 90 % of single-level and 80 % of double-level had a  
 684 range of motion of 8°. The incidence of heterotopic ossification was  
 685 15 % for single-levels and 25 % for two-levels after ten years with an  
 686 incidence of 5 % and 7 % respectively of grades IV and V of  
 687 McAfee scale. A single double-level case had revision surgery and  
 688 one single-level had adjacent level surgery.  
 689 **Discussion** Bryan disc prosthesis were able to maintain preoperative  
 690 kinematics at the index level. We observed good range of motion also  
 691 in cases of heterotopic ossification. Clinical results were satisfactory.  
 692 **Conclusion** The Bryan cervical disc prosthesis has a clinical success  
 693 rate comparable to that of historical fusion controls with an accept-  
 694 ably low loss of motion due to heterotopic ossification. We believe  
 695 that in a selected population this technology may be an excellent  
 696 alternative to traditional fusion.

697 **Predicting postoperative segmental upper extremity motor**  
 698 **paresis after cervical laminoplasty by intraoperative**  
 699 **neurophysiological monitoring using transcranial electrically**  
 700 **stimulated muscle evoked potentials (TcE-MsEPs)**

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703 **Introduction** Postoperative segmental upper extremity motor paresis  
 704 in deltoid muscle and biceps brachii muscle (so-called "C5 palsy"), is  
 705 one of the most common postoperative complications after cervical  
 706 laminoplasty. The efficacy of transcranial electrically stimulated  
 707 muscle evoked potentials (TcMsEPs) is still controversial, because  
 708 some papers have reported that postoperative C5 palsy cannot be  
 709 predicted by TcMsEPs, although others have reported that it can be  
 710 predicted. In this paper, we describe our prospective study for pre-  
 711 dicting postoperative C5 palsy using TcMsEPs.

712 **Methods** This study included 160 consecutive cases that underwent  
 713 open door laminoplasty, and TcMsEP monitoring was performed in  
 714 the biceps brachii, triceps brachii, abductor digiti minimi, tibialis  
 715 anterior and abductor hallucis. A more than 50 % decrease in the  
 716 wave amplitude was defined as an alarm point. When alarm was  
 717 given, rescue interventions were performed including steroid, for-  
 718 mainotomy etc.

719 **Result** Postoperative C5 palsy occurred in five cases. Among the 155  
 720 cases without C5 palsy, there were no monitoring alarms. Among the  
 721 five C5 palsy cases, significant wave amplitude decrease in biceps in  
 722 three cases in which the C5 palsy occurred immediately after surgery  
 723 (acute type). Although foraminotomies and steroid administration were  
 724 performed, wave amplitudes did not recover. C5 palsy occurred  
 725 immediately after surgery. In the other two cases where the C5 palsy  
 726 occurred two days after the operation (delayed type), there were no  
 727 significant wave decrease. In all of the cases, the C5 palsy was  
 728 completely resolved within 6 months.

729 **Discussion** Majority of C5 palsy occurred several days following  
 730 surgery, but some of them occurred immediately after surgery. Our  
 731 results demonstrated that TcMsEPs can predict acute type C5 palsy,

732 although delayed C5 palsy cannot be predicted. A more than 50 %  
 733 decrease in the wave amplitude is useful to predict acute type C5  
 734 palsy. In this series, we could predict the occurrence of acute C5 palsy  
 735 in three cases, but we could not prevent the occurrence of the palsy.  
 736 Further examinations about the intervention for monitoring alarm will  
 737 be essential in order to prevent C5 palsy.

738 **Assessment of surgical treatment strategies for moderate**  
 739 **to severe adult cervical deformity reveals marked variation**  
 740 **in approaches, osteotomies and fusion levels**

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751 **Introduction/aim** Although previous reports suggest that surgery can  
 752 improve the pain and functional impact of ACD, approaches and  
 753 techniques for a given deformity are not standardized. Our objective  
 754 was to assess whether there is consensus on recommended surgical  
 755 plans for treatment of ACD based on a survey of deformity  
 756 surgeons.

757 **Methods** 18 ACD cases ranging from moderate to severe and  
 758 including a range of deformities was assembled, including a clinical  
 759 vignette, cervical imaging (x-rays, CT/MRI), and full-length standing  
 760 x-rays. Cases were reviewed by a panel of deformity surgeons who  
 761 were queried regarding recommended surgical plan. Plans were  
 762 compared across surgeons and by deformity type.

763 **Results** The panel included 14 surgeons (10 orthopedic, 4 neuro-  
 764 surgery) that had a mean of 11 yrs in practice, performed an average  
 765 of 80 instrumented cervical cases/yr, including a mean of 20 ACD  
 766 cases/yr. There was marked variation in treatment plans across all  
 767 deformity types. Even for the least complex deformities (moderate  
 768 mid-cervical apex kyphosis), there was lack of agreement on  
 769 approach (50 % combined anterior-posterior, 25 %, anterior-only,  
 770 25 % posterior-only), number of anterior (range: 2–6) and posterior  
 771 (range: 4–16) fusion levels, and types of osteotomies. As the kyphosis  
 772 apex moved caudally (CT junction/upper T-spine) and cases with  
 773 chin-on-chest kyphosis, >80 % of surgeons agreed on a posterior-  
 774 only approach and >70 % recommended a PSO or VCR, but the  
 775 range in number of anterior (4–8) and posterior (4–27) fusion levels  
 776 was exceptionally broad. Cases of cervical/CT scoliosis had the least  
 777 agreement in approach (48 % posterior-only, 33 % combined ante-  
 778 rior-posterior, 17 % 540°, 2 % anterior-only) and had broad variation  
 779 in number of anterior (2–5) and posterior (6–19) fusion levels, and  
 780 recommended osteotomies (41 % PSO/VCR).

781 **Discussion/conclusions** Although previous reports suggest that sur-  
 782 gery can improve the pain and functional impact of ACD, approaches  
 783 and techniques for a given deformity are not standardized. Based on a  
 784 series of 18 ACD cases presented to 14 deformity surgeons, a broad  
 785 range of recommendations was produced, including for surgical  
 786 approach(es), numbers of fusion levels and osteotomy types. These  
 787 findings suggest that further study is needed to assess whether specific  
 788 surgical treatment approaches may be associated with better  
 789 outcomes.

- 790 **Halo fixation in children: anatomical considerations and thickness** 847  
791 **at the pin insertion site** 848
- 792 J. Yamane<sup>1</sup>, P. Domenech<sup>1</sup>, N. Ventura<sup>1</sup>, J. Knorr<sup>1</sup> 849  
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794 Department of Paediatric Orthopaedic Surgery, Barcelona, Spain 851
- 795 *Introduction/aim* The halo skeletal fixator provides immobilization 852  
796 that stabilizes the cervical spine, and can correct with traction spinal 853  
797 deformities. Sometimes the pin penetrates bone of the skull and enters 854  
798 the intracranial space, resulting in potential complications. There is 855  
799 lack of relevant literature concerning pin insertion considerations in 856  
800 children. The aim of this study is to evaluate the thickness of the skull 857  
801 to use the halo fixation safely. 858  
802 *Materials and methods* A CT scan evaluation of skull thickness in 270 859  
803 children from 0 to 16 years old (y/o) stratified by age, 15 children 860  
804 each year of age, only 0 y/o divided into less and more than half year. 861  
805 All cases were attended in the emergency by accident, head CT scan 862  
806 performed, fractures and concomitant head or bone diseases were 863  
807 excluded. The thickness of the skull at the pin insertion sites (right 864  
808 and left anterolateral, right and left posterolateral), anterior and pos- 865  
809 terior and lateral of the vault of each case were measured. 866  
810 *Results* Both anterolateral and posterolateral skull thickness at the pin 867  
811 insertion site increase with age and they reach 2.5 mm by 1 y/o and 868  
812 3 mm by 5 y/o. Anterolateral and posterolateral thickness finally 869  
813 reach 4 mm and 5 mm respectively by 16 y/o. They are bigger in 870  
814 boys than girls at all ages. Lateral skull is thinner than all other points 871  
815 ( $p < 0.01$ ). 872  
816 *Discussion* Halo skeletal fixation is widespread to both adults and 873  
817 pediatric populations, and it is sometimes applied to the children, 874  
818 even if they are less than 3 y/o. In this study, some cases less than 3 875  
819 y/o had the thickness only less than 2 mm. The tapered tip of the pin 876  
820 is usually more than 2 mm, thus care must be taken when used. CT 877  
821 scans are recommended before applying to the patients especially less 878  
822 than 3 y/o. 879  
823 *Conclusion* Care must be taken when pin length is selected in young 880  
824 children. Special pins should be used according to the skull thickness 881  
825 at each age, in order to avoid complications. This study helps to 882  
826 choose the length of the point that should be ideally used in children 883  
827 when halo is applied. 884
- 828 **Reliability of computer tomography scanning for the analysis** 885  
829 **of cervical fusion and pseudarthrosis. A prospective study** 886  
830 **benchmarking CT-based decision making and surgical experience** 887
- 831 M. Mayer<sup>1</sup>, O. Meier<sup>1</sup>, J. Zenner<sup>2</sup>, C. Ullrich<sup>3</sup>, H. Koller<sup>1</sup> 888  
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835 Charlotte, NC, USA 892
- 836 *Objective* Radiological definition of fusion after ACDF impacts 893  
837 clinical course of pts, particularly if residual symptoms persist. CT- 894  
838 scans are accepted as radiographic standard of reference (SoR) to 895  
839 define fusion. However, the appropriate CT-criteria predicting fusion 896  
840 at best has yet not been identified. Thus, an analysis of prediction 897  
841 accuracy of CT-based criteria to assess cervical fusion using surgical 898  
842 exploration as SoR was conducted. 899  
843 *Materials and methods* Prospective analysis of 50 pts scheduled for 900  
844 anterior cervical revision surgery due to suspected pseudarthrosis 901  
845 (PA) after ACDF, spinal stenosis a/o ASD. Preop CT-scans were 902  
846 evaluated, using 9 different criteria to define fusion. Analysis of 903  
CT-scans was done by an independent radiology expert in this field. 904  
During revision surgery a manual segmental translation test was 905  
performed and PA defined as visualized motion at the treated 906  
ACDF-level. 907  
*Results* 44 pts (30 m/14f) with complete data-sets were included. Age 908  
was 54-6a, 19 pts (43 %) were smokers. On average, pts had 1.3 909  
previous surgeries w/ fusion length of 1.8-0.7 levels. 75 cervical 910  
levels were intraop analyzed. Removed implants included 43 PEEK- 911  
cages (62 %), 13 solid metal-cages (19 %) and 13 PMMA-spacers 912  
(19 %). 913  
Surgical exploration revealed motion in 61 ACDF-levels (81 %) 914  
indicating PA. After revision surgery, 3.7-1.1 levels were fused and 915  
1.6-0.7 intervertebral implants/pt had been removed. In 15 pts (34 %) 916  
corpectomies were indicated, in 2 pts (4.5 %) additional posterior 917  
instrumentation. FU was 42-7 months, fusion was achieved in all pts. 918  
Based on CT-scans, radiographic PA-rates, using 9 different param- 919  
eters, were 37-24 % (16-79), compared to 81 % in surgical 920  
exploration. Statistical analysis showed that of 9 parameters used to 921  
predict fusion Bridging bony trabeculae on  $\geq 3$  CT-slices" yielded 922  
highest sensitivity (100 %) & specificity (59 %). Multivariate anal- 923  
ysis revealed that prediction accuracy could not be increased by 924  
combination of several parameters. 925  
*Conclusions* CT-based PA-rates after ACDF, applying 9 different 926  
definitions, varied betw. 16 to 79 %, compared to 81 % assessed 927  
intraoperatively. CT-scans do not have 100 % accuracy to assess 928  
fusion. However, the most reliable parameter to define fusion could be 929  
determined in a prediction analysis. Results might help in decision 930  
making regarding definition of cervical fusion and stress that surgical 931  
exploration remains a viable option in pts with clinical suspicion of PA. 932
- Observations on the natural history of non-operative** 876  
**management of C2 odontoid process fractures in the elderly** 877
- H. Shekhar<sup>1</sup>, A. Daud<sup>1</sup>, P. F. S. Statham<sup>1</sup>, A. Demetriades<sup>1</sup> 878  
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- Introduction/aim* Management of odontoid fractures in the elderly 880  
remains controversial and the use of cervical collars has variable 881  
success. We aimed at studying the outcomes of non-operative 882  
management. 883  
*Materials and methods* Design: Retrospective observational study. 884  
Setting: patients with a C2 odontoid process fracture seen in the 885  
cervical spine fracture clinic over a 2 year period (January 2013- 886  
January 2015). 887  
Inclusion criteria: age  $>70$  years. Exclusion criteria: initial surgical 888  
management; non-compliance with collar; incomplete follow up. 889  
Case-notes and radiology reviewed with patient demographics, clin- 890  
ical status and fracture characteristics. 891  
Outcomes assessed: osseous fusion, stable non-union and unstable 892  
non-union rates. 893  
*Results* 34 patients fulfilled inclusion criteria. Male:female ratio 9:25. 894  
Mean age 83 (range 72-94). 895  
Classification: 1 type I, 24 type II and 9 type III fractures (Anderson 896  
and D'Alonzo classification). 897  
The overall osseous fusion rate achieved at an average of 6 months 898  
c-spine immobilisation was 30 %. Mean age was 80 years. 899  
The healing rates were: 0 % for type I; 8 % for type II; 89 % for type 900  
III. 901  
Non-union rate was 70 %. Of this, about half (ie 38 % of cohort) had 902  
no abnormal movement at the fracture site on dynamic x-rays at an 903  
average of 7 months. 904  
The remaining half, ie those without bony fusion or stable non-union 905  
(32 % of cohort), were offered lifelong collar immobilisation due to 906



907	comorbidities and patient choice. The average age of patients with	<b>Epidemiological survey of ossification of the posterior</b>	967
908	lifelong collar was 85 years.	<b>longitudinal ligament in an adult Korean population:</b>	968
909	4 patients experienced occipital neuralgia and neck pain. 2 patients	<b>three-dimensional computed tomography observation</b>	969
910	died during the observation period due to unrelated causes.	<b>of 3240 cases</b>	970
911	<i>Discussion</i> The patients with unstable non-union tend to be older	S. Sohn <sup>1</sup> , C. K. Chung <sup>1</sup>	971
912	(average age 85) and have significant co-morbidities. Their man-	<sup>1</sup> <i>Seoul National University College of Medicine, Neurosurgery, Seoul,</i>	972
913	agement is guided by patient preference and is challenging. Collar	<i>South Korea</i>	973
914	non-compliance rate was 19 %.	We investigated the prevalence of cervical OPLL based on 3D CT	974
915	<i>Conclusion</i> In the elderly, conservative management of the odontoid	and features of OPLL distribution in an adult Korean population.	975
916	process fracture is a practical option.	During 2011 and 2012, total 3240 patients were enrolled who had	976
917	The majority of patients have a good clinical outcome, with 30 %	undergone thyroid 3D CT. 1084 men and 2156 women were included.	977
918	union and 38 % stable non-union.	Axial and sagittal reconstruction images were used for observations.	978
919	54 % (13/24) of non-union cases were stable on dynamic X-rays. In	The prevalence rate was adjusted according to a standardized popu-	979
920	unstable non-union (32 % of cohort), the question remains whether a	lation by using the "Age Structure of Population in Korea 2010" from	980
921	lifelong collar is appropriate or if the benefits of surgical intervention	Statistics Korea.	981
922	outweigh the risks.	The OPLL prevalence rate was 5.7 %. The standardized prevalence	982
923	<b>The impact of cervical deformity correction for fixed cervical</b>	rate was 4.60 %. The male and female standardized prevalence rates	983
924	<b>kyphosis of more than 50 degrees on clinical results and global</b>	were 6.43 % and 3.61 %, respectively. The over 70 year age group	984
925	<b>spinal alignment</b>	had the highest prevalence rate of OPLL. Age and prevalence rate	985
926	T. Toyone <sup>1</sup> , T. Ozawa <sup>1</sup> , T. Shirahata <sup>1</sup> , S. Kudo <sup>1</sup> , A. Matsuoka <sup>1</sup> ,	were positively correlated in males and females (correlation coeffi-	986
927	K. Inagaki <sup>1</sup>	cients 0.991, 0.991; P = < 0.001, <0.0001, respectively). Among	987
928	<sup>1</sup> <i>Showa University School of Medicine, Department of Orthopaedic</i>	OPLL types, the multiple segmental type was most frequent (37.3 %).	988
929	<i>Surgery, Tokyo, Japan</i>	The most commonly involved level was C5 (4.8 % in male, 2.2 % in	989
930	<i>Introduction/aim</i> Over the past decade, influence of the pelvis on	female), C4 (4.6 % in male, 1.2 % in female), and C6 (3.7 % in male,	990
931	spinal deformity has been explored. However, the role of the cervical	2.4 % in female) segments in decreasing order.	991
932	spine in influencing global spinal alignment has not been well elu-	The standardized OPLL prevalence rate was 4.60 %. The male and	992
933	cidated. The purpose of this study was to investigate the results of	female standardized prevalence rates were 6.43 % and 3.61 %,	993
934	surgery for fixed cervical kyphosis, and to illustrate the impact of	respectively. The prevalence rate of cervical OPLL tended to increase	994
935	surgery for fixed cervical kyphosis, and to illustrate the impact of	with increasing age. The C5, C4, C6 segments were commonly	995
936	cervical kyphosis on global spinal alignment.	involved in the decreasing order.	996
937	<i>Methods</i> Six patients with rigid but non-ankylosing cervical	<b>Analysis of a prospectively acquired database of complications</b>	997
938	kyphosis of more than 50 degrees who underwent anterior pro-	<b>in instrumented cervical surgery and associated risk factors</b>	998
939	cedure were prospectively followed (24–60 months, average:	J. J. N. M. Lukassen <sup>1</sup> , C. C. L. A. M. Vleggeert-Lankamp <sup>1</sup> ,	999
940	42 months) and clinical and radiological outcomes were evaluated.	H. H. de Dauwe <sup>1</sup>	1000
941	Before surgery, all 6 patients complained of loss of horizontal	<sup>1</sup> <i>Leiden University Medical Center, Neurosurgery, Leiden,</i>	1001
942	gaze, and 3 patients exhibited progressive inability to lift their	<i>Netherlands</i>	1002
943	chin off their chest, resulting in the dropped head position that	<i>Aim/introduction</i> Reported complication rates on instrumented	1003
944	impaired their activities of daily living (ADL). Four patients	cervical spinal surgery vary widely in literature. In patient counselling	1004
945	underwent two or three discectomies and placement of trapezoid	and decision making, it is however of high importance to adequately	1005
946	interbody cages and a ventral plate following posterior instru-	be informed on complication rates. The purpose of this study was to	1006
947	mentation (Combined procedure). Two patients underwent two	determine the incidence of complications of instrumented cervical	1007
948	corpectomies and placement of a cylindrical cage and a ventral	spinal surgical interventions and to assess the correlation of these	1008
949	plate (Anterior procedure).	complications to patient-related risk factors.	1009
950	<i>Results</i> Mean operative time was 158 min and mean blood loss was	<i>Methods</i> We prospectively collected data from all patients receiving	1010
951	105 ml in the anterior procedure, and 245 min and 193 ml, respec-	an instrumented cervical surgical intervention from January 1, 2003 to	1011
952	tively, in the combined procedure. The average JOA-score improved	July 31, 2012 in the LUMC neurosurgery department. We excluded	1012
953	from 8.8 points preoperatively to 13.7 at the follow-up (recovery rate:	interventions in which merely cages were implanted. Complications	1013
954	60 %) in patients with myelopathy. Although subsidence of the cage	were collected in a standardized manner, up to 30 days after surgery.	1014
955	was observed in one patient (anterior procedure), the correction was	For evaluation, complications were marked as minor or major impact.	1015
956	maintained with minimal change in the sagittal angle. There were no	<i>Results</i> Of patients treated with anterior (n = 90), posterior	1016
957	other major complications. Mean cervical kyphosis decreased from 59	(n = 232), combined anterior-posterior (n = 29), or anterior poste-	1017
958	to 20 degrees in the anterior procedure, and 60 to 5 degrees in the	rior in 2 tempi (n = 10) procedures, respectively 32, 40, 59 and 90 %	1018
959	combined procedure. T1 slope, lumbar lordosis, and sagittal vertical	had 1 or more complication (total 255 complications). The incidence	1019
960	axis (C7) improved from 2 to 27 degrees, 72 to 52 degrees, and -5 to	of major complications was 14 %, 10 %, 13 %, 29 % (total 34 major	1020
961	+2 cm, respectively. All 6 patients regained horizontal gaze and were	complications). The most common complications were wound	1021
962	satisfied with their ADL.	infections (6.3 %), dysphagia (5.9 %) and CSF leakage (4.7 %).	1022
963	<i>Conclusion</i> In patients with cervical kyphosis of more than 50	Wound infections were more common in anterior/posterior	1023
964	degrees, although compensation was observed globally (T1 slope,		
965	SVA, lumbar lordosis), horizontal gaze was not achieved. Successful		
966	cervical deformity correction yielded not only improvement in ADL		
	but also better global spinal balance.		

- 1024 procedures (17.2 %) compared with anterior only (1.1 %) or posterior  
1025 only procedures (5.0 %) ( $p = 0.009$ ).
- 1026 Complications were associated with more levels of fixation  
1027 ( $p = 0.016$ ), trauma surgery ( $p = 0.009$ ), and tumour surgery  
1028 ( $p = 0.043$ ), but were not associated with ASA score or increased  
1029 operation time. Major complications were associated with increased  
1030 operation time ( $p < 0.001$ ), smoking ( $p = 0.05$ ), combined anterior  
1031 posterior procedure ( $p = 0.049$ ) and combined anterior posterior  
1032 procedures in 2 tempi ( $p < 0.001$ ) and tumour surgery ( $p = 0.005$ ).
- 1033 Multivariate analysis of factors associated with complications identified  
1034 trauma surgery (OR 4.3,  $p = 0.004$ ). Multivariate analysis of  
1035 factors associated with major complications identified combined  
1036 anterior-posterior surgery in 2 tempi (OR 49.8,  $p = 0.005$ ) and  
1037 tumour surgery (OR 8.6,  $p = 0.041$ ).
- 1038 **Conclusion** Instrumented cervical surgery has a substantial compli-  
1039 cation incidence, although most of the complications are minor and  
1040 without long-term impact. Factors associated with major complica-  
1041 tions are combined anterior-posterior procedures in 2 tempi, and  
1042 surgery for spinal tumours.
- 1043 **Laminoplasty and wide decompression were risk factors of C5**  
1044 **palsy: analysis of 303 surgical cases with cervical compression**  
1045 **myelopathy**
- 1046 S. Nori<sup>1</sup>, R. Aoyama<sup>1</sup>, K. Ninomiya<sup>1</sup>, J. Yamane<sup>1</sup>, K. Kitamura<sup>2</sup>,  
1047 T. Shiraishi<sup>1</sup>
- 1048 <sup>1</sup>Tokyo Dental College Ichikawa General Hospital, Department  
1049 of Orthopedic Surgery, Chiba, Japan, <sup>2</sup>Hiratsuka City Hospital,  
1050 Department of Orthopedic Surgery, Kanagawa, Japan
- 1051 **Introduction** C5 palsy is a potential complication after posterior  
1052 cervical decompression. Before 2009, the incidence of C5 palsy was  
1053 9.5 % after double-door laminoplasty combined with laminectomy  
1054 (DL) at our institute. Since 2009, we have performed laminectomy  
1055 alone (LAM) of 2–3 mm wider than the spinal cord width which was  
1056 measured on preoperative myelogram-CT, successfully reducing its  
1057 incidence to 1.0 %. Purpose of this study is to elucidate the risk  
1058 factors of C5 palsy by reviewing the surgical outcomes.
- 1059 **Materials and methods** Out of 303 cervical myelopathic patients  
1060 enrolled in this study, 105 patients underwent DL. The rest of 198  
1061 underwent LAM as wide as preoperatively planned. We statistically  
1062 analyzed risk factors of C5 palsy such as surgical procedures, dif-  
1063 ference in width between surgical decompression and spinal cord  
1064 (DW), dimension of C4/5 foramen measured at its narrowest point on  
1065 axial CT, the amplitude of posterior spinal cord shift at C4/5 level  
1066 (PSS) on sagittal MRI, cervical curvature on plain X rays, the num-  
1067 bers of surgically interfered laminae, OPLL, T2 high intensity area at  
1068 C3/4 level on MRI, age, gender, operation time and blood loss.
- 1069 **Results** Univariate analysis showed significantly higher incidence of  
1070 C5 palsy in patients with DL than those with LAM ( $p = 1.60E - 05$ )  
1071 and in males ( $p = 1.67E - 02$ ). DW ( $p = 5.16E - 05$ ), PSS ( $p =$   
1072  $7.38E - 05$ ), age ( $p = 9.80E - 03$ ), the numbers of surgically inter-  
1073 ferred laminae ( $p = 4.96E - 03$ ), operation time ( $p = 1.13E - 03$ ),  
1074 and blood loss ( $p = 3.02E - 05$ ) were significantly greater in  
1075 patients with C5 palsy than those without. Dimension of C4/5 fora-  
1076 men was significantly narrower in patients with C5 palsy than those  
1077 without ( $p = 6.76E - 04$ ). Multivariate logistic regression analysis  
1078 revealed that DL (OR, 17.2; 95 % CI, 2.8 to 103.9), DW (OR, 1.2;  
1079 95 % CI, 1.0004 to 1.4), dimension of C4/5 foramen (OR, 0.2; 95 %  
1080 CI, 0.08 to 0.6) and age (OR, 1.2; 95 % CI, 1.1 to 1.4) were con-  
1081 sidered as the risk factors of C5 palsy.
- 1082 **Discussion and conclusion** Double-door laminoplasty, wide decom-  
1083 pression, C4/5 foraminal stenosis and advanced age at surgery were  
considered as the risk factors of C5 palsy. Laminectomy of  
2–3 mm wider than the spinal cord width dramatically reduced its  
incidence.
- Surgical management of dropped head syndrome: report of nine cases**
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- Dropped head syndrome (DHS) is relatively rare condition caused by  
posterior neck muscle insufficiency and/or dysfunction of posterior  
cervical stabilizers. DHS significantly affects patients quality of life,  
and sometimes results in chin-on-chest deformity. We report results  
of surgical correction for 9 patients with of DHS.
- Nine patients with DHS who underwent surgical correction were  
reviewed. There were 6 men and 3 women, and their mean age was  
65.1 years (range 32–78). Causes of DHS were idiopathic in 4  
patients, postlaminectomy or postlaminoplasty in 2 and posttraumatic,  
ankylosing spondylitis and rheumatoid arthritis in each 1. All patients  
were suffered from horizontal gaze disturbance, and 7 patients had  
dysphagia preoperatively. 3 patients had cervical myelopathy preop-  
eratively. Deformity had progressed to chin-on-chest deformity in 3of  
9 patients. 7 patients underwent single posterior osteotomy: two  
level Smith-Peterson osteotomy in 6 and pedicle subtraction osteot-  
omy at C7 in 1. Remaining 2 patients underwent combined anterior  
and posterior osteotomy. Cervical pedicle screw fixation utilized in all  
patients. Cervicothoracic fixation for 8 patients and occipitothoracic  
fixation for one patient were performed.
- Sagittal vertical axis (SVA) on standing lateral projection X-ray  
picture was preoperatively had shifted to anterior of the sternum in all  
patients. SVA was transferred by surgical correction to posterior of  
the sternum in all patients. 76 degree of preoperative cervical or  
cervicothoracic kyphosis in average (range: 46–105) was corrected to  
17 degree (range: 5–43). Regarding complication by surgery, transient  
C5 nerve palsy in 2 patients and loss of correction requiring caudal  
extension of fusion levels in one were observed.
- Surgical intervention for DHS caused by neuromuscular disorders had  
been considered difficult and sometimes non-effective. However,  
sufficient correction can be expected by combined use of multilevel  
cervical osteotomy and rigid instrumentation for selected patients.  
Surgeons must consider choice of posterior or combined anterior/  
posterior osteotomy, the spinal levels of osteotomy and length of  
fixation.
- Multilevel anterior cervical decompression, fusion and plate fixation crossing the cervicothoracic junction: surgical outcomes and complications**
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Surgery, Bad Wildungen, Germany
- Objective** Specific anatomic and biomechanical aspects represent  
considerable challenges in anterior cervical decompression, fusion  
and plate fixation (ACDFP) across the cervico-thoracic junction  
(CTJ). While standards for multilevel ACDFP in the subaxial cervical

- 1139 spine C3-C7 are established and outcomes reported, only scarce data  
1140 exists regarding outcomes and complications when crossing the CTJ,  
1141 especially in multilevel reconstructive spine surgery.  
1142 **Materials and methods** Retrospective database analysis. All pts.  
1143 treated w/ ACDFP stopping at T1 for various pathologies were  
1144 included, pts. w/ primary intended antero-posterior surgery and w/  
1145 ankylosing spinal disorders excluded. Pts. charts were reviewed for  
1146 outcomes and complications until final FU, as were preop & postop  
1147 X-rays, CT- and MRI- scans up to last FU, identifying risk factors for  
1148 surgical complications. Pts w/ ACDF  $\geq 4$  levels were identified and  
1149 analyzed separately.  
1150 **Results** 82 pts (45 m/37f, age  $59 \pm 11a$  (21–86) w/ complete clinical  
1151 and radiographic datasets were included in the analysis. FU was  
1152  $64 \pm 42$  m (13–178). Treated pathologies included degenerative  
1153 instability/cervical spinal stenosis at C7/T1 (86 %), fracture (9 %), RA  
1154 (4 %) and spondylodiscitis (1 %). 32 pts had previous anterior cervical  
1155 spine surgery (31 ACDF, 1 CDR). Single- level corpectomies (CE)  
1156 were performed in 18 and 2-level CE in 2 pts. Fusion-length after  
1157 ACDFP was  $3 \pm 1$ (1–5) segments. 40 pts w/ fusion  $\geq 4$  levels were  
1158 identified. Construct failure, increasing segmental kyphosis at C7-T1 or  
1159 telescoping at C7-T1 occurred in 16 % of the overall cohort vs. 22.5 %  
1160 ACDF  $\geq 4$ , indicating revision surgery in overall 7.3 % vs. 7.5 % in  
1161 ACDF  $\geq 4$ . Construct failure or increasing segmental kyphosis was  
1162 observed in 40 % of the overall cohort in pts. initially treated w/ CE.  
1163 55 % of pts with construct failure in the ACDF  $\geq 4$  group were primary  
1164 treated with CE. Non-union at lower cervical spine occurred in 7.5 % of  
1165 pts. w/ ACDF  $\geq 4$ . Revision surgery was furthermore conducted in  
1166 2.4 % w/ persisting C8 radiculopathy and 1.2 % w/ dysphagia.  
1167 **Conclusions** Crossing the CTJ in ACDFP imposes a larger risk for  
1168 loss of alignment and construct failure, especially in cases with  
1169 multilevel reconstructions and if corpectomies have to be performed.  
1170 Our data in the largest cohort of its kind indicate thorough consider-  
1171 ation of primary intended posterior instrumented augmentation in  
1172 this subgroup at risk when accompanied by further risk factors such as  
1173 RA or osteoporosis.
- 1174 **The association between psychiatric factors and the development**  
1175 **of chronic dysphagia after anterior cervical spine surgery**
- 1176 S. Shik Kang<sup>1</sup>, J. K. Shin<sup>1</sup>, T. S. Goh<sup>1</sup>, J. Sub Lee<sup>1</sup>  
1177 <sup>1</sup>*Pusan National University Hospital, Orthopaedic surgery, Pusan,*  
1178 *South Korea*
- 1179 **Aim** The purpose of this study was to identify associations between  
1180 psychiatric factors and the development of chronic dysphagia in  
1181 patients after anterior cervical spine surgery.  
1182 **Materials and methods** The authors prospectively examined 72  
1183 patients with degenerative disc disease of the cervical spine who were  
1184 treated by single-level anterior cervical discectomy and fusion.  
1185 Demographic data including age, gender, body mass index, and  
1186 smoking status were collected. Short form 36 (SF-36), mental com-  
1187 ponent scores (MCS), physical component scores (PCS), Neck  
1188 Disability Indices (NDI), and the Neck Pain and Disability Scale  
1189 (NPDS) were assessed before surgery and at final follow-up. Psy-  
1190 chiatric conditions were evaluated using the Zung depression scale  
1191 and the Zung anxiety scale For statistical analyses, patients were  
1192 divided into two groups: group I, those with No or Mild dysphagia,  
1193 and group II, those with Moderate or Severe dysphagia at least one  
1194 year after surgery. Potential risk factors of chronic dysphagia were  
1195 evaluated by multivariate logistic regression analysis.  
1196 **Results** The prevalences of No/Mild (group I) and Moderate/Severe  
1197 (group II) dysphagia were 69.4 % (50 patients) and 30.6 % (22  
1198 patients), respectively. The two study groups were significantly dif-  
1199 ferent in terms of the presence of a psychiatric problem, preoperative  
NDIs, and MCS scores. However, multivariate logistic regression  
showed that the presence of a psychiatric problem prior to surgery  
( $P = 0.005$ ) was the only significant predictor of chronic dysphagia.  
**Discussion** Little data is available regarding the influence of psychiatric  
factors on chronic dysphagia after anterior cervical spine surgery. The  
variable prevalence and different risk factors of chronic dysphagia  
might be resulted from different definition and evaluating period.  
Dysphagia is very subjective symptoms complained by each patient.  
**Conclusions** The presence of a psychiatric problem seems to be one of  
an important risk factor of chronic dysphagia in patients with cervical  
disc herniation.
- Effectiveness of posterior decompression for cervical disc  
herniation**
- T. Omoto<sup>1</sup>, A. Miyauchi<sup>1</sup>
- <sup>1</sup>*Hiroshima City Asa Hospital, Orthopedics, Hiroshima, Japan*
- Introduction** Anterior discectomy and fusion have been widely per-  
formed with satisfactory results for cervical disc herniation (CDH).  
However, the adjacent segment degeneration is inevitable, which can  
require salvage surgery, especially in the cases with spinal canal  
stenosis. Thus, apart from the central type of CDH, we have performed  
posterior discectomy (PD) or transdural discectomy (TD) with or  
without an expansive open-door laminoplasty. The purpose of this study  
was to report the effectiveness of posterior decompression for CDH.  
**Methods** Forty-eight patients with a more than 2-year follow-up  
period were evaluated in this study. The age at surgery averaged  
49.2 years old; there were 37 males and 11 females. All patients had  
radiculopathy or radiculomyelopathy due to CDH and underwent  
posterior decompression under microscopy. As for surgical options, if  
the canal stenosis was not present, PD alone was selected; however, in  
the cases that the nerve root was tightly compressed with mobility  
disturbed, TD was performed. If the canal stenosis was present,  
laminoplasty was performed and then, either PD or TD was added  
according to the operative findings. Thus, PD alone was performed in  
38 patients, TD alone in 2 patients, PD with laminoplasty in 7  
patients, and TD with laminoplasty in 1 patient. The intensity of  
radiculopathy was scored based on a 10-point VAS; range, 0 (no pain  
or numbness) – 10 (the worst pain or numbness).  
**Results** There was no postoperative infection or symptomatic epidural  
hematoma. Three patients who underwent TD had a transient cere-  
brospinal fluid leakage, but apart from that, there were no  
postoperative complications. Preoperative VAS score averaged  
 $7.6 \pm 1.4$  (range, 3–10), which decreased significantly at follow-up to  
the average of  $0.5 \pm 1.0$  ( $p < 0.01$ ). There was no recurrence of CDH.  
**Conclusion** Posterior discectomy with or without laminoplasty is  
effective with successful relief of radiculopathy and very little risk of  
recurrence of CDH or the adjacent segment problems. TD is con-  
troversial, but familiar with the posterior decompression procedures  
can make it successful option.
- Human induced pluripotent stem cells generated  
from intervertebral disc cells improve neurologic functions  
in spinal cord injury**
- Y. Ha<sup>1</sup>, J. Oh<sup>1</sup>
- <sup>1</sup>*College of Medicine, Yonsei University, Neurosurgery, Seoul, Korea*
- Introduction** The induced pluripotent stem cells (iPSC) have been  
considered as the new cell source for the autografting in regenerative



- 1255 medicine. Recently, it has been found that iPSC derived from human  
1256 fibroblast could differentiate into neurons and improve neurologic  
1257 functions in experimental spinal cord injury (SCI) model. During the  
1258 human SCI treatment, we remove large amount of disc cells as a  
1259 waste product during anterior cervical decompression and fusion.  
1260 Therefore, disc cells should be utilized as a potential substrate for  
1261 generating iPSC cells. To provide the new therapeutic paradigm in SCI  
1262 management, we used the human intervertebral disc cells for estab-  
1263 lishing neural progenitor cells (iPSC-NPC) and differentiate iPSC-  
1264 NPC to neurons in vitro. Moreover, we transplant iPSC-NPCs into  
1265 mouse SCI models and investigate the therapeutic effect of iPSC-NPC  
1266 on neurologic recovery.
- 1267 **Materials and methods** Human iPSC-NPC were generated from  
1268 human intervertebral disc cells which were isolated from lumbar  
1269 discectomy L4/5 specimen. We differentiated human iPSC-NPC into  
1270 neurons in EGF/FGF2 free media. Mouse SCI was induced at the 10th  
1271 thoracic level (T10) with clip application model. Neuronal and glial  
1272 differentiations were identified with immunocyto/histochemical  
1273 staining using Tuj1, GFAP and electrophysiological study. Behavioral  
1274 analyses were performed to identify the neurologic improvement  
1275 after SCI.
- 1276 **Results** The iPSC-NPC was strongly positive with Nestin in growth  
1277 media containing EGF/FGF2. The most of iPSC-NPC were differ-  
1278 entiated into the Tuj1 positive neuron in media without EGF/FGF2. In  
1279 addition, these cells showed the neuron specific electrical signaling  
1280 (Figure 2). To investigate the therapeutic effect of iPSC-NPC on SCI  
1281 model, cells were transplanted into the injured mouse spinal cord at  
1282 9 days after SCI injury. We identified that transplanted cells were  
1283 survived, which was confirmed by human nuclei immunostaining, in  
1284 mouse spinal cord at 5 week after transplantation. Most of trans-  
1285 planted cells were either Nestin-positive neural precursor cells or  
1286 Tuj1-positive neurons. Few of transplanted cells were differentiated  
1287 into GFAP-positive astrocytes. Behavioral analyses demonstrated  
1288 neurologic improvement from two weeks after the initial injury until  
1289 6 weeks after SCI.
- 1290 **Discussion and conclusion** We developed the iPSC-NPC from human  
1291 intervertebral disc cells. These iPSC-NPCs could generate neurons  
1292 and improve neurologic outcomes in mouse SCI model. Therefore, we  
1293 suggest that autologous NPC generated from intervertebral disc cells  
1294 could be one possible stem cell source for SCI.
- 1295 **Clinical characteristics and surgical outcome of revision surgery**  
1296 **in patients with cervical ossification of the posterior longitudinal**  
1297 **ligament**
- 1298 Y. Ha<sup>1</sup>, D. H. Yoon<sup>1</sup>
- 1299 <sup>1</sup>College of Medicine, Yonsei University, Neurosurgery, Seoul, Korea
- 1300 **Objective** Achieving the decompression of spinal cord is the major  
1301 goal of surgical treatment of cervical ossification of longitudinal  
1302 ligament (OPLL). After the index surgery, some patients require a  
1303 revision operation due to failure of appropriate decompression or  
1304 recurrence of symptom. However, there are few articles investigating  
1305 the clinical characteristics and surgical outcomes for revision surgery.  
1306 The goal of this study is to identify the clinical characteristics and  
1307 surgical outcome of revision surgery after the first surgical decom-  
1308 pression of OPLL.
- 1309 **Methods** The authors performed retrospective analysis of a total of  
1310 913 patients (from 1998 to 2012) who underwent surgical decom-  
1311 pression of cervical OPLL. Among them, thirty-five patients  
1312 underwent revision operation. Neurologic and surgical outcomes were  
1313 evaluated using the Japanese Orthopedic Association (JOA score) and  
1314 visual analogue scale (VAS). We measured clinical outcomes,
- radiological findings (C2-7 cervical lordosis, thickness and length of  
OPLL, type of OPLL), surgical procedures and complications. Pre-  
operative, postoperative, and follow-up questionnaires were obtained  
to evaluate clinical outcomes. Causes of revision operation were  
compared between early (within 24 months after the first surgery) and  
delayed (more than 24 months after the first surgery) reoperation.
- Results** Patients with revision operation showed higher prevalence in  
male (89 %) than OPLL patients without revision surgery (71.2 %,  
p = 0.033). Duration of symptom was significantly longer in revision  
operation patients (20.9 vs. 34 months, p = 0.036). However, there  
were no significant difference in age, preoperative symptoms, types of  
OPLL and involved level of cervical spine. In anterior approach,  
compare to OPLL patients without revision surgery, revision opera-  
tion patients required higher number of anterior corpectomy  
procedures (75 % vs. 26.4 % vs. p < 0.001). Preoperative JOA score  
demonstrated significantly lower JOA scores in reoperation patients  
(12.7 vs. 11.5, p < 0.01). However, no significant difference in postop  
1 month JOA scores was found between OPLL without revision and  
revision surgery (14.0 vs. 14.0). Posterior neck pain was improved  
both OPLL without revision (from 3.0 to 2.1, p < 0.001) and revision  
operation (from 3.0 to 2.2, p < 0.001) patients. Incidence of CSF  
leakage (8.6 %, p = 0.02) and instrument failure (2.6 %, p < 0.001)  
in revision operation patients were significantly elevated. Causes of  
revision operation in early reoperation group (n = 15) were higher  
number of symptomatic residual stenosis than delayed reoperation  
(75 % vs. 25 %, p < 0.001). In delayed reoperation group, growth of  
OPLL (50 %) was the primary cause of revision operation.
- Conclusions** Clinical outcomes (JOA and neck VAS) of revision  
operation is as close to the outcome of patients who did not require  
revision surgery. Inadequate decompression and residual stenosis  
after the index surgery is the most common cause of early revision  
surgery. Therefore, in order to prevent unwanted early revision  
operation, surgeons should carefully consider achieving appropriate  
decompression of spinal canal during the index surgery.
- Surgical outcome and prognostic factors of anterior  
decompression and fusion versus posterior open-door  
laminoplasty for cervical compressive myelopathy due  
to ossification of the posterior longitudinal ligament**
- D. H. Yoon<sup>1</sup>
- <sup>1</sup>Spine and spinal cord institute, Yonsei University College  
of Medicine, Neurosurgery, Seoul, Korea
- Introduction/aim** To compare surgical outcome of anterior decom-  
pression and fusion (ADF) with that of laminoplasty, and to  
investigate prognostic factors of ADF for cervical myelopathy due to  
ossification of the posterior longitudinal ligament (OPLL).
- Materials and methods** Between 2005 and 2012, 105 patients  
underwent ADF and 154 patients underwent laminoplasty for com-  
pressive myelopathy due to OPLL at our institution. Finally, 71 ADF  
patients and 64 laminoplasty patients were followed (mean follow-up,  
48 months vs 41 months). We investigated the effects of such vari-  
ables as age, gender, body mass index, presence of diabetes, smoking  
history, type of OPLL, shape of the ossified lesion, occupying ratio of  
OPLL, presence of intramedullary increased signal intensity (ISI) on  
magnetic resonance imaging (MRI), and cervical alignment on sur-  
gical outcome. Neurologic assessment was conducted using the  
Japanese Orthopaedic Association (JOA) scoring system.
- Results** Mean recovery rate was 72.6 % in ADF and 52 % in  
laminoplasty. In multiple regression analysis, older age (p = 0.033), a  
higher ISI grade (p = 0.001) and laminoplasty (p = 0.046) were  
significantly associated with a lower recovery rate. Gender, type of

- 1375 OPLL, shape of the ossified lesion, occupying ratio of OPLL and  
1376 cervical alignment were not associated with recovery rate.  
1377 *Discussion* Although the proportion of excellent or good outcome was  
1378 similar between ADF and laminoplasty patients, poor outcome was  
1379 more frequent in the laminoplasty group than in the ADF group  
1380 ( $p = 0.011$ ). In patients with an occupying ratio  $\geq 60\%$  or with  
1381 presence of ISI on MRI, ADF yielded better surgical outcome than  
1382 laminoplasty ( $p = 0.048$ ;  $p = 0.058$ ).  
1383 *Conclusion* Presence of higher ISI grade, older age and laminoplasty  
1384 were associated with a poor long-term surgical prognosis. ADF is  
1385 preferable to laminoplasty in patients with an occupying ratio  $\geq 60\%$   
1386 or with presence of ISI on MRI in this study. Therefore, evaluating  
1387 ISI and occupying ratio on preoperative MRI is important for  
1388 selecting the appropriate surgical approach and for predicting clinical  
1389 outcome after surgery for cervical compressive myelopathy due to  
1390 OPLL.
- 1391 **Surgery vs nonsurgical treatment of cervical radiculopathy.**  
1392 **A 5–8 year follow-up of a prospective, randomized trial**
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1401 Hospital, Department of Neuroscience, Neurosurgery, Uppsala,  
1402 Sweden, <sup>6</sup>Spine Center Göteborg, Göteborg, Sweden
- 1403 *Introduction/aim* Anterior cervical decompression and fusion (ACDF)  
1404 is a commonly used surgical procedure for patients suffering from  
1405 cervical radiculopathy, but the knowledge of the effects compared to  
1406 nonsurgical treatment is scarce. The aim of this prospective, ran-  
1407 domized study was to evaluate the mid- to long-term results of ACDF  
1408 followed by physiotherapy, compared to physiotherapy alone.  
1409 *Materials and methods* 59 patients were randomized to ACDF with a  
1410 titanium implant (BAK/C), followed by physiotherapy or the same  
1411 structured physiotherapy program alone for at least three months.  
1412 Patients were followed by an unbiased observer for 5–8 years. Out-  
1413 come measures were disability assessed with Neck Disability Index  
1414 (NDI 0–100 %), neck and arm pain assessed with Visual Analogue  
1415 Scale (VAS 0–100 mm), patients' global assessment (better/much  
1416 better or unchanged/worse) and health status assessed with Euroqol  
1417 5-dimensions index (EQ-5D index 0–1). The mean age at inclusion  
1418 was 46 years (range 29–63). The proportion of men was 51 %.  
1419 *Results* There were no significant differences between the two groups  
1420 before randomization. At the 5–8 year follow-up, NDI was reduced  
1421 with a mean difference of 21 (14–28) score % (mean (95 % CI)) in  
1422 the surgical group and 11 (4–18) in the nonsurgical group ( $p = 0.03$ ).  
1423 Neck pain was reduced by 39 (26–53) mm compared to 19 (7–30)  
1424 ( $p = 0.01$ ), and arm pain by 33 (18–49) mm compared to 19 (7–32)  
1425 ( $p = 0.1$ ). EQ 5D index was increased with 0.29 (0.13–0.45) com-  
1426 pared to 0.14 (0.01–0.27) ( $p = 0.12$ ). 93 % of the patients in the  
1427 surgical group rated their symptoms as “better” or “much better”  
1428 compared to 62 % in the nonsurgical group ( $p = 0.005$ ). Significant  
1429 improvement compared to baseline was seen in both groups and for  
1430 all outcome measures.  
1431 *Conclusion* In this group of patients, anterior cervical decompression  
1432 and fusion in combination with physiotherapy was more effective in  
1433 reducing disability and neck pain than physiotherapy alone at the  
1434 5–8 year follow-up. A significantly larger part of the surgically  
treated patients also rated their symptoms as better or much better.  
There were no significant differences between the treatment groups  
regarding improvement of arm pain or health status.
- Is age associated with increased complication rates in cervical spine surgery? A review of 11,765 cases from the scoliosis research society database 2004–2007**
- B. Skovrlj<sup>1</sup>, J. Z. Guzman<sup>2</sup>, I. T. McNeil<sup>1</sup>, A. Lovy<sup>2</sup>, J. M. Caridi<sup>1</sup>,  
S. K. Cho<sup>2</sup>
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- Introduction/aim* Increasing life expectancy and advances in medical sciences have led to more aggressive treatments being offered to the elderly including spine surgery. A few studies have identified advanced age as a risk factor to develop complications following spinal surgery, however these reports are often limited by relatively small number of study subjects.  
*Materials and methods* The Scoliosis Research Society Morbidity and Mortality database was queried for all cervical spine surgeries from 2004–2007. Patient demographics, diagnoses, and complications were analyzed. Two-tailed t-test and Chi square test were performed.  
*Results* Of 11,765 patients, 427 (3.63 %) had complications. Patients with complications were on average 4.4 years older (55.7 vs. 51.3,  $p < 0.001$ ). Mortality was 0.16 %. Patients who died were on average 14.7 years older than those who did not have complications (66.0 vs. 51.3,  $p < 0.001$ ). There was a trend towards increasing complication rates with increased age across all diagnoses. Patients with cervical disc herniation greater than 60 years old were 2.02 times more likely to experience complications ( $p = 0.028$ ). Patients with cervical stenosis experiencing complications were significantly older compared to those that did not experience complications (59.2 vs 56.9,  $p < 0.001$ ), and those older than 60 were 1.32 times more likely to experience complications ( $p = 0.05$ ) Patients with spondylotic radiculopathy with perioperative complications were significantly older than those who did not experience complications (55.2 vs 52.5,  $p = 0.02$ ).  
*Conclusion* Advanced age was associated with increased complication rates including mortality following cervical spine surgery. Other factors such as diagnoses and patient comorbidities may also influence surgical outcome and merit further investigation.
- The impact of anxiety and depression on self-assessed neck disability after surgery for cervical radiculopathy**
- M. Skeppholm<sup>1</sup>, C. Olerud<sup>2</sup>
- <sup>1</sup>Karolinska Institute, Stockholm Spine Center, Stockholm, Sweden, <sup>2</sup>Uppsala University Hospital, Institute for surgical sciences, Uppsala, Sweden
- Introduction/aim* In this study of patients treated for cervical radiculopathy, the aim was to evaluate impact of preoperative anxiety and depression on outcome.  
*Methods* 151 patients included in a RCT comparing ACDF with artificial disk replacement, were evaluated at a two-year follow up. 48 % were women and mean age was 47 years. Primary outcome was Neck Disability Index (NDI) at two years. Preoperative data included age, gender, smoking, level and duration of pain, sick leave, unemployment and use of analgesics. Preoperative anxiety and depression

- 1490 was evaluated with the Hospital Anxiety and Depression Scale:  
 1491 HADa and HADd respectively. The results were blinded to the surgeons  
 1492 before intervention. The preoperative possible risk factors were  
 1493 correlated to NDI at two years postoperative and also computed in a  
 1494 linear regression model.  
 1495 **Results** The stepwise regression analysis showed that HADa  
 1496 ( $p < 0.01$ , adjusted  $r$  square = 0.25), HADd ( $p < 0.01$ , adjusted  $r$   
 1497 square = 0.21) constituted the major factors for the variance in NDI  
 1498 after two years. Patients scoring low in anxiety (HADa  $< 11$ ;  $n = 104$ )  
 1499 and depression (HADd  $< 11$ ;  $n = 124$ ) had mean preoperative NDI  
 1500 levels of 59 and 60 respectively while patients scoring high ( $> 11$ ),  
 1501  $n = 32$  and  $n = 12$  respectively, had corresponding NDI levels of 68  
 1502 and 74. At two years, the low scoring patients' mean NDI levels were  
 1503 30 and 32 respectively while the high-scoring groups' were 54 and 56.  
 1504 The difference was statistically significant, even after Bonferroni  
 1505 correction,  $p < 0.01$ .  
 1506 **Discussion** The mechanisms for the association between mental distress,  
 1507 pain and self-assessed function are not fully understood but it is  
 1508 possible that the pathways are bidirectional: Painful conditions can  
 1509 most likely cause anxiety and in long term also depression, and  
 1510 probably also vice versa. We therefore suggest that screening, with  
 1511 the intention to detect mental distress, should be a part of the pre-  
 1512 operative evaluation.  
 1513 **Conclusion** Patients with high preoperative levels of anxiety and  
 1514 depression did not improve to the same extent. More studies are  
 1515 needed to investigate whether this group of patients may achieve  
 1516 better results if other treatments are offered, either non-surgical  
 1517 treatment alone or as an adjunct to surgery.
- 1518 **Abnormal magnetic resonance image's and radiographic findings**  
 1519 **of the cervical spine in over 1200 asymptomatic subjects:**  
 1520 **a prospective investigation**
- 1521 Y. Yukawa<sup>1</sup>, H. Nakashima<sup>2</sup>, F. Kato<sup>1</sup>
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 1524 of Orthopedic Surgery, Nagoya, Japan
- 1525 **Introduction** To determine the importance of abnormalities on mag-  
 1526 netic resonance image (MRI), we must take into account (1)  
 1527 frequency and (2) spectrum of structural abnormalities which may not  
 1528 cause symptoms. There are no large- scale studies regarding abnormal  
 1529 findings of cervical spine on MRI in asymptomatic subjects. The  
 1530 purpose of this study was to reveal the frequency and details of  
 1531 abnormal findings in cervical spine MRI images of asymptomatic  
 1532 subjects over 1200.  
 1533 **Materials and methods** 1,211 healthy volunteers were enrolled in this  
 1534 study. Exclusion criteria included a history of brain or spinal surgery,  
 1535 neurologic disease such as cerebral infarction and neuropathy,  
 1536 symptoms related to sensory or motor disorders. At least 100 men and  
 1537 100 women of each decade between ages 20 and 70 were included in  
 1538 this study. MRI scans were performed with a 1.5-Tesla supercon-  
 1539 ductive magnet. All the participants underwent both MRI and  
 1540 neurological examinations by two spinal surgeons. Abnormal findings  
 1541 such as spinal cord compression, signal changes in the spinal cord and  
 1542 disc bulging ( $> 1$  mm) were recorded. To study the effect of aging on  
 1543 the prevalence of abnormal images, we compared the frequency of  
 1544 unusual MRI findings in adults below and above 40 years old.  
 1545 **Results** Compression of the spinal cord was found in 64 (5.3%)  
 1546 patients. Of those, 0.5% and 7.7% are  $< 40$  and  $> 40$  years respec-  
 1547 tively. High signal intensity changes in T2 sagittal images were found  
 1548 in 28 (2.3%). 0.2% of these patients were  $< 40$ , while 3.3% are  
 1549  $> 40$  years old. 1061 patients (87.6%) had disc bulging. Within this  
 population, 78.8% and 91.8% were less and greater than 40 years  
 old. Prevalence of spinal cord compression, signal changes on MRI  
 and disc bulging were significantly higher in subjects greater than  
 40 years old ( $p < 0.05$ ).  
**Conclusions** As a consequence of aging, prevalence of abnormal MRI  
 findings related to degenerative change such as spinal cord com-  
 pression, high signal intensity changes and disc bulging increased.  
 These data emphasize on the dangers of predicating operative deci-  
 sions on diagnostic tests without precisely correlating MRI findings  
 with clinical signs and symptoms.
- Cervical PEEK cages with demineralized bone matrix - to fill  
 or not to fill?**
- J. Schroeder<sup>1</sup>, M. Winking<sup>1</sup>, A. G. Hellwig<sup>1</sup>, T. Krampulz<sup>1</sup>
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 Germany
- Introduction** The implantation of a spacer is common practice after  
 anterior discectomy in cervical spine. PEEK cages are in favor due to  
 their better radiological behavior in postoperative MRI-scans but  
 earned a bad reputation due to their low fusion rates. The question is,  
 does filling the cage with demineralized bone matrix (DBM) enhance  
 the fusion rate?  
**Materials and methods** We report two consecutive groups of patients  
 suffering from cervical radiculopathy or mild myelopathy treated with  
 single level PEEK Cage fusion with their 1- or 2-year follow up  
 completed. The implantation was performed in 68 cases with dem-  
 ineralized bone matrix (DBM) in the central hole of the cage and in  
 74 cases empty. At follow up examination fusion was determined by  
 either plain X-ray or CT scan in selected cases.  
**Results** After minimum follow up of one year (mean 15  $\pm$  4 month)  
 in 46 cases of the DBM group ( $n = 68$ ) fusion occurred as bony  
 bridging around the PEEK cage, in 17 cases the result was indifferent  
 and 5 cases showed signs of nonunion suspect of a pseudarthrosis. In  
 the group with empty cages ( $n = 74$ ) 50 were fused, 20 indifferent  
 and 4 were considered pseudarthrotic. There is no significant differ-  
 ence between the two groups ( $p = 0.874$  in Chi square test).  
**Discussion** The fusion rate of PEEK cages does not improve by  
 adding demineralized bone matrix (DBM). The additional costs of  
 DBM are not justified in monosegmental anterior cervical decom-  
 pressive surgeries.
- PICA end vertebral artery as potential risk factor of cervical  
 surgery: relation between frequency and diameter of vertebral  
 artery**
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- <sup>1</sup>Teine Keijinkai Hospital, Spine Center, Department of Orthopaedic  
 Surgery, Sapporo, Japan
- Introduction** Vertebral artery (VA) injury exists in cervical spine  
 surgery. Typically, both VA configure basilar artery (BA), cover  
 posterior circulation. So one side VA injury doesn't result in posterior  
 circulation ischemia. And dominant VA is advocated to be paid  
 attention to preserve. Oppositely the risk of non-dominant side injury  
 isn't advocated, it is not clear whether safe or not. There is PICA end  
 VA, that doesn't unite the other side and ends as PICA. Injury of such  
 type of VA possibly leads to cerebellar infarction. Features of PICA  
 end VA is described.



- 1604 **Materials and methods** Consecutive 367cases of head and neck MRA  
1605 were taken. The purpose of taking MRA were for acute and chronic  
1606 stroke, tumor, simply medical check-up, etc. Diseases which alter  
1607 normal anatomy, were excluded. Diameter of VA was measured at V2  
1608 portion. If non-dominant side VA was less than 3/4 to dominant side,  
1609 it was classed as asymmetric. Epidemiological fact, relation between  
1610 laterality, diameter and frequency of PICA end VA was analysed.  
1611 **Results** 358 cases were included in this study. They were 207male and  
1612 151female, age were 10–94(67.8 ± 13.8). As typical, both VA con-  
1613 figure BA in 296cases (82.7 %). PICA end VA were in 44cases  
1614 (12.3 %). And in 18cases (5.0 %), one side VA were absent. VA  
1615 were symmetric in 194cases (54.2 %). And in 164cases (45.8 %), it  
1616 was asymmetric. Diameter of all VA were 3.2 ± 0.76 mm. Diameter  
1617 of PICA end VA were 2.0 ± 0.55 mm, which were significantly  
1618 smaller than non-dominant but not PICA end VA, 2.8 ± 0.59 mm.  
1619 38/44cases (86.4 %) were less than 2.5 mm. Among VA less than  
1620 2.0 mm, 26/56cases (46.4 %) were PICA end VA. PICA end VA  
1621 were only 4cases (2.1 %) in symmetric VA, 40 of 146cases (27.4 %)  
1622 in asymmetric (except 18cases of one side VA). And if dominant side  
1623 is more double than the other, 55.9 % were PICA end VA.  
1624 **Conclusions** It is not clear that injury of PICA end VA result in cere-  
1625 bellar infarction, and no such case was reported. Even so, non-  
1626 dominant VA also should be preserved since potential risk exists. From  
1627 present study, PICA end VA is not rare. In case of VA asymmetry, and  
1628 thin VA, the possibility of PICA end VA should be recognized.
- 1629 **Novel classification of cervical myelopathy and surgical results**
- 1630 H. Mihara<sup>1</sup>, Y. Tataro<sup>1</sup>, T. Niimura<sup>1</sup>, Y. Ito<sup>1</sup>, T. Morii<sup>1</sup>
- 1631 <sup>1</sup>*Yokohama Minami Kyosai Hospital, Spine Center, Yokohama, Japan*
- 1632 **Introduction** We propose a novel classification system according to  
1633 quantitative motor and sensory scores in the four extremities. The  
1634 aims of this study were to introduce this classification system and  
1635 compare the post-operative neurological improvements among the  
1636 types.  
1637 **Methods** This study included 253 patients who were diagnosed with  
1638 cervical myelopathy and underwent surgical treatments with at least a  
1639 one-year follow-up. All patients were evaluated regarding the motor  
1640 function with performance tests and Daniels' manual muscle test. The  
1641 performance tests used were the Grip and Release Test (GRT) for the  
1642 upper extremities and the Triangle Step Test (TST) for the lower  
1643 extremities. In addition, quantitative sensory scores were recorded.  
1644 The motor disturbance pattern was classified into five types according  
1645 to the affected extremities as follows; Type I (Anterior lesion syn-  
1646 drome) developed motor dysfunction on unilateral upper extremity.  
1647 Type II (Central type) involved motor dysfunction mainly of the  
1648 bilateral upper extremities. Type III (Posterior type) showed an ataxic  
1649 gait and severe deterioration of the deep sensation. Type IV (Uni-  
1650 lateral type) was characterized by hemi-palsy of the upper and lower  
1651 extremities. Type V (Transverse type) involved motor and sensory  
1652 disturbance of all extremities. The cervical JOA score was used to  
1653 evaluate the severity of myelopathy. On post-operative follow-up, the  
1654 improvement rate of each score was calculated.  
1655 **Results** All patients were classified into five types by our system. The  
1656 mean age at surgery was higher in Type III and Type V. The per-  
1657 formance tests of the GRT and the TST showed lowest scores in Type  
1658 V. As to the severity of myelopathy, the Type raised the JOA score  
1659 was inversely decreased. Post-operative neurological improvement  
1660 was significantly higher in Type I (60.0 %) and Type II (62.3 %)  
1661 compared with Type III (42.5 %) and Type V (48.5 %). As to surgical  
1662 method, anterior procedure indicated better improvement in all types  
1663 except for Type IV.
- Discussion/conclusion** According to our classification system, Types I  
and II which mainly involved segmental signs of the upper extremi-  
ties showed better neurological improvement compared to the other  
types which might include damage on the white matter containing the  
long tracts in the spinal cord.
- The transverse atlantal ligament (TAL) does not matter:  
a retrospective review of fixation of C1 ring fractures**
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- <sup>1</sup>*Harborview Medical Center/University of Washington, Orthopaedic  
Surgery, Seattle, USA*
- Introduction/aim** Our goal was to evaluate a series of unstable C1  
fractures treated with C1 open reduction and internal fixation (ORIF)  
in order to assess clinical and radiographic outcomes by evaluating  
success of reduction and pain relief.  
**Materials and methods** A retrospective review of all patients with C1  
fractures was performed to identify all patients treated with ORIF for  
an unstable C1 fracture from 2002–2013. Primary outcomes included  
radiographic reduction, visual analog scale (VAS), and development  
of instability at C1-C2.  
**Results** Twelve patients underwent C1 ORIF with mean age 43 (9  
males and 3 females) and mean follow up of 17 months. The TAL  
was found to be disrupted with Type I or Type II injury in 11 of the 12  
patients – 5 type I and 6 type II. Preoperative lateral mass displace-  
ment averaged 7.1 mm with postoperative displacement averaging  
2.4 mm (p value <0.001). VAS score averaged 0.7 at latest follow up.  
No patient went on to develop C1-C2 instability on final flexion-  
extension films. No patient had a complication resulting in neurologic  
deficit or vascular injury associated with the procedure, nor were there  
late sequelae of malunion or loss of reduction. Two surgically related  
complications occurred including 1 errant screw requiring return to  
OR for and 1 case of osteonecrosis of the lateral mass of C1.  
**Discussion** The results illustrate that C1 ORIF effectively reduces and  
holds C1 fractures with few complications while providing excellent  
pain relief. Additionally, the above data suggests ORIF is not pri-  
marily contingent on TAL integrity and provides alternative to C1-2  
fusion in this setting.  
**Conclusion** Patients with unstable C1 ring fractures can be success-  
fully managed with primary ORIF. ORIF results in a stable construct  
that maintains reduction, results in excellent pain control and does not  
lead to C1-2 instability. Lack of TAL integrity is not a contraindica-  
tion for the procedure.
- Clinical management for spinal cord injury in patients  
with cervical ankylosing spinal disorders**
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- Introduction** Ankylosing spinal disorders (ASD) includes ankylosing  
spondylitis (AS), ankylosing spinal hyperostosis (ASH) and diffuse  
idiopathic skeletal hyperostosis (DISH). ASD is a great risk factor for  
fracture due to the loss of spinal flexibility and bone fragility. Minor  
trauma can lead to spinal fracture with subsequent severe neural  
damage. The purpose of this study is to discuss about the pathology of  
cervical fracture in ASD and review our management.  
**Materials and methods** We report 43 cervical ASD cases with spinal  
cord injury (SCI). The clinical records were reviewed about pain and

1719 neurological functions. Image analysis was essential for surgical  
 1720 planning. CT revealed bone condition and MRI identified 3-columns  
 1721 injury. We investigated ASD type and bone condition.  
 1722 **Results** Neurological deficits were revealed in 37/43 patients. 39  
 1723 patients (91 %) had minor trauma and 21 patients had late neurological  
 1724 deterioration. Surgical treatment has been performed in 40 patients.  
 1725 The rest three patients were followed conservatively due to their co-  
 1726 morbidity. In this series, all patients except one ABF case were treated  
 1727 with using posterior screw fixation. Surgical outcomes were reliable.  
 1728 Pain control was good in all cases. 13/34 cases showed neurological  
 1729 recovery. However there was no improvement in 21 cases including 9  
 1730 Frankel A. We divided into three groups to assess ASD type ((1)  
 1731 continuous, (2) segmental, (3) combined type). 40 surgical cases were  
 1732 divided in 18 continuous, one segmental and 21 combined cases.  
 1733 **Discussion** We assessed ASD type and bone condition. Pathology of the  
 1734 fracture was different between ASD types. Continuous group showed  
 1735 bone injury like long bone, however 21 combined cases showed 11 bone  
 1736 fractures and 10 marginal lesions. Though bone quality was poor, CT  
 1737 revealed rim sclerosis including bone bridge and ossification in 20 cases.  
 1738 The rim sclerosis sign assisted short fusion in 7/20 cases.  
 1739 **Conclusion** Spinal fracture in ASD extends completely across the ver-  
 1740 tebral segment. Secondary neurological deterioration is easily occurred  
 1741 due to extremely unstable spine. Cervical fracture in ASD requires  
 1742 aggressive surgical intervention. Multiple screw fixation is the first line to  
 1743 allow sound bone healing. However short fusion is also available in  
 1744 combined ASD type and good bone condition with rim sclerosis.

1745 **Investigation of the etiology of dysphagia after occipitospinal**  
 1746 **fusion by videofluoroscopic swallowing study**

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1750 **Introduction** Dysphagia is one of serious complications of occipi-  
 1751 tospinal fusion (OSF). It has been suggested that posterior shift of

mandible and tongue root caused by the reduction of the occipito-C2  
 angle (O-C2A) makes the oropharyngeal space narrow and resulted in  
 postoperative dysphagia. In fact, there has been little tangible evi-  
 dence to support this hypothesis. The aim of this study is to elucidate  
 the mechanism of dysphagia after OSF by analyzing swallowing  
 process using the videofluoroscopic swallowing study (VFSS).

**Materials and methods** A total of 42 patients underwent OSF between  
 2005 and 2014 and six patients experienced postoperative dysphagia.  
 Four patients with postoperative dysphagia (group D: all were female,  
 averaged 76.0 y.o.) and four patients without postoperative dysphagia  
 (group N: all were female, averaged 67.3 y.o.) participated in this  
 study. For VFSS, all patients were monitored to swallow 5-ml diluted  
 barium solution under fluoroscopic condition in the lateral view, and  
 then dynamic passing pattern of the barium solution were analyzed. In  
 addition, O-C2A was measured in each patient for the assessment of  
 craniocervical alignment.

**Results** O-C2A in group D was  $-8.0$  degrees, which was relatively  
 smaller than  $7.8$  degrees in group N ( $P = 0.07$ ). In group D, all cases  
 presented smooth medium passing without any obstruction at the  
 upper cervical level regardless of the posterior shift of the mandible  
 and tongue root. However, the obstruction to the passage of medium  
 by the pharyngeal stenosis was detected at the level of the apex of  
 mid-lower cervical curvature below piriform sinus, where the anterior  
 protrusion of mid-lower cervical spine compressed directly the pha-  
 ryngeal space. In group N, all cases showed smooth passing of  
 medium through the process of swallowing.

**Discussion** This study presented postoperative dysphagia did not  
 occur at the upper cervical level even though there was smaller angle  
 of O-C2A and demonstrated the narrowing of the oropharyngeal  
 space due to direct compression by the anterior protrusion of the mid-  
 lower cervical spine was the etiology of dysphagia after OSF.

**Conclusion** We showed the evidence that dysphagia after OSF  
 occurred at the level of mid-lower cervical spine.