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ABSTRACTS

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INFECTION, TUMOR, EPIDEMIOLOGY

1

FOSTERING PHYSICAL ACTIVITY AFTER COMPLEX LUMBAR SPINE SURGERY: A RANDOMIZED TRIAL

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Background: Prolonged sedentary lifestyle after recuperation from lumbar surgery is due to fear of spine injury, pain, deconditioning, and habit, and incurs serious long-term adverse consequences (e.g., Sedentary Death Syndrome). Because the surgical team understands the extent of surgery and spine condition, it ideally can advise and encourage prudent activity.
Purpose: To determine if a behavioral intervention would be effective in increasing prudent physical activity, primarily walking.
Sample: 225 patients, RCT 3 months after complex lumbar surgery, subsequent follow-up after additional 4–6 months.
Outcome: Paffenbarger Physical Activity and Exercise Index (PAEI).
Methods: During routine postop visits, 111 intervention patients received 1) a booklet about benefits of physical activity/national activity guidelines 2) instruction on how increase lifestyle walking 3) a pedometer calibrated to stride length 4) made a self-contract specifying walking goals and 5) received periodic telephone contract-directed encouragement from study personnel. 114 controls received information about safe physical activity. At enrollment all patients completed the valid 3-domain PAEI measuring number of blocks walked and stairs climbed daily and sports during the past week. Kcal/week were calculated for each domain and for an overall total. The national recommended threshold overall total is $\geq$ 2000 kcal/week. Patients also completed the GAD7 for general anxiety. OR records were reviewed and a Surgical Invasiveness Index (SII) value was calculated (max 10 points/vertebral level); higher is greater complexity. The primary outcome was change in PAEI walking domain Kcal/week after 4–6 months; another outcome was change in overall total Kcal/week.
Results: At enrollment intervention and control groups were similar in mean age (64 vs 64), women (44% vs 50%), median SII value (11 vs 10), PAEI walking Kcal/week (1447 vs 1246), PAEI overall total Kcal/week (1826 vs 1631), and percent meeting the recommended activity threshold (37% vs 30%) (all $p > .05$). Mean time from surgery to enrollment was 2.9 months, and from enrollment to follow-up was 4.2 months. The within-patient mean increase in PAEI walking was 1132 vs 582 kcal/week ($p = .03$) and the increase in PAEI overall total was 1713 vs 1067 kcal/week ($p = .04$). In multivariable analysis with change in PAEI walking as the dependent variable, intervention group ($p = .02$), younger age ($p = .003$), and more anxiety ($p = .05$) were associated; more complex surgery was not ($p = .26$). Similar results were found with PAEI overall total as the dependent variable. At the follow-up more patients in the intervention group met the $\geq$ 2000 kcal/week threshold (63% vs 46%) (OR 2.0, CI 1.2–3.5, $p = .009$).
Conclusions: A behavioral intervention in the spine care setting succeeded in increasing physical activity after recuperation from lumbar surgery and in helping patients regain prudent activity to promote subsequent spine and overall health.
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2

EXPRESSION OF TRPV4 IN HUMAN IVDS AND ITS RELEVANCE IN STRETCH-INDUCED INFLAMMATION

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Introduction: Transient receptor potential (TRP) channels are cation selective transmembrane channels with diverse activation mechanisms and physiological function. Dysregulation of TRP channels is implicated in numerous pathologies. TRPV4 for example is involved in mediating inflammatory swelling in arthritic joints; in addition, TRPV4 regulates transduction of mechanical signals in various cell types. A first study from 2016 indicates that TRPV4 is expressed in the IVD and seems to be associated with reduced osmolarity and pro-inflammatory cytokines. The aim of this study was to (1) investigate TRPV4 expression patterns in a comprehensive manner and (2) determine whether TPRV4 plays a role in stretch-induced inflammation.
Methods: For the analysis of TRPV4 mRNA expression in human IVDs, a total of n = 22 human degenerated (IVD degeneration/herniation) and n = 12 non-degenerated IVD tissue samples (autopsies) were used. Gene expression was compared between degeneration and non-degeneration, NP and AF, as well as for various patient characteristics. In a second step, the relevance of TRPV4 in stretch-induced inflammation (gene/protein), calcium flux and activation of the MAPK pathways was investigated in human AF cells in vitro, using a commercial bioreactor ($n \geq 3$, with/without pharmacological TRPV4 inhibition = GSK2193874, 20–500 nM). Results of inhibition studies were confirmed by CRISPR/Cas9. Statistical analysis was conducted by Student t-tests, Aspin-Welch unequal variance tests or one-way ANOVA with Tukey correction, with a significance level of $p < 0.05$.
Results: TRPV4 mRNA was detected in all human IVD tissue samples. No statistically significant differences were found between the degenerated and non-degenerate samples, IVD zones, degeneration grade, Modic changes, pain intensity and duration. Based on the constitutive expression of TRPV4, we subsequently investigated its role in IVD mechanobiology. To determine the relevance of TRPV4 in mechanotransduction, 1 h of stretching at 20% strain/1 Hz (= high physiological levels) was used, resulting in a significant mRNA upregulation of inflammatory mediators, such as IL-6 (2.6 fold) and COX-2 (8.1 fold). Induction of inflammation could also be confirmed on the protein level for selected targets, such as PGE2. Stretch-induced inflammation was accompanied by a significant MAPK activation and calcium flux. Importantly, pharmacological inhibition of TRPV4 was able to reduce cytokine expression (Fig. 1) and MAPK activation. First results using CRISPR/Cas9-based knockout of TRPV4 verify its relevance in stretch-induced inflammation.
Discussion: TRPV4 was consistently expressed in human IVD samples, indicating its fundamental function in IVD physiology and mechanotransduction. Our results suggest that stretch-induced inflammation is at least in part mediated by TRPV4. TRPV4 may thus constitute a potential target to modulate mechano-immunosensing in the IVD and thus tackle degenerative disc disease.

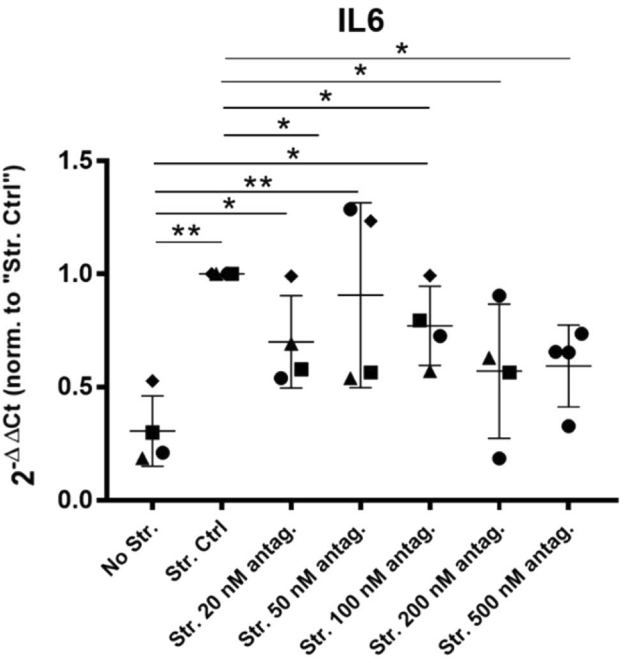

Fig.1 Gene expression of IL-6 in human AF cells that were non-stretched (No. Str.), stretched or stretched with simultaneous TRPV4 inhibition with GSK2193874 (Str. antag.) (n=4). *p<0.05, **p<0.01.

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3

INTRAOPERATIVE SALVAGED AUTOLOGOUS BLOOD TRANSFUSION IS SAFE IN METASTATIC SPINE TUMOUR SURGERY: EARLY OUTCOMES OF PROSPECTIVE CLINICAL STUDY

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Introduction: Allogeneic blood transfusion (ABT) is the mainstay of blood replenishment; however, it is associated with immune-mediated complications. Salvaged blood transfusion (SBT) has allowed us to overcome such complications. We have proved the safety profile of SBT in MSTS. However, surgeons remain reluctant to employ SBT in metastatic spine tumour surgery (MSTS) due to ill-founded fears of tumour dissemination and disease progression. We aimed to investigate tumour progression, overall survival (OS), reduction in ABT requirement and to reaffirm safety profile in patients who receive SBT during MSTS.

Methods: We present a prospective study of 73 patients who underwent MSTS at our institution from 2014 to 2017. Data collected included demographics, tumor histology, metastatic disease burden, clinical and investigational findings, operative & blood transfusion (BT) details and post-operative complications. Patients were divided based on BT type into 3 groups: no blood transfusion (NBT), SBT and ABT. Primary outcomes were assessed at 6, 12 and 24 months. Tumour progression was evaluated using Response Evaluation Criteria in Solid Tumours (RECIST) (v1.1). Modified Tokuhashi score was studied for its association with OS. All follow-up investigations (CT chest/thorax-abdomen-pelvis, MRI spine and bone scans) were studied. Patients were then classified into those with non-progressive and progressive disease.
Results: Seventy-three patients [39 (53.4%) males & 34 (46.6%) females], had a mean age of 61 years [range: 20–84 years]. Overall median follow-up and survival were 26 and 12 months respectively. Most common primary tumours were lung [20(27.4%)], breast [13(17.8%)], prostate [6(8.2%)] and colon [6(8.2%)]. Overall median blood loss was 500 mL [IQR: 250–970 mL] and BT was 1000 mL [IQR: 500–2000 mL]. Twenty-six (35.6%) patients received SBT, 27 (37.0%) ABT and 20 (27.4%) required NBT. Blood loss in NBT group was significantly lower ($p < 0.001$) than that in SBT and ABT groups. Females had a lower OS and a higher risk of tumour progression compared to that of males. Higher Tokuhashi score had decreased risk of death and tumour progression. Overall, patients who had received SBT had a better OS (Fig. 1) and a reduced risk of tumour progression than those who received ABT. Total blood loss was not associated with tumour progression. Medical complications and SSI were comparable among all 3 groups. Infective complications other than SSI were significantly ($p = 0.027$) higher in ABT group than that in NBT and SBT groups.
Conclusions: (i) Patients who had received SBT had outcomes (OS and tumour progression) comparable to or better than ABT and NBT groups. (ii) This study proves that the use of salvaged blood in MSTS is safe and can become a standard of care for these surgeries. (iii) To the best of our knowledge, we are the first to report this contemporary practice of the use of SBT in comparison with control groups (ABT and NBT groups) in MSTS.

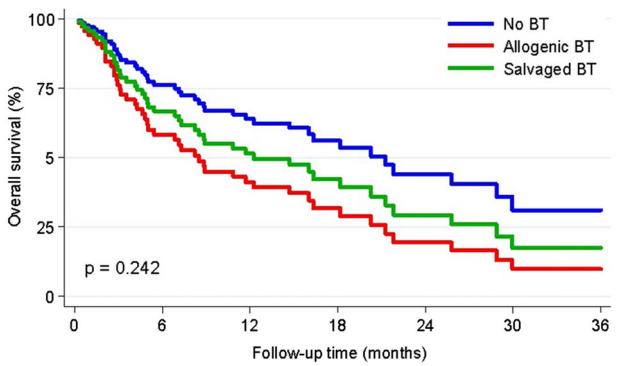

Fig. 1: Overall survival curves over follow-up time according to blood transfusion type, adjusted for age group (≥ 60 years vs. < 60 years), gender (female vs. male), total blood loss (ln scale) and total Tokuhashi score by the multivariable Cox proportional hazards regression model

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CURRENT TRENDS AND PERIOPERATIVE COMPLICATIONS OF SURGERIES FOR SPINAL INFECTIONS IN THE SUPER-AGEING SOCIETY: A MULTI CENTER STUDY

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Purpose: The increase of the elderly and compromised hosts can result in the growing numbers of the patients with spinal infections. Japan is now experiencing a „super-aging"society and this multicenter study aimed to investigate the current characteristics in surgeries for spinal infections in Osaka of which aging rate is above 25%.
Method: A total of 22,295 patients who underwent spinal surgeries at 25 institutions around Osaka in Japan were registered prospectively between 2012 and 2017. 341 patients who underwent surgeries for spinal infections were reviewed from this database. The demographic data (age and gender), pathology (pyogenic or tuberculous), affected level, surgical procedures, and perioperative complications were investigated.
Results: The annual ratio of surgeries for spinal infections to those of all spinal surgeries was between 1.21% and 1.98% in the last 6 years. Of the 341 patients, 201 patients were diagnosed with pyogenic spondylitis and 79 patients were tuberculous spondylitis; however, the other 61 patients were not identified due to lack of information. The number of surgeries for pyogenic spondylitis increased during this period; however, that of surgeries for tuberculous spondylitis decreased. The median age of patients with pyogenic spondylitis and tuberculous spondylitis at the time of the surgeries was 70 years (range, 14–91 years) and 74 years (range, 22–88 years) respectively, and the median age did not change significantly during this period both in pyogenic and tuberculous spondylitis. The percentage of the male performed surgeries for tuberculous spondylitis was significantly higher than those for pyogenic spondylitis (53% vs. 33%, $p = 0.003$). In both pathologies of infection, lumbar spine was more frequently affected than the other levels. The surgical procedures for pyogenic spondylitis consisted of various surgical approaches with or without instrumentation. In contrast, 72% of the surgeries for tuberculous spondylitis were performed with anterior instrumentation and fusion. Perioperative complications occurred in 28 patients (8.2%); 19 of 201 patients (9.5%) in pyogenic spondylitis, 5 of 79 patients (6.3%) in tuberculous spondylitis, and 4 of 61 patients (6.1%) in unknown pathology. In particular, perioperative mortality rate in pyogenic spondylitis was 2.5% (5 of 201 patients), though that in tuberculous spondylitis was 0%. Toxic shock syndrome, hemorrhagic shock, and septic shock were the causes of perioperative death in this study. The mortality rate in pyogenic spondylitis was 25 times higher than that of all spinal surgeries in this data base (0.1%).
Conclusion: The number of the surgeries for pyogenic spondylitis increased during last 6 years in our super-aging society. The perioperative complication rate was relatively high in patients with spinal infections. In particular, perioperative mortality of the pyogenic spondylitis was 2.5%.
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5

PENETRATION INTO THE INTERVERTEBRAL DISC OF ANTIBIOTICS USED FOR PERIOPERATIVE PROPHYLAXIS IN SPINE SURGERY: IMPLICATIONS FOR THE CURRENT STANDARD AND FOR THE TREATMENT OF DISC INFECTIONS

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Introduction: Intervertebral discs are avascular, have low pH and disc infections differ from infections of other tissues. The intradiscal penetration of typically used antibiotics and hence their effectiveness may also differ. This could have clinically relevant implications. A high prevalence of Propionibacterium acnes (P. acnes) colonisation in intervertebral disc material obtained from patients undergoing discectomy or microdiscectomy has led to the suggestion that this prominent human skin and oral commensal may exacerbate the pathology of degenerative disc disease. This hypothesis, in turn, raises the possibility that antibiotics could play an role in treating this debilitating condition. In addition, the existence of low-grade disc infections with P. acnes, which is not consistently sensitive to cephalosporins, challenges the current recommendations as to which antibiotic should be used for perioperative prophylaxis in spinals surgery. To date, however, little information about antibiotic penetration into the intervertebral disc is available.
Methods: Nucleus pulposus material from 54 microdiscectomy patients that had received prophylactic Cefazolin (n = 25), Clindamycin (n = 17) or Vancomycin (n = 12) based on their individual allergies, was used in this prospective cohort study. Indications for surgery were symptomatic lumbar disc herniations with either a fresh paresis or failure of conservative care to relieve neuropathic pain. The administration of the antibiotic followed the standard protocol of the participating institutions. Analysis was performed by means of high-performance liquid chromatography (HPLC), with Cefaclor serving as an internal standard, to determine the concentration of antibiotic penetrating into the disc tissue.
Results: Intervertebral disc tissues from patients receiving the positively charged antibiotic clindamycin contained a significantly greater percentage of the antibacterial dose than the nucleus material from patients receiving the negatively charged cefazolin ($p < 0.0001$). Also vancomycin, which has a slight positive charge had higher concentrations ($p < 0.0001$)—see table. While Vancomycin reached minimal bactericidal concentration in the nucleus material, none of the 3 antibiotics tested reached minimal biofilm eradication concentration.
Conclusions: Positively charged antibiotics appear more appropriate for future studies investigating potential options for the treatment of low-virulent disc infections with P. acnes. The current standards for perioperative antibiotic prophylaxis in spinal surgery probably should be reexamined. The expanding knowledge about low-grade disc infections (beyond the better-known pyogenic infections) underlines the already existing need to reexamine currently established standards of perioperative antibiotic prophylaxis in spine surgery, particularly that none of the 3 antibiotics tested appears capable of treating an existing biofilm within the disc.

Antibiotic (charge) (mw)	Patients (*N*)	Antibiotic dose (g)	Disc concentration (ug/ml of antibiotic/ml disc tissue)[a]		Penetration rate (% of antibiotic dose/ml of disc tissue)[a]	
Cefazolin (1−) [454.50]	25	2	59.91	±25.79	3.0	±1.0
Clindamycin (1+) [424.98]	17	0.6	68.20	±46.79	9.1	±4.9
Vancomycin (0/1+) [477.60]	12	1	10.65	±4.88	1.5	±0.6

[a](mean ± SD)

Antibiotic	Disc concentration	CMAX	Antibiotic accumulates	MIC[a]	MBC[a]	MBEC[a]
Cefazolin	59.9	404.0 [40]	No	NA[b]	NA[b]	NA[b]
Clindamycin	68.2	10.9 [41]	Yes	0.125	512	128
Vancomycin	10.6	63.0 [42]	No	1.0	8	512

CMAX maximum serum concentration, *MIC* minimum inhibitory concentration, *MBC* minimal bactericidal concentration, *MBEC* minimal biofilm eradication concentration. Note: all values are in µg/ml

[a]*P. acnes* MIC, MBC, MBEC reference values from [39]

[b]*P. acnes* MIC, MBC, MBEC for cefazolin were not found in any literature searches on PubMed

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6

IMPACT OF RADIOLOGIC VARIABLES ON ITEM RESPONSES OF ODI AND SRS22 IN ADULT SPINAL DEFORMITY PATIENTS: DIFFERENTIAL ITEM FUNCTIONING (DIF) ANALYSIS RESULTS FROM A MULTI-CENTER DATABASE

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Background: Evaluating whether the responses given to the items in a scale differ by external variables is a method used to evaluate the internal construct validity of the scale. Statistically, items being affected by external factors (e.g., radiological) are deemed biased and this bias is referred to as differential item functioning (DIF). On the other hand, this bias may be useful for clinical purposes and denote a sensitivity of the item to the factors (e.g., radiological) analyzed.
Purpose: To analyze whether responses given to ODI and SRS22 items are influenced by radiological parameters (RP) such as Global Tilt, Sagittal SVA, RSA, Sagittal PT, RPV, PI-LL, RLL, Coronal Balance, Major curve cobb angle, we conducted a DIF study. The hypothesis was that only some items from ODI and SRS22 are directly affected by radiologic changes.
Materials and methods: Patients enrolled in a multicentric prospectively collected ASD database who had complete SRS22 and ODI data at baseline and the 1st year (n = 923; 774F, 149 M; 500 surgical, 423 non-S; average age: 51.97 ± 19.5) were analyzed retrospectively. DIF of items in relation to radiological parameters (RP)

was analyzed using Mixed Rasch Model to define latent classes derived from personal factors; which yielded results on the presence of DIF and if so, the threshold value(s) associated with it.

Results: Overall DIF results can be seen in Fig 1. In summary, for ODI; questions (Q) 3, 6, 9 and 10 were found not to be sensitive to any RP whereas Q4 was sensitive to 6, and Q5 to 4. For SRS22; Q3, 5, and 18 were sensitive to almost all RP. More importantly, 12 SRS22 Q were found to be sensitive to MCCA, which attests to its origin as a scale for scoliosis.

Conclusion: The results of this study demonstrate that both ODI and SRS22 are moderately sensitive to radiological parameters in ASD patients, through certain questions. These items, analyzed separately or assembled as a specific ASD HRQoL scale may be functional in establishing a connection between changes in RP and HRQoL.

SRS22 (Q#)	GT		SVA		RSA		PT		RPV		PI-LL		RLL		Coronal Balance		MCCA
	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year
1																		>32.94
2																		>32.94
3	≤16		0	0	≤5.96	≤6.04	0		>2.61	≤ 6.01	≤15		>19.6	>28.1			≥44	
4																		>32.94
5	≤16		0	0	≤5.96	≤6.04					≤15		>19.6	>28.1				≤32.94
6														≤ 28.1				
7																		>32.94
8				0										>28.1				>32.94
9				0														
10																		>32.94
11																		
12				+,++	>5.96				≥2.61	≤ 6.01	≥15							
13																		
14																		
15			+,++										≤19.6					>32.94
16	≤16				≤5.96				>2.61		≤15		>19.6					
17																		
18	>16		+,++		>5.96		0		≥2.61		>15						≥44	>32.94
19			0															>32.94
20				0		≤6.04				≤ 6.01								≤32.94
21																		>32.94
22																		

ODI (Q#)	GT		SVA		RSA		PT		RPV		PI-LL		RLL		Coronal Balance		MCCA	
	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year	Baseline	1st year
1				+,++								>11						
2					>14.6								≤17					
3																		
4	≤24		0	0	≤14.6		0				≥20		>17					
5				+,++	>14.6				≥4.22								≥24	
6																		
7				0								≤11						
8				+,++														
9																		
10																		

Fig 1: Differential item functioning results for SRS 22 and ODI questions. An empty cell denotes insensitivity of the corresponding Q and RP, whereas a value denotes sensitivity at the specified treshold. The items underlined in green are the most sensitive to radiologic parameters changes.

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THERAPEUTIC RADIATION THERAPY IMPROVES SURVIVAL FOR CHORDOMA PATIENTS

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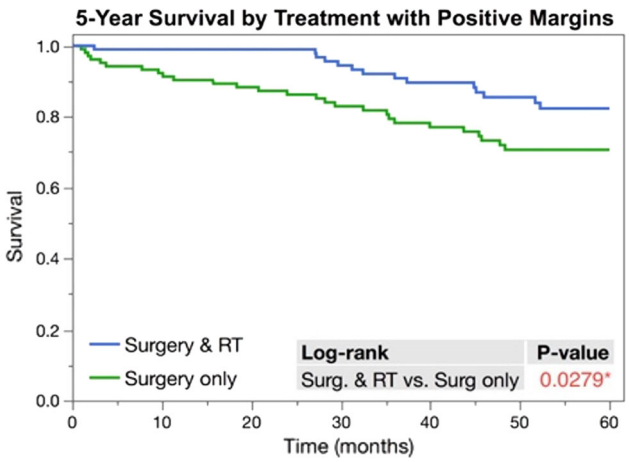
Background: The role of radiation therapy (RT) for the treatment of axial chordomas remains controversial. Previous large database reviews have not found adjunct RT to improve overall survival, but these studies did not stratify based on high/low dose RT, the modality of RT, or the patient's surgical margin status. We investigated the National Cancer Database (NCDB) to determine if high dose RT improves survival in patients with positive versus negative surgical margins. Additionally, the study compares the 5-year overall survival between high versus low dose RT and advanced versus conventional delivery methods.

Methods: 1480 patients were identified in the NCDB between 2004 and 2015 with a histologically confirmed axial chordoma. Survival analysis was performed using the Kaplan–Meier method. The 5-year survival was compared between surgical resection alone and surgical resection and adjunct therapeutic RT for the overall cohort, patients with positive surgical margins, and patients with negative surgical margins. Therapeutic RT was defined as a dose greater than 65 Gy. For patients treated with RT, the 5-year survival was compared between palliative dose (< 40 Gy), low dose (40–65 Gy), and high dose (> 65 Gy) RT. Similarly, 5-year survival was compared between proton beam therapy (PBT), stereotactic radiosurgery (SRS), intensity-modulated radiation therapy (IMRT), and conventional external beam radiation therapy (EBRT). A multivariable analysis was performed to determine independent prognosticators associated with 5-year overall survival.

Results: The cohort included 1480 chordoma patients; skull base (n = 569), sacral (n = 551), mobile spine (n = 360). The 5-year survival for entire cohort was 76%. The survival for patients treated with surgical resection and adjunct therapeutic RT was greater than surgery alone (85% vs 80%, p = 0.04). Therapeutic adjunct RT improved survival compared to surgery alone in the setting of positive surgical margins (82% vs 71%, p = 0.03). In the setting of negative surgical margins adjunct RT did not statistically improve survival (p = 0.33). Radiation dose > 65 Gy improved survival when compared to radiation dose between 40 and 65 Gy (85% vs 69%, p < 0.001). Comparing the modality of RT, PBT had the greatest 5-year survival (85%), which was statistically greater than EBRT (85% vs 68%, p < 0.001). In the multivariate analysis improved 5-year survival was associate with age < 65, private health insurance, tumor size < 5 cm, surgical resection, negative surgical margins, and treatment at an academic facility.

Conclusion: Adjunct RT (dose > 65 Gy) was associated with improved survival for patients with positive surgical margins. A survival benefit was not observed for patients with negative surgical margins who were treated with adjunct RT. High dose RT and advanced radiation techniques, specifically PBT, were associated with improved 5-year survival.



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DEGENERATIVE (THORACOLUMBAR), BASIC SCIENCE

8

DISC DEGENERATION: MORE THAN AN AGING PROCESS

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Introduction: Disc degeneration is frequently associated with back pain however many people with disc degeneration are asymptomatic. Most systems for disc grading typically rely only on visual features of the disc and do not take age into account. However, disc degeneration is known to increase with age, with degenerate discs more prevalent in older individuals. Here, we investigated the prevalence of disc degeneration, in the form of Pfirrmann grading, in different age groups in both a symptomatic clinical sample and in an asymptomatic population sample.

Methods: Two study samples were included: (1) a population sample from TwinsUK which consisted of 968 volunteers, 1384 scans in total, 8292 discs, and (2) a symptomatic clinical sample from Oxford Secondary Care Lumbar MRI Cohorts (OSCLMRIC) which consisted of 660 patients having a total of 905 scans, 5411 discs. Since TwinsUK consist mainly of female volunteers, only scans from female patients in OSCLMRIC were used in this study. Only TwinsUK volunteers without back pain were used in this study. Scans are T2-weighted sagittal. For each scan, we look at the Pfirrmann grading (grading 1 to 5) of the lower two lumbar discs, L4-L5 and L5-S1, which were averaged, resulting in one grade per scan. Gradings were obtained automatically using SpineNet and are consistent across the study samples. SpineNet provides rapid automatic reading comparable with those of a radiologist, and is able to compare scans from large cohorts even if read on different machines without tremendous time and labour effort. We examined four age groups: 30–39, 40–49, 50–59, and 60–69 years.

Results: Table 1 shows the average Pfirrmann grading by age group. Disc degeneration follows aging as the average grading of the discs tend to get higher as the subjects get older. This progression can be seen both in the population and clinical samples. Interestingly, we observed significant differences in distributions between the two samples in younger age groups, 30–39, 40–49 and 50–59, but not in the oldest age group. The highest difference in grade is in the youngest age group, 30–39, where there is an average difference of one Pfirrmann grade between the asymptomatic population (TwinsUK) and the symptomatic population (OSCLMRIC).

Discussion: The results obtained by comparing two different cohorts, both analysed by automated image analysis on the same grading system, show a clear difference in the Pfirrmann grading of disc degeneration between the clinical and population samples at the younger age groups, but this difference disappears in the 60–69 years age group. This suggests that degeneration at a younger age is more significant than at an older age since the degree of degeneration, or the difference in average grade seen in Table 1, between asymptomatic and symptomatic samples tend to decrease with ageing. The results indicate that when considering the clinical significance of degeneration scores, age needs to be considered.

Ag Groups	Asymptomatic (TwinsUK)	Symptomatic (OSCLMRIC)	Difference	H_0 at 5% Significance Level (Mann-Whittney U Test)
30 - 39	2.23 ± 1.09	3.20 ± 1.10	0.97	Reject ($p \leq 0.05$)
40 - 49	2.88 ± 1.08	3.44 ± 0.93	0.57	Reject ($p \leq 0.05$)
50 - 59	3.43 ± 0.95	3.65 ± 0.84	0.22	Reject ($p \leq 0.05$)
60 - 69	3.90 ± 0.77	4.06 ± 0.70	0.16	Does not reject ($p > 0.05$)

Disclosures: author 1: none; author 2: stock/shareholder; Company = Optellum & Plexalis, employee; Company = Optellum; author 3: none; author 4: employee; Company = Nuffield Department of Orthopaedics, Rheumatology and Muscleskeletal Sciences, none; author 5: none; author 6: none; author 7: none; author 8; author 9; author 10.

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THE STABILIZING EFFECT OF THE RIB CAGE DEPENDS ON SPINAL LENGTH, SEGMENTAL LEVEL, AND ANTERIOR RIB CAGE INTEGRITY: AN IN VITRO STUDY

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Introduction: For a better understanding of the formation and treatment of spinal deformities, such as scoliosis or hyperkyphosis, the basic biomechanics of the thoracic spine has to be further examined. The effects of the single rib cage structures and the spinal length on thoracic spinal stability are still poorly understood, but essential for the interpretation of in vitro studies investigating surgical treatments and novel implants as well as the validation of numerical models of the thoracic spine. Therefore, the purpose of this in vitro study was to quantify these effects.

Methods: Eight fresh frozen human thoracic spine specimens (C7-L1, mean age 56 ± 7 years) including the rib cage were loaded with pure moments of 5 Nm in flexion/extension, lateral bending, and axial rotation. Specimens were loaded displacement-controlled with a rate of 1°/s for 3.5 cycles, of which the third cycle served for data evaluation. Relative motions of all vertebrae were measured using the

optical motion tracking system Vicon MX13 consisting of 12 cameras. Biomechanical testing was performed stepwise (Fig. 1): First in the intact condition, in the second step after transversally cutting the rib-to-rib connections, in the third step in monosegmental specimens with ribs, and finally without ribs. Ranges of motion and neutral zones of the single motion segments were determined using Matlab and statistically analysed using the Friedman test in SPSS.

Results: The median range of motion of the global thoracic spine (T1-T12) significantly ($p < 0.05$) increased in all motion planes after cutting the rib-to-rib connections, especially in axial rotation by 72% (flexion/extension: 9%, lateral bending: 11%). On the segmental level, significant increases were mainly found in the upper half of the rib cage and particularly after rib removal in the monosegmental state, while the stabilizing effect generally decreased from cranial to caudal direction. Stability was also significantly reduced on all segmental levels between T1-T2 and T9-T10 after severing the rib-to-rib connections. The biggest effect of specimen length reduction from polysegmental to monosegmental specimens was found in lateral bending.

Discussion: The results of the present in vitro study indicate that spinal length as well as integrity of the rib cage affect the stability of the thoracic spine. These effects, however, also depend on the segmental level, since the upper part of the rib cage seems to be of higher importance in stabilizing the spine due to the bony sternal connection, while cartilaginous or missing connections do not distinctly affect thoracic spinal stability. Posterior rib resection and sternal cutting therefore could lead to spinal destabilization after surgery. Using the results of the present study, calibration and validation processes of numerical models can be performed more accurately.

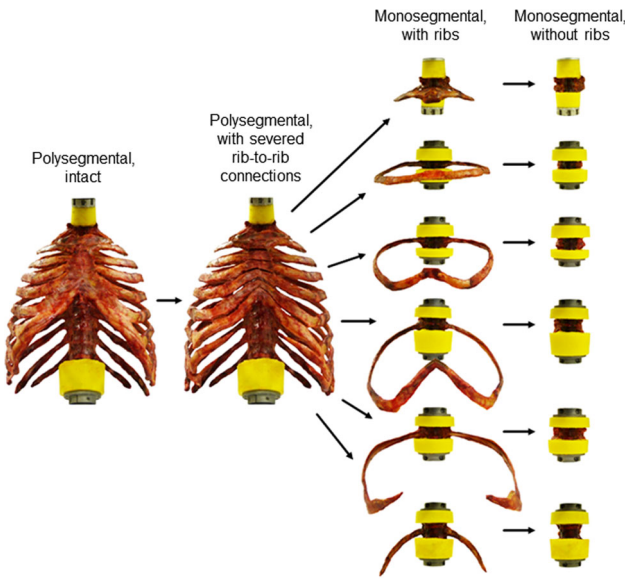

Fig. 1: Schematic illustration of stepwise reduction testing.

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THE CYTOKINE PROFILE DIFFERENCES IN UPPER AND LOWER SEGMENT DEGENERATIVE SPONDYLOLISTHESIS AND THEIR INVOLVEMENT IN PAIN MEDIATION

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Background: There are differences in mechanical stress applied on lower and upper lumbar segments. This can change also immunological and biochemical response in degenerative spondylolisthesis (DSL) evolution.

Purpose of the study: In order to identify differences in pathogenesis-related role of cytokines, their concentrations in the intervertebral disc (IVDs) and subchondral bone of the facet joints (FJBs) in perioperatively collected samples of patient suffered from lower (L4-L5, L5-S1) and upper (L2-L3, L3-L4) lumbar DSL were evaluated and compared with those of control subjects obtained during multiorgan procurement.

Materials and methods: A total of 27 proinflammatory and anti-inflammatory cytokines were determined in the tissue of the IVDs and subchondral FJBs obtained from 19 patients with lower lumbar DSL (4 men and 15 women; age, 57.7 ± 11.25 years), 8 patients with upper lumbar DSL (4 men and 4 women; age, 62.38 ± 11.51 years) and 6 control adult male (age, 44.2 ± 13.2 years) using Bio-Plex (Bio-Rad Laboratories) analysis and adjusted to a total protein amount1. The cytokine concentrations for the patients with DSL were statistically evaluated and compared with those from the control group. The analysis of the relationship cytokine-pain localization and intensity (as assessed by visual analog scale) involved quantification of dependence using robust linear regression.

Results: In lower DSL, statistical analysis of the results and the comparison with the control samples confirmed a marked increase in the synthesis of platelet-derived growth factor (PDGF-BB; p in order: FJBs, annulus fibrosus (AF), nucleus pulposus (NP): < 0.001, < 0.05, < 0.01), interleukin (IL)-6 ($p < 0.05$, < 0.01, < 0.05), IL-8 ($p < 0.01$, < 0.001, 0.05), and tumor necrosis factorα (TNFα; $p < 0.01$, < 0.001, < 0.01)) in all parts of the functional spinal units. In upper DSL, significantly elevated IL-1ß, IL-6 and TNFα (with $p < 0.05$ in all parts) were assessed in FJBs and IVDs. The marked correlation with back pain intensity was related to the cytokine IL-1b ($p = 0.039$ in AF and $p = 0.05$ in FJB) in lower segment DSL. In upper DSL only IL-1b levels in AF corresponded to back pain intensity ($p = 0.02$), but robust correlation and statistically significant p values for IL-6 increases in AF ($p = 0.037$) and FJB ($p = 0.001$) related to leg pain intensity were found.

Conclusion: In the condition of DSL, the synthesis and release of many mediators will increase considerably, especially IL-6 and TNFα. Differences in pathogenetic mechanisms, e.g., mechanical factors can be responsible for activation of various biochemical pathways in upper (IL-1ß) and lower (PDGF-BB, IL-8) segments that mediate pain perception.

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A RANDOMIZED, PROSPECTIVE CLINICAL TRIAL TO EVALUATE THE EFFICACY AND SAFETY IN LUMBAR FUSION SURGERY OF IMPLANTATION OF AUTOLOGOUS BONE MARROW MESENCHYMAL CELLS EXPANDED EX VIVO AND COMBINED WITH ALLOGENEIC BONE TISSUE (XCEL-MT-OSTEO-ALPHA), AS COMPARED WITH THAT OF AUTOLOGOUS ILIAC CREST GRAFT. (EUDRACT NO. 2010-023999-12; NCT01552707)

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Objective: To evaluate the feasibility, safety, and efficacy of implantation of a scaffold of heterologous human cancellous bone tissue seeded with autologous bone marrow mesenchymal cells expanded ex vivo (XCEL-MT-OSTEO-ALPHA) and to compare the resulting intervertebral fusion as evaluated by radiography and computed tomography (CT) and the clinical outcome with that obtained in patients who received autologous iliac crest graft.

Materials and methods: Multicenter, prospective, open-label, randomized, parallel, and single-dose phase I-II study (EudraCT No. 2010-023999-12; NCT01552707). Sixty-five patients (mean age 61.05y; 65.6% female) with degenerative spondylolisthesis (79.4%) and/or disc disease at L4–L5 underwent PSFI L4–L5; TLIF with autologous iliac crest graft was performed, and intertransverse fusion consisted of local bone graft on the TLIF side and randomly assigned XCEL-MT-OSTEO-ALPHA (Group A, treatment) or autologous iliac crest graft (Group B, control) on the contralateral side. Adverse events were recorded and fusion was assessed by radiography (3, 6, and 12 months) and CT (6 and 12 months). Bone fusion status was evaluated according to previously established qualitative criteria by a radiologist blind to treatment allocation. Patients were evaluated clinically (lumbar and sciatic VAS and ODI) before and 3, 6, and 12 months after surgery. The percentage of patients with an improved or worsened clinical status was determined based on the minimal clinically important difference (MCID) defined in the literature (changes in VAS and ODI of $\geq$ 3 and $\geq$ 12 points, respectively). All variables were compared between treatment (Group A) and control (Group B) groups.

Results: Groups A and B comprised 31 and 34 patients, respectively. There were no significant differences in preoperative variables between groups, and no serious adverse reactions were associated with the product. Radiological findings are shown in Tables 1. Compared with controls the treatment group showed a significantly higher rate of intertransverse fusion as determined by radiography at 3 (85.7% vs. 56.3%), 6 (81.5% vs. 48.3%), and 12 months (96.3% vs. 51.7%) and by CT at 6 months (96.3% vs. 54.8%). One year after surgery the intertransverse fusion rate (CT) was higher in the treatment than the control group (86.2% vs. 66.7%), although this difference was not significant. There were no significant differences in clinical variables between groups (Table 2 and 3).

Conclusions: XCEL-MT-OSTEO-ALPHA is a viable and safe product for use in lumbar fusion surgery. Radiological fusion rates in the area in which the product was applied were significantly higher than those obtained with autologous iliac crest graft. No significant differences between groups were found in clinical outcome and comparable rates of improvement/worsening in pain and disability were observed for both treatments. Thus, it appears to have no detrimental clinical effects in lumbar disease patients.

Table 1. Fusion on Radiography and Computed Tomography

Radiography	Total	Group A (Treatment)	Group B (Control)
Anterior fusion at 3 months (%) (n = 58, A = 31, B = 33)	15.8	11.1	20
Posterior fusion at 3 months (%)	70	85.7*	56.3
Anterior fusion at 6 months (%) (n = 56, A = 27, B = 29)	21.4	29.6	13.8
Posterior fusion at 6 months (%)	64.3	81.5*	48.3
Anterior fusion at 1 year (%) (n = 55, A = 27, B = 28)	32.7	44.4	21.4
Posterior fusion at 1 year (%)	73.2	96.3*	51.7
Computed Tomography	Total	Group A (Treatment)	Group B (Control)
Intertransverse fusion at 6 months (%) (n = 59, A = 28, B = 31)	75	96.3*	54.8
Anterior fusion at 6 months (%)	80	85.7	74.2
Intertransverse fusion at 1 year (%) (n = 61, A = 28, A = 33)	75.8	86.2	66.7
Anterior fusion at 1 year (%)	82.3	92.9	75.8

* Significant difference between groups (p<.05)

Table 2. Clinical Variable

Baseline visi			
	Total (n=62	Group (Treatment, n = 29	Group (Control, n = 33
ODI	42.09 (14.57)	40.74 (13.84)	43.27 (15.31)
Lumbar VAS	6.73 (2.29)	6.77 (2.38)	6.69 (2.25)
Sciatic VAS	7.24 (2.31)	7.35 (2.15)	7.15 (2.47)
3 month			
	Total (n=57	Group (Treatment, n = 28	Group (Control, n = 29
ODI	28.44 (17.03)	29.03 (16.34)	27.93 (17.89)
Lumbar VAS	3.21 (2.51)	3.7 (2.63)	2.75 (2.35)
Sciatic VAS	2.49 (2.62)	3.44 (2.64)	3.42 (2.56)
6 month			
	Total (n=55	Group (Treatment, n = 27	Group (Control, n = 28
ODI	25.78 (18.04)	26.83 (19.53)	24.74 (16.71)
Lumbar VAS	3.43 (2.56)	3.44 (2.64)	3.42 (2.53)
Sciatic VAS	2.04 (2.56)	2.35 (2.54)	1.71 (2.48)
12 month			
	Total (n=56	Group (Treatment, n = 28	Group (Control, n = 28
ODI	24.20 (15.9)	23.8 (17.97)	24.63 (13.66)
Lumbar VAS	3.14 (2.81)	3.2 (2.94)	3.09 (2.73)
Sciatic VAS	2.56 (2.87)	3.12 (2.95)	2 (2.71)

Table 3. Minimum Clinically Important Differences (%)						
	Total		Group A (Treatment)		Group B (Control)	
	Improvement	Worsening	Improvement	Worsening	Improvement	Worsening
3 months						
	60.8	3.4	68.2	0	53.6	7.14
Lumbar VAS	56.6	1.7	50	4.16	60.7	0
Sciatic VAS	67.9	0	70.8	0	64.3	0
6 months						
ODI	64.7	5.1	62.5	4.54	65.4	7.69
Lumbar VAS	56.9	0	58.3	0	53.8	0
Sciatic VAS	95.9	1.8	95.8	0	95.8	4.16
1 year						
ODI	62.3	0	61.5	0	61.5	0
Lumbar VAS	58	1.8	64	4	52	0
Sciatic VAS	64	1.8	68	4	60	0

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DOES 3 MONTHS TERIPARATIDE TREATMENT AFFECT THE CROSS-SECTIONAL AREA OF THE SPINAL CANAL: A POST HOC ANALYSIS OF PATIENTS PARTICIPATING IN THE RANDOMIZED PLACEBO-CONTROLLED PARADESE-STUDY

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Background: The role of parathyroid hormone (PTH) has been discussed among surgeons performing fusion surgery for treatment of degenerative lumbar disorders such as lumbar spinal stenosis (LSS) due to spondylolisthesis. Several studies investigate if teriparatide treatment has the ability to enhance fusion. However the evidence for „safety concerns"regarding the risk for spinal canal narrowing with additional treatment with teriparatide remains uninvestigated.
Purpose: The primary purpose is to evaluate if the objectively measured cross-sectional area (CSA) of the spinal canal postoperatively is affected after three months of teriparatide treatment. Secondary we wanted to subjectively determine whether teriparatide changes the severity of the stenosis at baseline and three month after surgery versus patients receiving placebo instead.
Study design: A post hoc analysis of patients participating in the single center, prospective, randomized double-blinded placebo-controlled clinical trial, the „PARADESE"-study.
Methods: Patients with LSS due to degenerative spondylolisthesis and scheduled for non-instrumented posterolateral fusion surgery were randomly assigned, in a ratio 1:1, to fusion surgery with or without teriparatide (recombinant human PTH). The treatment consisted of 90 days' postoperative treatment with daily subcutaneous injections (20 μg teriparatide) versus placebo. Clinical and imaging outcomes were obstained. Magnetic resonance imaging (MRI) was performed preoperatively and 3 months after surgery. The region of interest (ROI) was the stenotic area, mid disc level, due to degenerative spondylolisthesis. The CSA of the affected stenotic areas were manually measured on transaxial T2-weighted images by two blinded and X. A screening of the general lumbar spine was performed to exclude cases with spinal stenosis on multiple levels than the ROI. Finally grading the stenosis of the ROI was performed. The MRI scans were independently evaluated in EasyViz (Medical Insight), a PACs workstation by a team of two medical observers,, trained by an experienced senior radiologist at the Department of Radiology, SLB Hospital. The team was unaware of the patients' treatment arm assignment.
Results: The two groups showed no difference in the size of the CSA at baseline compared with three months postoperatively. Teripartide treatment was well tolerated, but, provided no additional benefits regarding clinical outcome after 24 month or in achieving a solid fusion after surgical arthrodesis, compared with placebo at 12 months.
Conclusion: Ensuring patient safety during clinical trials is one of our paramount considerations. The present study showed that 90 days administration of 20 mg teriparatide postoperative does not affect the cross-sectional area of the spinal canal. Our research showed that whether or not patients received additional teriparatide treatment, compared with placebo, it does not influence the cross-sectional area.
Disclosures: author 1: grants/research support; Eli Lilly $109,155; author 2: none; author 3: none; author 4: none; author 5: grants/research support; Eli Lilly.

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A NEW METHOD FOR EVALUATION OF PARASPINAL MUSCLE MORPHOLOGY: SPINAL OBJECTIVE MUSCLE MORPHOLOGY ASSESSMENT (SOMMA)

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Background context: Low back pain (LBP) is a worldwide health ailment, yet its etiology is not well understood. Paraspinal muscle atrophy, characterized by reduction in muscle size and increase in muscle fat content, has been proposed as a potential etiological factor but no standard clinical protocol is established to objectively evaluate such parameters.
Purpose: To quantify paraspinal muscle morphology by a new semi-automatic method, based on magnetic resonance images.
Study design: Magnetic resonance imaging (MRI) cohort study.
Patient sample: A cohort 55 individuals with chronic LBP and no previous lumbar spine surgery were included in the study.
Outcome measure: Patients were subjected to lumbar MRI and were invited to answer the Oswestry Low Back Pain Disability Questionnaire. Physicians classified MRI images by Kader et al. 2000 visual grading system.
Methods: A T2 weighted axial magnetic resonance imaging (MRI) acquisition at L3-L4 level was collected from each patient. Based on the grey scale range of lean muscle and fat tissue, and a new semi-automatic tool was created to evaluate paraspinal muscle morphology: the „Spinal Objective Muscle Morphology Assessment"(SOMMA). MRI images were evaluated by four skilled physicians using an established visual grading system and re-evaluated for the MRI images segmented by SOMMA.
Results: Intra and inter-observer reliability was found to be moderate when grading the lumbar muscles atrophy based on the 3-point visual grading system. An increase in intra and inter-observer reliability was obtained when classifying segmented MRI assisted by the SOMMA

tool. Additionally, fat content in the paraspinal muscles could be determined in an objective, quantitative and reproducible manner with the SOMMA tool, as compared with using the 3-point subjective visual scale.
Conclusion: The new SOMMA tool brought a reliable and more precise technique to characterize and quantify paraspinal muscle morphology, which could be useful in terms of prognostic and follow up of patients with low back pain.
Disclosures: author 1: none; author 2: no indications; author 3: none; author 4: no indications; author 5: no indications; author 6: no indications; author 7: none.

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RECOVERY AFTER SURGERY FOR LUMBAR DISK HERNIATION, A RANDOMIZED CLINICAL TRIAL COMPARING THE EFFECT OF SUPERVISED REHABILITATION VERSUS HOME EXERCISES

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Background: In surgical spine practice lumbar discectomy is one of the most frequent interventions to treat symptomatic lumbar disc herniation. Patients are typically referred to physical rehabilitation at discharge from the hospital. The effect of postoperative rehabilitation is however a controversial topic with conflicting evidence.
Purpose: This study investigates the effects of referring patients to postoperative supervised physical rehabilitation compared to no referral in patients recovering after surgery for lumbar disc herniation (LDH).
Methods: This single center randomized controlled trial investigated differences in function, quality of life and pain between two groups of patients. 146 patients scheduled for primary discectomy due to LDH were included. First group (REHAB) received supervised rehabilitation at the municipal facility starting 4–6 weeks postoperative, whereas the second group (HOME) was sent home after surgery without any planned rehabilitation course. Follow-up questionnaires were obtained after 1, 3–6, 12 and 24 months. Outcome measures consisted of Oswestry Disability Index (ODI), EuroQoL-5D (EQ-5D) and Visual Analogue Scale (VAS) to evaluate leg- and back pain.
Results: A total of 146 patients were enrolled in the study: 73 allocated to the REHAB-group and 73 to the HOME-group. The groups were similar at baseline in terms of demographics and PROs. Follow-up rates at 12 and 24 months was 78%. PROs in both groups improved significantly after surgery, but no statistically significant differences were observed between the groups at any follow-up time point in either the intent-to-treat, as-treated and per-protocol analyses.
Conclusion: Surgery for lumbar disc herniation is effective in relieving pain, improving function and quality of life. The postoperative outcome is not altered significantly by participating in supervised rehabilitation compared to doing normal daily activities and home exercises.
Disclosures: author 1:; author 2: other financial report; travel from University of Southern Denmark, employee; Company = Norton Healthcare; author 3: none.

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LUMBAR DISCECTOMY PATIENTS WHO UNDERGO REOPERATION EXPERIENCE WORSE CLINICAL OUTCOMES AND GREATER SOCIOECONOMIC BURDEN 3 YEARS AFTER THE PRIMARY PROCEDURE

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Introduction: Multiple studies have observed that the clinical outcomes of patients who have undergone revision surgery after lumbar discectomy are less positive than outcomes in patients who did not require revision. Lumbar disc herniation patients with large annular defects undergoing discectomy are at significantly greater risk for symptom recurrence and revision, indicating that this population is also at significantly greater risk for worse clinical outcomes. The goal of this analysis was to assess the clinical and socioeconomic outcomes associated with post-discectomy reoperations and the utility of a bone-anchored annular closure device (ACD) for avoiding reoperations in patients with large annular defects.
Methods: This was a retrospective analysis of a prospective randomized controlled trial (RCT). Lumbar discectomy patients with large ($\geq$ 6 mm) annular defects were randomized to treatment with limited discectomy alone (Control; n = 278) or limited discectomy augmented by an annular closure device (ACD; n = 272). Clinical outcomes included visual analog scale (VAS) for ipsilateral leg and back pain, Oswestry Disability Index (ODI), reoperations at the index-level, serious adverse events (SAE), inpatient hospital days, and working status. Comparisons of clinical and socioeconomic outcomes were made between reoperated and non-reoperated patients, regardless of ACD or Control treatment, at 3 years following the primary surgery.
Results: At 3 years, clinical outcomes data were available for 75% of the patients. Among patients with data at 3 years, 64 experienced at least one index-level reoperation (Reoperated group) and 351 were not reoperated (Non-reoperated group). The proportion of subjects experiencing at least one index-level reoperation in 36 months was 11% in the ACD group and 19.3% in the Control group (Table 1; $p = 0.007$). The reoperated patients had significantly worse scores than non-reoperated patients for ODI (24 ± 19 vs. 11 ± 13; $p < 0.0001$), VAS ipsilateral leg pain (28 ± 30 vs. 12 ± 19; $p < 0.0001$), and VAS back pain (36 ± 31 vs. 17 ± 21; $p < 0.0001$). Reoperated patients accumulated significantly more inpatient hospital days (median = 4 days vs. 0 days; $p < 0.0001$). A significantly greater proportion of non-reoperated patients were working again at 36 months (97%) compared to reoperated patients (84%; $p < 0.001$).
Conclusion: Index-level reoperations following lumbar discectomy in patients with large annular defects are associated with worse clinical outcomes and greater socioeconomic burden. These findings are consistent with reports on outcomes from large registry analyses including the Spine Patient Outcomes Research Trial (SPORT) and the Swedish National Spine Registry (Swespine). The ACD was effective in minimizing the number of patients subject to revision, primarily through prevention of repeat discectomy, with 43% fewer patients undergoing at least one index-level reoperation.

Table 1. Summary of index-level reoperations between ACD and Control patients

Reoperation Type / Indicatior	Index-level Reoperations (n)	
	ACD	Control
Discectomy	14	45
Discectomy with Supplemental	8	5
Dural Tear	1	0
Hematoma and Other decompr	3	5
Removal / Partial Removal	5	0
Supplemental Fixation	6	9
Wound Revision / Infection	1	6

Disclosures: author 1: grants/research support; Intrinsic Therapeutics, consultant; Intrinsic Therapeutics; author 2: consultant; intrinsic therapeutics; author 3: consultant; Stryker, Medtronic, Wright Medical, Asahi, Allosource, Mirus, royalties; Company = Stryker; author 4: grants/research support; Intrinsic Therapeutics; author 5: consultant; Intrinsic Therapeutics; author 6: royalties; Company = SpineArt; author 7: grants/research support; BrainLab, DepuySynthes, Intrinsic Therapeutics, Pfizer, Medtronic, TETEC, Icotec, consultant; DepuySynthes, Signus Medizintechnik, Intrinsic Therapeutics, Medtronic, Icotec.

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DEGENERATIVE CHANGES ON ADJACENT LEVELS AFTER INSTRUMENTED POSTEROLATERAL FUSION WITH AND WITHOUT TLIF: 10 YEAR MRI FOLLOW UP ON A RANDOMIZED STUDY

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Background: Due to the increasing number of spinal procedures, performed worldwide adjacent degenerative disease (ASD) has become a new focus area. Whether ASD is a matter of normal degenerative development in the disc over time or a result of increased stiffness and stress due to the fusion is still debated. Nowadays TLIF is the most widely used interbody fusion method. The use of inter-body fusion has be claimed to reduce the degenerative changes in the spared free disc over time due to better sagittal balance and restoration of the lost lumbar lordosis.
Objective: To compare degenerative MR findings in a RCT between PLF and TLIF, 10 years after surgery.
Methods: 100 patients included in a prospective RCT between interbody fusion (TLIF) and Instrumented posterolateral fusion (PLF) was offered a visit in the outpatient clinic and an MRI at long-term follow up. All MRI were classified according to degree of Modic changes, Pfirrmanns classification, Schizas classification and Fardon and Milette in order to show the degree of degeneration of the discs above and below the fusion. The grading was done by to independent observers without any contact to the patient. In patients who underwent secondary surgery, the MR prior to that was used and the degenerative changes measured according to the above-mentioned classifications.
Results: 79 patients were available for MR long-term follow up. The groups were equal regarding sex, age, diagnosis and number operated levels. The follow up length was 9.6 years. The Modic change found at the first upper disc was none in (85% TLIF/68% PLF), if present mostly grade 2 Modic change (12%TLIF/26%PLF) was found. There were no significant difference between the two groups p = 0.274. Mostly all patients did not show any sign of treatment needs regarding spinal stenosis according to Schizas classification A&B, 92% (TLIF)/92% (PLF) only 8% (TLIF)/8% (PLF) had type C and D at the 1 proximal level. No difference between groups could be detected p = 0.930. The Pfirrmann grading at the first proximal level was type 1: 0%(TLIF)/0%(PLF), type 2: 17%(TLIF)/16%(PLF), type 3: 54%(TLIF)/43% (PLF), type 4: 27%(TLIF)/35%(PLF), type 5: 2%(TLIF)/5%(PLF). There was no difference between groups, too p = 0.952. Degenerative disc protrusion posterior according to Fardon and Milette was none: 61%(TLIF)/63%(PLF), and bulge: 39%(TLIF)/32%(PLF), protusion: 0%(TLIF)/5%(PLF), extrusion 0%(TLIF)/0%(PLF), p = = 0.289.
Conclusion: In a prospective randomized design the use of inter-body fusion TLIF, do not reduce the adjacent segment degeneration (ASD) in MRI, in the proximal or distal discs in comparison to a normal posterolateral instrumented fusion (PLF).
Disclosures: author 1: none; author 2: none; author 3: none; author 4: none.

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COMPARISON OF GENERIC VS SPINE-SPECIFIC PAIN SURVEYS ADMINISTERED BEFORE SURGERY AND FULFILLMENT OF EXPECTATIONS MEASURED AFTER SURGERY FOR LUMBAR DEGENERATIVE SPONDYLOLISTHESIS

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Background: Generic and spine-specific surveys are used before surgery for lumbar degenerative spondylolisthesis (LDS) to measure pain. While both types of surveys can discern various aspects of pain, such as pain intensity and pain-associated disability, their ability to capture how pain impacts other outcomes, such as fulfillment of expectations, is not known.
Purpose: To determine which pain surveys are most closely associated with fulfillment of expectations after surgery for LDS.
Study design/setting: Prospective 2-year longitudinal study, tertiary spine center.
Patient sample: 146 patients undergoing surgery for LDS.
Outcome measures: HSS Lumbar Spine Surgery Expectations Survey.
Methods: Patients were interviewed several days before surgery with the valid 20-item Expectations Survey addressing symptoms, physical function, and psychological well-being. Patients rated how much improvement they expected for each item with response options of complete to no improvement. To measure pain, patients completed back-specific measures of global pain with a numeric rating scale (0–10) and the modified ODI (0–100), and generic PROMIS measures of Pain Intensity and Pain Interference. Medical records were reviewed for surgeon-reported pain on flexion/extension and surgical complexity according to the Invasiveness Index. Two years postop patients again completed the Expectations Survey rating how much improvement they actually received. A proportion of expectations fulfilled was calculated as total improvement received divided by total improvement expected. In multivariable linear regression analyses controlling for complexity, the proportion was the dependent variable and various pain measures were independent variables, expressed as estimates with desired 95% confidence intervals (CI) not to cross 0.
Results: Mean age 68, 61% women, 82% had LDS at only one level (69% L4/5), mean PI was 61o (30–84), mean PI-LL was 10o ((− 16)− 50), and the median surgical complexity was 7 (1–22). With respect to pain, 60% of patients had pain with extension, 25%

with flexion. The median global (VAS) back pain was 6 (0–10), and mean values were: ODI 50 (6–88), PROMIS Intensity 55 (31–72), and PROMIS Interference 63 (3–100). The mean time to follow-up was 2.1 years. The mean Expectations Survey proportion of expectations fulfilled was .99 (0–3.53) Controlling for surgical complexity, higher proportions were associated with less ODI pain (1.1, CI 0.5–1.6, p = .0001), less global back pain (4.5, CI 1.6–7.3, p = 002) and, to lesser extents, less generic PROMIS Pain Intensity (1.5, 0.3–2.6, p = .01) and Pain Interference (0.8, − 0.1–1.6, p = .08).

Conclusions: Compared to generic pain surveys, preop pain measured by spine-specific pain surveys were more closely associated with the outcome of fulfillment of expectations. Whether generic pain surveys, such as PROMIS, are sufficiently sensitive to explain other outcomes of LDS needs to be assessed further.

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UNEXPECTED RECURRENCE OF PELVIC INCIDENCE IN ADULT SPINAL DEFORMITY PATIENTS WHO UNDERWENT LONG INSTRUMENTATION WITH S2AI DURING THE FOLLOW UP: ANALYSIS OF POSSIBLE FACTOR WITH MINIMUM FOLLOW-UP OF TWO YEARS

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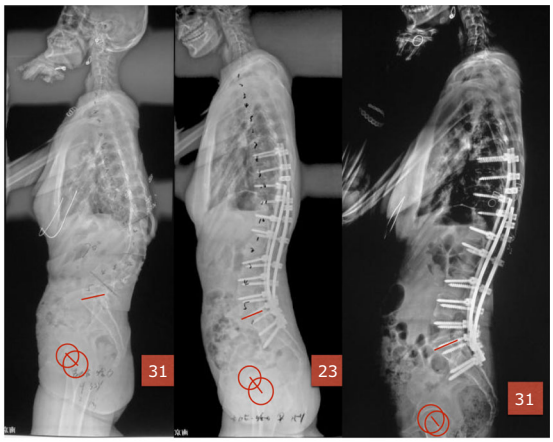
Objective: The purpose of this study is to evaluate the radiographic and clinical outcomes of degenerative scoliosis (DS) patients who underwent long instrumentation with S2AI fixation whose pelvic incidence (PI) decreased postoperatively.

Method: Patients over age 50 who underwent long instrumentation with S2AI fixation with minimum follow-up of two years between November 2014 to January 2017 were retrospectively reviewed. A total of 28 patients who underwent long instrumentation with S2AI fixation meanwhile whose PI decreased more than 5 degree postoperatively were included in our study. The following sagittal radiographic parameters were measured: PI, pelvic tilt (PT), sacral slope (SS), sagittal vertical axis (SVA), Lumbar lordosis (LL) and PI-LL.

Results: In this study, 28 DS patients (27 females; mean age 58.39 ± 6.29 years) were ultimately included in our study with the minimum follow up of two years. Of these patients, the mean follow-up period was 31.75 ± 7.68 months, range from 24 to 50 months. PI significantly decreased from 51.34° ± 13.96° preoperatively to 40.93° ± 14.03° postoperatively and increased to 44.46° ± 15.01° at last follow-up, with a mean change of 11.02° ± 6.17° postoperatively and 3.54° ± 6.81° at last follow up respectively ($P < 0.05$). Among these patients, 11 patients (39%) were found whose PI increased more than 5° from postoperative to last follow up. Meanwhile, PT, SVA and PI-LL were decrease significantly while SS and LL was increased significantly from preoperatively to postoperatively ($P < 0.05$). From postoperative to last follow up, PT increased significantly ($P < 0.05$). While SS, LL, SVA, PI-LL changed without statistical significance.

Conclusion: In conclusion, our retrospective study exhibit that DS patient who underwent long instrumentation with S2AI fixation whose PI significantly decreased from preoperative to postoperative, meanwhile part of patient in this cohort found increased PI at the last follow up compared with postoperative value.

Keywords: degenerative scoliosis; pelvic incidence;



Preoperative Postoperative 2y-follow-up

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ADULT DEFORMITY, DIAGNOSTICS AND IMAGING

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DECISION ANALYSIS IN QUEST OF THE IDEAL TREATMENT IN ADULT SPINAL DEFORMITY REVISITED

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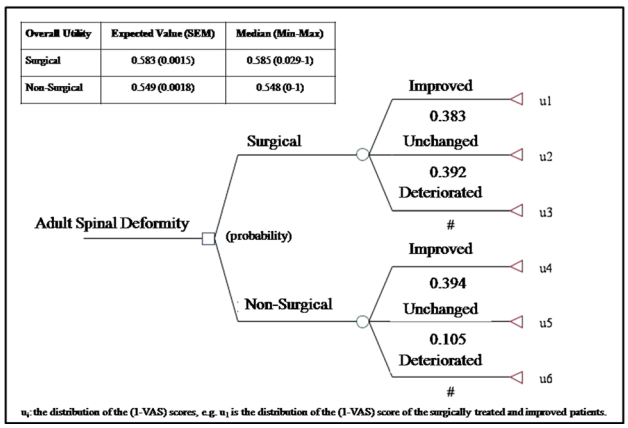
Introduction: Identification of the best treatment modality in adult spinal deformity (ASD) provides a challenge. Surgery (S) has been shown to yield better results compared to non-surgical methods (NS) by several studies using fixed minimum clinically important difference (MCID) values for improvement or deterioration. Recent studies however, suggest that MCID values may vary significantly by the treatment modality.
Aim: To analyze the utilities and improvement rates provided by surgery (S) and non-surgical (NS) treatment modalities in ASD.
Patients and methods: A decision analysis model was performed in a prospectively collected multicenter ASD database. A total of 1452 patients (F: 1216, M: 236; S: 746, NS: 706) with a follow-up period of 2 years were analyzed. S group was further subcategorized into; no complication (N, n = 1259), minor complications (Min, n = 103) and major complications (Maj, n = 90) groups to analyze the effect of complications on treatment results. MCID values for ODI were calculated by latent class analysis specific to ASD and its treatment (Overall: 14.31, S: 14.96, NS: 2.48), then the patient outcomes were categorized as improved (I), unchanged (U) and deteriorated (D). Utilities, as measures of the disease were calculated for each population (range: 0-worst- to 1-no burden-) and treatment modality based on VAS mapping. Finally, these data were incorporated into decision trees.
Results: At the end of the 2nd year, 38.3% of S patients were I, 39.2% U, and 22.5% D whereas these values were 39.4%, 10.5%, 50.1%, respectively, for NS patients. S group were sensitive to complications with improvement rates of 40.1%, 39.3% and 33.3% and deterioration rates of 19.2%, 22.5% and 29.4% for N, Min and Maj, respectively. For utilities; S provided a higher value (0.583) than NS (0.549); hence, less burden (Fig. 1). Utilities in S were sensitive to the presence of treatment complications, being 0.634, 0.564 and 0.497 in N, Min and Maj, respectively.
Conclusion: This study has demonstrated that S has a less disease burden and a less chance of deterioration than NS, but equal chances for improvement at the end of the 2nd year. The effect of complications are clearly delineated.

Figure 1. Utilities and probabilities of the treatment modalities including basic decision model without complications.

Overall Utility	Expected Value (SEM)	Median (Min-Max)
Surgical	0.583 (0.0015)	0.585 (0.029-1)
Non-Surgical	0.549 (0.0018)	0.548 (0-1)



u_i: the distribution of the (1-VAS) scores, e.g. u_1 is the distribution of the (1-VAS) score of the surgically treated and improved patients.

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FORCED DECISION TREE CLASSIFIER FOR DETERMINING WIDESPREAD ACTING FEATURES AFFECTING MECHANICAL COMPLICATIONS

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Background: Patients with adult spinal deformity differ widely in their individual characteristics and clinical presentation, and risk factors associated with mechanical complications are multifactorial and plentiful (> 60 have been suggested). AI-based decision trees can be used to identify subgroups possessing a particular risk factor. By repeatedly dividing the cohort into subgroups, decision trees cover both classification and regression. Impurity (having traces of one subgroup in another), entropy (degree of randomness of factors) and information gain guide the selection of features at each step for

maximum accuracy. In doing so, a decision tree identifies numerous classification factors, although some are relevant only for a small group of patients. However, there must be a trade-off between accuracy and performance, since in the real world dividing data into pure classes is often not feasible.

Purpose: The aim of the study was to identify widespread acting risk factors for mechanical complications.

Material-methods: 163 features derived from history, demographic, radiographic, technique-related and PROM data were included to predict mechanical complications: PJK/PJF, DJK/DJF, rod and implant-related. T-tests were performed to rank the features in order of significance. A hierarchical forced decision tree was performed, in which the feature splitting each branch of a step was forced to be the same by averaging the ranks. The number of steps was limited to 5, to provide a parsimonious set of risk factors related to the occurrence or otherwise of a mechanical complication, for the whole cohort.

Results: 457 patients (362F, 95 M, 53 ± 19 yrs) with ≥ 4-level fusion, and a mean follow-up of 39.3 (24–94) months were included. Sagittal plane quantified by the postoperative GAP Score was the most important feature. Forced decision trees in GAP-Proportioned (175), GAP-Moderately Disproportioned (152) and GAP-Severely Disproportioned (130) groups revealed sacroiliac fixation, age, BMI and the number of comorbidities to be the most relevant and widespread acting features, in the given order.

Conclusions: Using data from an adult spinal deformity database, including 457 patients with ≥ 2 years' follow-up after surgery, and a 43.8% complication rate, an artificial intelligence (AI) based "forced" decision tree was created, in which the feature splitting each branch of a given step was forced to be the same. Although more important factors that affect a specific group of patients might exist, 5 factors were identified in this study that are relevant for the whole cohort. The postoperative GAP Score, sacroiliac fixation, age, BMI and number of comorbidities were the most relevant and widespread acting factors affecting mechanical complications for the whole cohort.

Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: grants/research support; depuy synthes, consultant; depuy synthes, Medtronic, royalties; Spineart, Clariance, Alphatec; author 9: grants/research support; DepuySynthes; author 10: grants/research support; Depuy, consultant; Globus; author 11: grants/research support; Company = Depuy Synthes, Medtronic, royalties; Company = AOSpine; author 12: grants/research support; Company = DePuySpine, Medtronic; author 13: grants/research support; Depuy, consultant;, author 14: none.

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COMBINED ANTERIOR–POSTERIOR VS ALL-POSTERIOR APPROACHES FOR ADULT SPINAL DEFORMITY CORRECTION: A MATCHED CONTROL STUDY

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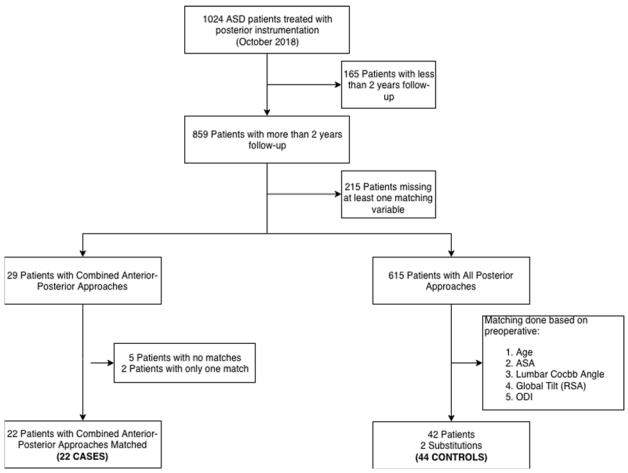
Introduction: Anterior approaches are gaining popularity for Adult Spinal Deformity (ASD) surgeries especially with the introduction of hyperlordotic cages and improvement in MIS techniques. Combined Approaches (CA) provide powerful segmental sagittal correction potential and increase the surface area available for fusion in ASD surgery, both of which would improve overall outcome when compared to all posterior approaches. This is the first study directly comparing surgical outcomes between Combined Anterior–Posterior (CA) approaches and All Posterior (PO) approach in a matched ASD population.

Methods: Retrospective Matched-Control cohort analysis with substitution using a multicenter prospectively collected ASD data of patients with > 2-yr FU. Matching criteria include: Age, American Society of Anesthesiologists Score, Lumbar Cobb angle, Sagittal deformity (Global Tilt) and ODI. Patients with missing data were excluded (Flowchart).

Results: 1022 ASD patient were available for analysis. Out of the 29 CA patients who met inclusion criteria only 22 could be matched to 2 controls each (1:2 Ratio). Preoperative non-matched demographical, clinical, surgical and radiological parameters were comparable between both groups, validating matching criteria. CA group had longer surgeries (548 mns vs 283; $p < 0.001$) with more blood loss (2850 ml Vs 1471; $p < 0.001$) and needed longer ICU stays (74 h Vs 27; $p < 0.001$). Despite the added morbidity, they had comparable complication rates but with significantly less readmissions (9.1% vs 38.1%) and reoperations (18.2% vs 43.2%). CA group achieved a more individualized and harmonious deformity correction as measured by Global Tilt and GAP score parameters. Both groups however achieved similar final radiological corrections and functional results were comparable up to two years after surgery. At the 2-year control, CA patients reported better outcomes as measured by COMI and SRS scores. This trend was maintained in the CA group reaching 3-years.

Conclusion: Despite an increased initial surgical aggression, combined approaches seem to achieve a more harmonious correction with superior sagittal deformity control, they need less revisions and have improved long-term functional outcomes starting two years after index surgery when compared to all-posterior approaches for ASD deformity correction.



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NEW CLASSIFICATION OF CORONAL MALALIGNMENT FOR ADULT SPINAL DEFORMITY: A VALIDATION STUDY

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Object: In addition to sagittal malalignment, coronal malalignment (CM) may cause severe impairment of function for adult spinal deformity (ASD) patients. Moreover, certain types of CM are reported to run the risk of correction failure. However, CM has received minimal attention in the medical literature compared to sagittal malalignment. Recently, a new classification system of CM was published by Obeid et al. (Obeid-CM classification). This classification divides patients into 6 groups, firstly according to the main coronal curve direction (concave or convex), and subsequently by modifiers for the stiffness of the main coronal curve and the coronal mobility and degeneration of the lumbosacral junction. (see figure below). However, whether new classification for CM has substantial reliability and agreements among spine surgeons have not been identified yet.
Study design: Validation study for intra- and inter-rater reliability and agreement.
Methods: Fifteen readers from fourteen international institutions were assigned and classified 28 cases who represented CM (C7-CSVL $>$ 20 mm) according to the Obeid-CM classification with reference to their full-length standing anteroposterior and lateral X-rays. The person who selected the cases was blinded to the treatments and outcomes, and the assignment was repeated 2 weeks later, with the curves presented in a different order. Intra- and inter-rater reliability were determined by calculating Cohen's and Fleiss' kappa coefficients, respectively.
Results: Inter-rater reliability was calculated as 0.91 for main curve types, 0.75 for subtypes with first modifier, 0.52 for total with two modifiers. Intra-rater reliability averaged 0.95 for main curve types, 0.86 for subtypes with first modifier, 0.73 for total with two modifiers. No differences in intra-rater reliability were shown between four expert scoliosis surgeons who participated in the establishment of the classification and other readers.
Conclusion: Substantial intra- and inter-rater reliability was shown in the new classification of CM for ASD. Even non-expert deformity surgeons could grade the patients with the same reliability as expert surgeons. Surgeons should consider both the sagittal and coronal planes for ASD, and new classifications may allow better understanding and surgical decision making for CM.

Figure: New classification system for corpnal malalignment

Types	Subtypes	
Main coronal curve types	First modifier: the apex of the curve	Second modifier: flexibility of curve
Type 1	**Type 1A**	**Type 1A1**
Concave	Between T12 and L4	Flexible
		Type 1A2
		Rigid
	Type 1B	
	Above T11-12	
Type 2	**Type 2A**	**Type 2A1**
Convex	between T12 and L4	Flexible
		Type 2A2
		Rigid
	Type 2B	
	Lumbosacral junction: below L4-5	

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RESTORING THE IDEAL ROUSSOULY SAGITTAL PROFILE IN ADULT SCOLIOSIS SURGERY DECREASES THE RISK OF MECHANICAL COMPLICATIONS

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Introduction: Optimizing global sagittal alignment in adult deformity improves the patient's quality of life and decreases the rate of complications. However, there is still no data proving if restoring the ideal sagittal profile (according to Roussouly classification) in adult scoliosis (AS) patients, leads to any additional benefit, especially regarding mechanical complications.
Methods: We present a retrospective analysis of operated AS patients recorded in a prospective multicenter database. Demographic and the following radiographic (preoperative and 6-week postoperative) data were analyzed: sagittal parameters (PI, PT, SS, Global Tilt-GT-), PI-LL mismatch, upper instrumented vertebra (UIV), lower instrumented vertebra (LIV), Roussouly type (R-type), Lumbar Apex, and Inflexion point. Patients with and without mechanical complications were compared looking especially at the surgical restoration of the ideal (based on Pelvic Incidence) sagittal profile as described by Laouissat and Roussouly: type 1 & 2 = PI $<$ 45°, type 3 = 45°–60°, and type 4 = PI $>$ 60°. Univariate and multivariate analysis was performed to identify causes of mechanical complications at 2-yr minimum follow-up.

Results: 96 AS patients were analyzed. 39 patients suffered a mechanical complication (18 PJK, 11 pseudoarthrosis, 10 screw pull-out), 57 patients had no mechanical complications. After surgery, 72% of patients not matching the ideal Roussouly type suffered mechanical complications compared to 15% of postoperatively matched patients ($P < 0.001$). Univariate analysis showed that older patients 64.9 ± 13 vs 40.7 ± 15.6 years ($P < 0.001$), higher postoperative Global Tilt (27° vs 14.7°), higher postoperative Pelvic Tilt (25° vs 16°) ($P < 0.001$), UIV at the thoracolumbar junction (62% vs 21%) ($P < 0.001$), LIV to the Iliac (76% vs 6%) ($P < 0.001$), and postoperative Roussouly-type mismatch (72% vs 15%) ($P < 0.001$), significantly increased the rate of mechanical complications. Setting a higher R-type than ideal and a higher lumbar apex than the ideal associated higher rate of complications. Multivariate logistic regression analysis selected: postoperative Roussouly-type mismatch (OR = 41.9; 95%CI = 5.5–315.7; $p < 0.001$), Iliac instrumentation (OR = 19.4; 95%CI = 2.6–142.5; P = 0.004), and age (OR = 1; 95%CI = 1–1.1; P = 0.004), as the most important variables.
Conclusions: Adult scoliosis surgery should restore the ideal Roussouly sagittal profile (dictated by pelvic incidence) to decrease the rate of mechanical complications, especially in patients older than 65, instrumented to the pelvis.

Table 2. Comparison of postoperative parameters

	Mechanical complications	No mechanical complications	P value
Sagittal parameters			
Pelvic Incidence (º)	55.1º ± 13.6	56.7º ± 12.8	0.538
Pelvic Tilt (°)	25.4º ± 8.8	16.4º ± 9.7	0.000*
Sacral Slope (º)	29.3º ± 11.4	40º ± 10.3	0.000*
PI-LL mismatch (º)	6.9º ± 16.4	2º ± 20.1	0.217
Global Tilt (º)	27.1º ± 13.7	14.7± 10.6	0.000 *
Postoperative sagittal profile matching			
Match	15.1%	84.9%	0.000*
Unmatch	72%	27.9%	
Upper instrumented vertebra			
Proximal Th (T2-T5)	21.6%	78.4%	0.000*
ThL junction (T9-L2)	62%	37.8%	
Lower instrumented vertebra			
Iliac	76.6%	23.4%	0.000*
Above Iliac	6.1%	93.9%	
Postoperative Roussouly-type			
Higher than ideal	77.4%	22.6%	0.000*
Same than ideal	15.1%	84.9%	
Lower than ideal	58.3%	41.7%	
Postoperative Lumbar apex			
Higher than ideal	55.6%	44.4%	0.009*
Same than ideal	20%	80%	
Lower than ideal	38.1%	61.9%	
Postoperative Inflexion point			
Higher than ideal	40.6%	59.4%	0.126
Same than ideal	29.4%	70.6%	
Lower than ideal	57.9%	42.1%	
* statistical significance			

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DOES INTERBODY FUSION PROTECT AGAINST ROD FAILURE IN THE LOWER LUMBAR SPINE AFTER LONG FUSIONS TO THE SACRUM: A COMPARATIVE ANALYSIS OF ADULT SPINAL DEFORMITY PATIENTS

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Introduction: Rod failures in the lumbar spine after long fusions to the sacrum for Adult spinal deformity (ASD) correction remain high despite the use of BMP and sacropelvic fixation. The question whether Interbody fusion is needed with the combination of sacropelvic fixation and use of BMP after long PSF to the sacrum in ASD remains unanswered. We compared the rate of rod failures (RF) in 256 ASD patients (pts) who underwent long spinal fusion using BMP and sacropelvic fixation with and without Interbody fusion in the lower lumbar spine.
Methods: We reviewed clinical records of patients who underwent surgery for correction of ASD between 2008 and 2014. Patients demographics, comorbidities, indications for surgery, as well as intra- and post-operative variables were collected. Patients were dichotomized into one of two groups based on whether an interbody fusion was performed at the caudal levels of the fusion construct. All patients had a minimum two-year follow-up. 526 ASD pts was reviewed, only primary surgeries were included. Interbody fusions were performed in the lower lumbar spine L3-S1 most commonly at L5-S1. The primary outcome of interest was the rod failure rates from L3-S1. All patients had a minimum two-year follow-up.
Results: 256 pts underwent long PSF for correction of ASD, 141 pts had interbody fusion (IF group) at any level L3-S1 with mean follow up of 59 ± 29 months and 115 pts had no interbody fusion (NIF group) with 50 ± 22 months mean follow-up. At baseline, there were no significant differences between both groups in gender (p = 0.97), BMI (p = 0.62), smoking status (p = 0.40), diabetes (p = 0.34) or osteopenia p = 0.73. The median number of levels fused in the IF group was 10(7–15) compared with 8 levels (7–15) in the NIF group. BMP and sacropelvic fixation was used in all pts (233 iliac screws and 23 pts had S2AI screws). Pre-op sagittal plane deformity was not different between both groups. At last follow-up, there was no statistically significant difference in rate of Rod failure between IF n = 29(21%) vs NIF n = 17(15%) p = 0.23. IF group had 19(13%) unilateral rod failures and 10 (7%) bilateral rod failures. NIF group included 12(10%) unilateral rod failures and 5(4%) bilateral rod failures. The most common location of rod failures was different between the groups, L3-L4 was the most common location in the IF group with 6.5% followed by L5-S1 in 6.1% of patients. Interbody fusion was performed at L4-5 and L5-S1 in the majority of pts that failed at L3-4. In the NIF group L5-S1 was most common location in 6.4% followed by L4-L5 in 2.7% of patients.
Conclusions: This study suggests that interbody fusion of the lower lumbar spine in ASD patients may not be associated with a decrease in the incidence of rod failures at the Lubosacral junction. Interbody fusion does not protect against rod failure in the lower lumbar spine in

long PSF to the sacrum and may encourage failure at L3-4, the level above the interbody fusion.

Characteristic		Interbody Fusion Cohort(n=141)	No Interbody Fusion Cohort(n=115)	p-Value
Length of Follow-up(Months)		59.50±29.20	49.99±22.40	0.01
Rod Fracture (n,%)		29(21)	17(15)	0.23
Unilateral Rod fracture(n,%)		19(13)	12(10)	0.46
Bilateral Rod fracture(n,%)		10(7)	5(4)	0.34
2-years Radiographic Parameters				
Mean C7 SVA (mm)		2.78±3.80	2.44±3.85	0.48
Mean Pelvic Incidence(°)		54.88±12.21	53.30±14.43	0.35
Mean Sacral Slope (°)		32.15±8.82	32.21±10.25	0.96
Mean Lumbar Lordosis (°)		46.89±12.17	46.34±13.50	0.74
Mean Pelvic Incidence–Lumbar Lordosis (°)		8.11±12.15	6.96±15.74	0.53
Thoracic Kyphosis (°)		36.90±12.08	36.23±12.97	0.67
Thoracolumbar Kyphosis (°)		**8.24±12.05**	**12.45±10.16**	**0.01**
Coronal Cobb Angle		25.53±14.36	26.45±15.55	0.63
Location of Rod Fracture	**Rod failure uni-and bilateral in both groups**	**Interbody Fusion Cohort(n=141)**	**No Interbody Fusion Cohort(n=115)**	**p-Value**
L3(%)	2.5	0.32	0.45	0.65
L3-L4 (%)	31.25	6.51	2.28	0.08
L4-L5(%)	12.50	1.30	2.73	0.10
L5-S1(%)	41.25	6.18	6.39	0.17
S1-Ilium (%)	12.50	2.28	1.36	0.83

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THE IMPACT OF LORDOSIS DISTRIBUTION AND SAGITTAL HARMONY ON POSTOPERATIVE MECHANICAL COMPLICATIONS AFTER A LUMBAR PSO

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Introduction: Many variables have been associated with mechanical complications after a lumbar pedicle subtraction osteotomy (L-PSO). However, the impact on mechanical complications of postoperative ideal (based on patient's Pelvic Incidence-PI-) lordosis distribution and ideal sagittal harmony is still underexplored. Lordosis distribution depends on the position of the sagittal lumbar apex, which draws two different lumbar arches, above and below the apex. Ideal sagittal harmony depends on PI as published by Laouissat and Roussouly. The aim of the study was to assess whether this lordosis distribution and sagittal harmony had importance on postoperative mechanical complications after a lumbar PSO.

Methods: We conducted a retrospective analysis of prospectively collected adult deformity patients undergoing L-PSO. The following risk factors were analyzed: age, ASA score, gender, PSO level, interbody cages, rod material, rod diameter, number of rods, upper instrumented vertebra, lower instrumented vertebra, PI-LL mismatch, Global Tilt (GT), postoperative level of Lumbar Apex (LApex), postoperative level of Inflexion Point (InfxP), and postoperative type of Roussouly sagittal profile (R-type). The last three variables depended on the level of PSO, and final pelvic version, and they were compared to ideal. Univariate (Chi2, Student-t) and multivariate analysis (logistic regression) were performed to identify risks for mechanical complications with a minimum 2-yr follow-up.

Results: 87 consecutive patients with one level L-PSO were included. Mean follow-up was 4.5 ± 1.7 yrs. 40.2% of the patients suffered postoperative mechanical complications (7 PJK, 4 PJF, 18 pseudoarthrosis/rod breakage, 6 screw pull-out). Mean time for complications was 584 ± 416 days from surgery. Univariate analysis showed that: age (63 vs 57 years; $P = 0.04$), preoperative GT (50.7° vs 38.7°; $P < 0.001$), postoperative GT (28.9° vs 23.4°; $P = 0.018$), postoperative LApex location mismatched from ideal (77.8% vs 22.2%; $P = 0.036$), and postoperative R-type mismatched from ideal (67.6% vs 22.6%; $P < 0.001$), were significantly related to mechanical complications. The rest of the studied variables did not show significant difference $P > 0.05$. Multivariate analysis selected as the most important variables: postoperative R-type mismatched from ideal OR = 11.3 (95%CI = 3.9–32.6; $P < 0.001$), Age OR = 1.05 (95%CI = 1–1.1; $P = 0.03$), and LApex matching OR = 0.5 (95%CI = 0.27–0.97; $P = 0.04$). The further the LApex was from its ideal position, the higher the risk of mechanical complications ($P = 0.036$).

Conclusions: Over other multiple suspected risk factors, proper lumbar apex position, ideal lordosis distribution, and ideal sagittal shape restoration played an important role in postoperative mechanical complications after L-PSO.

Table. Complications at minimum 2 years follow-up (87 patients)			
	Mechanical complications (35)	No mechanical complications (52)	P value
Age	63.1±10.6	57.2±16.7	0.046*
ASA score	1.9±0.6	1.9±0.7	0.997
Preop Global Tilt	50.7±15.4	38.7±14.3	0.000*
Preop PI-LL mismatch	34.5±18.7	27.3±16.9	0.071
Postop Global Tilt	28.9±10.6	23.4±10.4	0.018*
Postop PI-LL mismatch	5.7±12.5	2.2±12.7	0.211
Gender			
Male	38.1%	61.9%	0.819
Female	40.9%	59.1%	
PSO Level			
L1-L2	42.9%	57.1%	0.310
L3	43.8%	56.2%	
L4	42.3%	57.7%	
L5-S1	0%	100%	
Interbody cages			
Yes	48.7%	51.3%	0.146
No	33.3%	66.7%	
Rod Material			
Titanium	38.3%	61.7%	0.549
Co-Chr	44.7%	55.3%	
Rod diameter			
5.5	40.4%	59.6%	0.950
6	44.4%	55.6%	
6.35	40%	60%	
Number of rods			
2 rods	41.2%	58.8%	0.220
linked double rods	29.2%	70.8%	
Unlinked double rods	63.6%	36.4%	
UIV			
ThL (T9-L2)	38.8%	61.2%	0.291
T2-T5	52.9%	47.1%	
LIV			
Iliac	40.8%	59.2%	0.780
Non Iliac	36.4%	63.3%	
Postoperative R-type matching			
Match (53)	22.6%	77.4%	0.000*
Unmatch (34)	67.6%	32.4%	
Postoperative Lumbar apex vs ideal			
Higher than ideal	32.7%	67.3%	0.036*
Same than ideal	43.5%	56.5%	
Lower than ideal	77.8%	22.2%	
Postoperative Lumbar apex position difference from Ideal			
-1 Level	100%	0%	0.067
-0.5 level	66.7%	33.3%	
+1 level	27.8%	72.2%	
+2 Levels	75%	25%	
+3 levels	100%	0%	
Postoperative Inflexion point vs Ideal			
Higher than ideal	46.4%	53.6%	0.290
Same than ideal	30.3%	69.7%	
Lower than ideal	48.1%	51.9%	
Postoperative Inflexion point position difference from ideal			
-3 levels	100%	0%	0.631
-2 levels	50%	50%	
-1 level	43.8%	56.2%	
+1 level	41.2%	58.8%	
+2 levels	50%	50%	
+3 levels	60%	40%	
* statistical significance			

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DIFFERENCES IN STANDING AND SITTING SPINOPELVIC SAGITTAL ALIGNMENT FOR PATIENTS WITH POSTERIOR LUMBAR FUSION IMPORTANT CONSIDERATIONS FOR THE CHANGES OF UNFUSED ADJACENT SEGMENTS LORDOSIS

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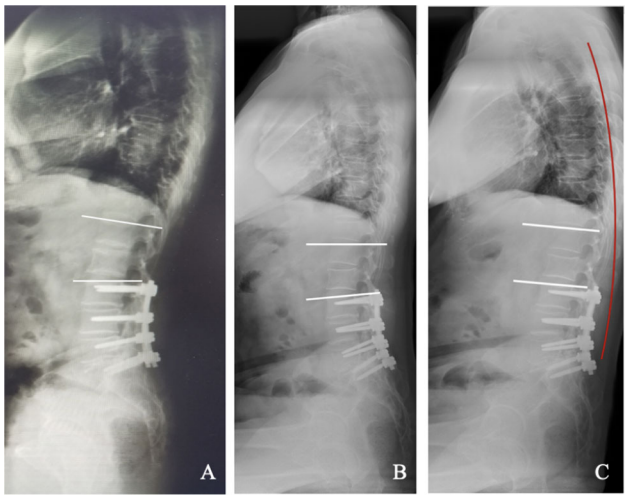
Objective: This study aimed to investigate the differences in spinopelvic sagittal alignment of patients with posterior lumbar fusion among three common functional postures: standing, an erect sitting and a natural patient-preferred sitting posture. The variation of spinopelvic sagittal alignment, especially the unfused adjacent segments lordosis in sitting position will be fully studied.
Methods: This was a prospective radiological analysis using full-spine standing, erect and natural sitting lateral radiographs of patients with posterior lumbar fusion. The exclusion criteria: (1) Patients with severe low back pain affecting sitting and standing position or ODI of more than 40. (2) Patients with hip or knee joint contracture. (3) Patients who had sagittal or coronal deformity. (4) Patients who had internal fixation breakage or pseudarthrosis formation. Total 44 patients (21 males, 23 females; mean age 63.4 $\pm$ 10.8 years; mean follow-up duration time 82.0 $\pm$ 7.3 months) were enrolled. Pelvic and spinal parameters were measured, including pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), lumbar lordosis (LL), fusion segment lordosis (FSL), upper residual lordosis (URL), lower residual lordosis (LRL), thoracic kyphosis (TK) and T1-pelvic angle (TPA). Using Student's t test, the parameters will be compared between standing and erect sitting posture, erect and natural sitting posture. The changes of sagittal alignment in different postures will be discussed. Using pearson's correlation test according to different positions, relationships between residual lordosis and other parameters will be discussed.
Results: 29 patients had lumbosacral fusion, including 5 patients with L5-S1 fusion, 13 patients with L4-S1 fusion, 11 patients with L3-S1 fusion. 15 patients had lumbar floating fusion, including 7 patients with L3-5 fusion, 5 patients with L4-5 fusion, 3 patients with L2-5 fusion. When moving from standing to erect sitting position, PT and TPA were significantly greater ($P > 0.05$), LL, SS, UR, LRL and TK were decreased ($P < 0.05$). When moving from erect sitting to natural sitting position, PT, TPA and TK were significantly greater ($P > 0.05$), LL, SS, UR and LRL were further decreased ($P < 0.05$). In standing position, the correlations between URL-PI and URL-FSL were existed. But in natural sitting position, the correlation in URL-FSL was lost, URL had close relationship with TK. Conclusion :In a natural sitting posture, the total spine becomes kyphotic and contributes to a single C-shaped sagittal profile comprising the thoracic, the unfused lumbar and fused lumbar spine. The unfused lumbar segments are more straighten in sitting position. In natural sitting position, the URL is more adjusted by TK. The characteristics of unfused segments lordosis in natural sitting position may provide information on one of the possible causes of proximal junctional failure or adjacent segment degeneration.



57 years male. At 77 month follow-up,whole spine X-ray in standing, erect sitting and natural sitting. In standing, URL was 13°; In erect sitting, URL was 9.8°; In natural sitting, URL was 3.8°. In a natural sitting posture, the total spine becomes kyphotic and contributes to a single C-shaped sagittal profile comprising the thoracic, the unfused lumbar and fused lumbar spine.
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THE LONG-TERM PSYCHOLOGICAL AND FUNCTIONAL STATUS OF FEMALE PATIENTS AFTER SURGICAL OR NON-SURGICAL TREATMENT FOR IDIOPATHIC SCOLIOSIS (IS): A QUALITATIVE AND QUANTITATIVE ANALYSIS

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Introduction: Research has demonstrated that negative self-image (SI) can result in decreased self-esteem (SE). Previous studies in the general population have also reported a link between SI/SE and sexual function (SF): women satisfied with their body image report better SF and satisfaction compared with their counterparts who are dissatisfied with their bodies. Idiopathic scoliosis (IS) considered during adolescence to be mainly a cosmetic problem, could have an impact on this SI/SE-SF link. This study aimed to compare the long term psychological (SI/SE) and functional status (General function (GF), SF) of female patients with IS treated surgically and non-surgically during adolescence.
Methods: To be included, patients had to be female, $\geq$ 25y (no menopause), with IS treated during adolescence (12–18y) with either brace or surgery, and have a thoracic Cobb > 40 at the time of treatment. The project used a combination of qualitative and quantitative data collection and analysis. The quantitative part involved validated self-report questionnaires (see Table). The qualitative part comprised the recording, transcription, coding and Network Text Analysis (NTA) of focus group and semi-structured individual interviews. Focus groups were used to fine-tune the individual interview. The following families of codes and their internal connections were qualitatively evaluated: Brace, Surgery, SI, SE and SF. The following nodes between families were also analyzed: Brace with SI-SE, Surgery with SI-SE, SF with SI-SE. Correlations between dimensions were also quantitatively analyzed.
Results: Overall, 57 patients were recruited. Two focus groups and 44 individual interviews were performed (2702 audio min). A total of 1979 codes organized in 21 families based on conceptual proximity were defined and analyzed. The most prevalent informative codes were: Pain_Yes (97), Support_Family (73), Self-image_Good (65), Brace_Negative (62), Physical_limitations (58), Acceptance_Yes (54). Both quantitative and qualitative results concluded that the SI/SE-SF link is present in IS patients (Table). Quantitative results suggested that it was especially important in surgically treated patients. No differences were found between treatment groups in any dimensions except TAPS-self-image (better in surgical group). Statistically significant differences were found when comparing age groups, with an important effect for the dimensions SF, GF and mental health (Table). Qualitative results suggested that the code Pain_Yes had a negative effect on SE, SI and SF.
Conclusion: This is the first mixed-methods study (combining qualitative and quantitative data) evaluating the long term status of IS patients. Our results suggest that the SI/SE-SF link is also present in IS, and especially prominent in surgically treated patients. The findings should provide clinicians with a greater awareness of the difficulties faced by these patients, in this hitherto poorly-researched area of patient outcome.

		Between 25-39 years of age (31 patients)			Over 40 years of age (26 patients)			TOTAL
		Focus 1a	Group 1b Surgical tx	Group 1c Conservative tx	Focus 2a	Group 2b Surgical tx	Group 2c Conservative tx	
Demographics	Number of patients	7	14	10	6	10	10	57
	AUDIO	168 min	52.1 min (22-73)	53.4 min (34-71)	136 min	57.1 min (31-85)	54.6 min (38-78)	2702 minutes
	Age (current)	32.43 (28-39)	33.6 (25-38)	31.7 (26-39)	44.3 (41-49)	44.7 (40-53)	45.3 (40-51)	38.25
	Age (diagnosis)	10.71 (5-15)	10.8 (4-15)	11.4 (7-14)	9.5 (6-12)	10.2 (6-14)	10.5 (5-14)	10.6
	Age (surgery)	23.71 (19-30)	15.8 (13-18)		30.0 (19-45)	14.8 (12-18)		
	Major Thoracic Cobb Preop/during brace treatment	65.00 (40-92)	62.3 (46-87)	46.5 (40-60)	72.8 (65-90)	65.5 (50-103)	46.2 (40-61)	58.7
	Major Thoracic Cobb Postop	32.14 (20-60)	28.0 (8-53)		30.8 (20-50)	30.9 (10-54)		
	Major Thoracic Cobb (current)	38.86 (20-69)	36.9 (26-59)	49.5 (40-69)	33.8 (19-57)	46.2 (23-75)	53.9 (43-68)	43.9
	Number of levels fused	11.71 (7-15)	11.4 (9-13)		12.5 (7-15)	11.4 (9-15)		

		Age groups		
		Between 25-39 years of age (24 patients)	Over 40 years of age (20 patients)	p
Self-reported questionnaires	FSFI (Sexual function)	29.3 (SD: 7.3)	21.4 (SD: 12.5)	0.024
	FSDS (Sexual distress)	7.7 (SD: 14.0)	6.1 (SD: 6.9)	0.905
	ODI.10 (Sexual function)	0.5 (SD: 0.9)	1.4 (SD: 1.4)	0.026
	Rosemberg (Self-esteem)	31.8 (SD: 6.9)	30.9 (SD: 7.6)	0.705
	TAPS (self-image)	3.1 (SD: 0.7)	2.6 (SD: 1.1)	0.13
	SRS22 subtotal	3.9 (SD: 0.7)	3.3 (SD: 0.8)	0.006
	SRS22 Self-image	3.7 (SD: 0.8)	2.9 (SD: 0.9)	0.011
	ODI score	12.4 (SD: 14.0)	29.8 (SD: 19.7)	0.001
	SF36 PCS	47.6 (SD: 10.5)	41.4 (SD: 12.7)	0.094
	SF36 MCS	51.3 (SD: 8.9)	46.0 (SD: 8.7)	0.024
		Treatment groups		
		Conservative Treatment (20 patients)	Surgical Treatment (24 patients)	p
	FSFI (Sexual function)	27.4 (SD: 8.9)	24.3 (SD: 11.9)	0.65
	FSDS (Sexual distress)	6.8 (SD: 8.8)	7.1 (SD: 13.1)	0.87
	ODI.10 (Sexual function)	0.9 (SD: 0.9)	0.9 (SD: 1.5)	0.29
	Rosemberg (Self-esteem)	31.4 (SD: 5.7)	31.3 (SD: 8.3)	0.75
	TAPS (self-image)	2.4 (SD: 0.7)	3.3 (SD: 0.9)	0.01
	SRS22 subtotal	3.6 (SD: 0.7)	3.6 (SD: 0.9)	0.58
	SRS22 Self-image	3.1 (SD: 0.8)	3.5 (SD: 1.0)	0.13
	ODI score	21.1 (SD: 17.6)	19.7 (SD: 20.1)	0.58
	SF36 PCS	44.9 (SD: 8.6)	44.6 (SD: 14.2)	0.62
	SF36 MCS	49.4 (SD: 7.1)	48.5 (SD: 10.6)	0.98

		Spearman correlations		
		All patients (57)	Surgical treatment (24)	Conservative treatment (20)
Correlations	SRS22_SI vs Rosemberg (SE)	r= 0.36 (0.005)	r= 0.52 (p=0.009)	r= 0.16 (p=0.49)
	SRS22_SI vs Rosemberg (SE) (age adjusted)	r= 0.40 (p=0.002)	r= 0.52 (p=0.0098)	r= 0.18 (p=0.50)
	SRS22_SI vs Rosemberg (SE) (Cobb adjusted_present)	r= 0.34 (p= 0.009)	r= 0.53 (p=0.01)	r= 0.07 (p=0.78)
	SRS22_SI vs Rosemberg (SE) (Cobb adjusted_preop/Baseline)	r= 0.38 (p=0.0043)	r= 0.50 (p=0.02)	r= 0.14 (p= 0.57)
	Rosemberg (SE) vs FSFI/FSDS (SF)	r= 0.10 (p=0.45 / r= -0.35 (p=0.007)	r=0.24 (p=0.27) / r= -0.53 (p=0.007)	r= 0.001 (p=0.99) / r= -0.23 (p=0.33)
	Rosemberg (SE) vs FSFI/FSDS (SF) (age adjusted)	r= 0.10 (p=0.48) / r= -0.35 (p=0.01)	r= 0.24 (p=0.26) / r= -0.53 (p=0.0089)	r= 0.002 (p=0.92) / r=0-.23 (p=0.38)
	Rosemberg (SE) vs FSFI/FSDS (SF) (Cobb adjusted_present)	r= 0.12 (p=0.387) / r= -0.38 (p=0.003)	r= 0.24 (p=0.28) / r= -0.55 (p=0.006)	r= -0.05 (p=0.85) / r= -0.20 (p=0.41)
	Rosemberg (SE) vs FSFI/FSDS (SF) (Cobb adjusted_preop/Baseline)	r= 0.10 (p=0.432) / r= -0.35 (p=0.007)	r= 0.24 (p=0.28) / r= -0.60 (p=0.0025)	r= -0.02 (p=0.92) / r= -0.19 (p=0.41)

Table: "FSFI: 2 (poor sexual function) to 36 (good sexual function)"; "FSDS: 0 (low levels of distress) to 52 (high levels of distress)"; "RSES: 10 (low self-esteem) to 40 (high self-esteem)"; "SRS22: 1 (worst status) to 5 (best status)"; "TAPS: 1 (worst status) to 5 (best status)"; "ODI: 0 (best status) to 100 (worst status)"; "SF36v2 age adjusted: low scores=more limitations".

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DEGENERATIVE (CERVICAL), CRANIOCERVICAL JUNCTION

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ASSOCIATION BETWEEN CERVICAL DEGENERATION AND SELF-PERCEIVED NON-RECOVERY AFTER WHIPLASH INJURY

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Background: Pre-existing radiological degenerative changes have often been considered not being a risk factor for non-recovery after motor vehicle accidents (MVA) resulting in neck pain. However, results from previous studies are often based on assessment of plain radiography or MRI and little consideration has been taken to facet joints. Further, previous studies have often been lacking a validated scoring system.
Purpose: To investigate association between cervical degeneration on Computed Tomography (CT) and non-recovery after whiplash trauma.
Outcome measures: The primary outcome measure was self-perceived non-recovery (yes/no) after 6 months. Secondary outcome measure was self reported pain (Numeric Rating Scale).
Materials and methods: In this longitudinal cohort study we included 121 patients seeking care at an Emergency Department because of neck pain after MVA, 2015–2017. All patients conducted a valid CT-scan of the cervical spine and completed the follow up after 6 months. Data regarding demographics and health factors were gathered through a web-based questionnaire. The CT-scans were assessed regarding degeneration of the facet joints and intervertebral discs according to a validated scoring system. Binary logistic regression was used to study the association between cervical degeneration and non-recovery.
Results: Moderate facet joint degeneration was associated with non-recovery (aOR 6.7, 95% Confidence interval: 1.9–24.3) There was no association between disc degeneration and non-recovery. Together, facet joint degeneration and disc degeneration were associated with non-recovery (aOR 6.2 (2.0–19.0)). Additionally moderate facet joint degeneration was associated with high pain level at follow up.
Conclusions: These results suggest a revaluation of the view of cervical degeneration, especially facet joint degeneration, not being a risk factor for non-recovery after whiplash trauma. We hypothesize that whiplash trauma can occasionally be a trigger for manifestation of facet joint mediated pain.
Association between non-recovery and degeneration and other factors. Logistic regression analysis.

		Count	Non recovery	p-value	Crude OR	95% C.I.	Adjusted O.R.**	95% C.I.
Facet joint degeneration	0	54	13 (23.6%)	<0.05	Ref		Ref	
	1	25	10 (41.7%)		2.3	0.8-6.4	2.1	0.6-7.3
	2	25	16 (69.6%)		7.4	2.5-21.8	6.7	1.9-24.3
	3	17	7 (38.9%)		2.1	0.7-6.4	1.1	0.2-5.6
Disc degeneration	0	66	21 (32.3%)	0.20	Ref		Ref	
	1	34	18 (52.9%)		2.5	1.0-5.5	1.8	0.5-6.4
	2	16	5 (31.3%)		1.0	0.3-3.1	0.92	0.2-5.8
	3	5	2 (40.0%)		1.4	0.2-9.0	3.04	0.2-46.9
Age groups	16-29	51	17 (33.3%)	0.36	Ref		Ref	
	30-45	37	13 (37.1%)		0.6	0.2-1.4	0.8	0.2-3.8
	46-70	33	16 (47.1%)		0.7	0.3-1.7	1.3	0.3-5.3
Gender	Male	63	21 (33.9%)	0.35	Ref		Ref	
	Female	58	25 (43.1%)		1.5	0.7-3.1	2.0	0.7-5.5
University education	No	69	26 (37.7%)	1.00	Ref		Ref	
	Yes	52	20 (39.2%)		1.1	0.5-2.3	1.0	0.4-2.7
Sick leave	No	96	36 (37.9%)	0.82	Ref		Ref	
	Yes	25	10 (40.0%)		0.9	0.4-2.3	1.1	0.4-3.6
Level of pain (NRS)	0-3	39	5 (12.8%)	<0.05	Ref		Ref	
	4-6	52	22 (42.3%)		5.0	1.7-14.8	3.4	0.7-16.8
	7-10	29	19 (65.5%)		12.9	3.9-43.4	6.9	1.0-46.2
Level of stiffness	0-2	33	5 (15.2%)	<0.05	Ref		Ref	
	3-6	59	25 (42.4%)		4.1	1.4-12.1	1.6	0.3-8.1
	7-10	29	16 (57.1%)		7.5	2.2-25.1	1.34	0.2-9.5
Level of mental distress	0-3	38	9 (24.3%)	<0.05	Ref		Ref	
	4-6	52	19 (35.8%)		1.7	0.7-4.4	1.0	0.3-3.1
	7-10	31	18 (60.0%)		4.7	1.6-13.3	2.3	0.6-9.6
Previous neck pain*	No	106	37 (34.6%)	<0.05	Ref		Ref	
	Yes	12	9 (69.2%)		4.3	1.2-14.8	3.6	0.8-16.0
RCT intervention	No	68	17 (32.1%)	0.26	Ref		Ref	
	Yes	53	29 (42.6%)		1.5	0.7-3.3	2.3	0.9-6.2

C.I. =Confidence Interval, NRS= Numeric Rating Scale, RCT= Randomized Clinical Trial
* missing values n= 3, ** adjusted for all eleven variables in the table

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IMPORTANCE OF THE PREOPERATIVE CROSS-SECTIONAL AREA OF THE SEMISPINALIS CERVICIS AS A RISK FACTOR FOR LOSS OF LORDOSIS AFTER LAMINOPLASTY IN PATIENTS WITH CERVICAL SPONDYLOTIC MYELOPATHY

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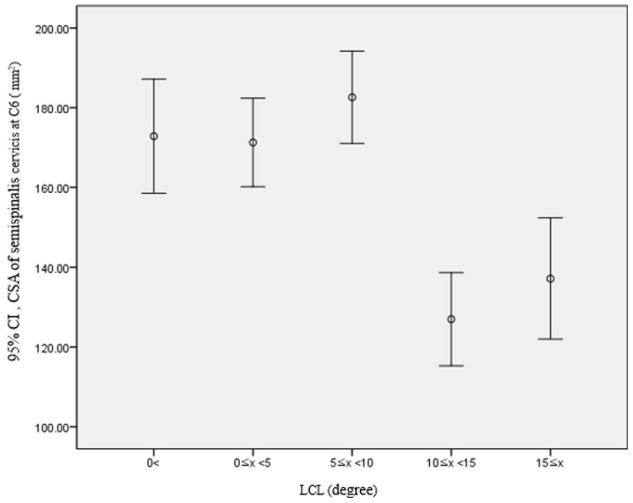
Purpose: To investigate the effect of the preoperative cross-sectional area (CSA) of the semispinalis cervicis on postoperative loss of cervical lordosis (LCL) after laminoplasty.
Methods: A total of 144 patients who met the inclusion criteria between January 1999 and December 2015 were enrolled. Radiographic assessments were performed to evaluate the T1 slope, C2-7 sagittal vertical axis (SVA), cephalad vertebral level undergoing laminoplasty (CVLL), preoperative C2-7 Cobb angle, and preoperative CSA of the semispinalis cervicis.
Results: The T1 slope and the summation of the CSAs (SCSA) at each level of the semispinalis cervicis correlated with LCL, whereas the C2-7 SVA, CVLL, and preoperative C2-7 Cobb angle did not.

Multiple regression analysis demonstrated that a high T1 slope and a low SCSA of the semispinalis cervicis were associated with LCL after laminoplasty in patients with cervical spondylotic myelopathy (CSM). The CSA of the semispinalis cervicis at the C6 level had the greatest association with LCL, which suddenly decreased with a LCL of 10°. The best cutoff point of the CSA of the semispinalis cervicis at the C6 level, which predicts LCL > 10°, was 154.5 mm2 (sensitivity, 74.3%; specificity, 71.6%; area under the curve, 0.828; 95% confidence interval, 0.761–0.895).

Conclusions: Preoperative SCSA of the semispinalis cervicis was a risk factor for LCL after laminoplasty. Spine surgeons should evaluate semispinalis cervicis muscularity at the C6 level when planning laminoplasty for patients with CSM.



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TYPE II ODONTOID FRACTURE IN ELDERLY PATIENTS TREATED CONSERVATIVELY: IS FRACTURE HEALING THE GOAL?

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Purpose: Analysis of functional outcome of elderly patients with type II odontoid fractures treated conservatively in relation to their radiological outcome.

Methods: 50 geriatric patients with type II odontoid fractures were treated with Aspen/Vista collars. On admission, each patient was assessed assigning ASA score, modified Rankin scale (mRS-pre) and Charlson Comorbidity Index (CCI). 12–15 months after treatment, functional evaluations were performed employing a second modified Rankin scale (mRS-post) together with Neck Disability Index (NDI) and Smiley Webster Pain Scale (SWPS). Radiological outcome was evaluated through dynamic cervical spine x-rays at 3 months and cervical spine CT scans 6 months after treatment. Three different conditions were identified: stable union, stable nonunion, unstable nonunion. Surgery was preferred whenever a fracture gap > 2 mm, an antero-posterior displacement > 5 mm, an odontoid angulation > 11° or neurological deficits occurred.

Results: Among the 50 patients, 24 reached a stable union while 26 a stable nonunion. Comparing the two groups, no differences of ASA (p = 0.60), CCI (p = 0.85) and mRS-pre (p = 0.14) were noted. Similarly, no differences of mRS-post (p = 0.96), SWPS (p = 0.85) and NDI (p = 0.51) were observed between patients who reached an osseous fusion and those with a stable fibrous non-union. No effects of age, sex, ASA, mRS-pre, fracture dislocation and radiological outcome were discovered on functional outcome. At logistic regression analysis, female sex and high values of CCI emerged associated with worse NDI.

Conclusions: In geriatric type II odontoid fractures pre-injury clinical status and comorbidities overcome imaging in determining post-treatment level of function. Hard collar immobilization led to a favourable functional outcome with mRS-post, NDI and SWPS values diffusely encouraging whatever a bony union or a fibrous nonunion was obtained.

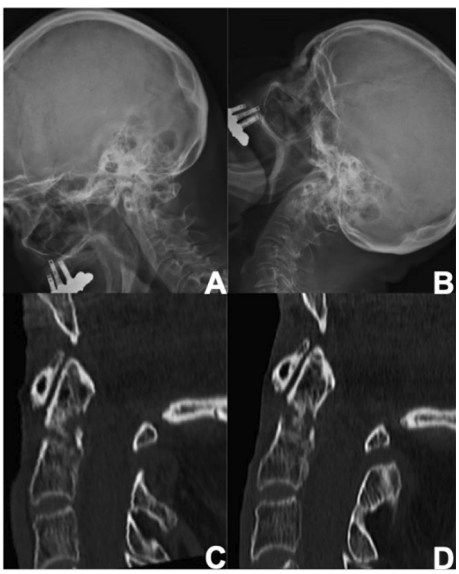

Figure. Dynamic cervical spine x-rays (flexion, A; extension,B) at 3 months and dynamic cervical spine CT-scan (flexion, C; extension, D) settling any doubts on evolutionary instability 6 months after injury.

Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: not indicated; author 7: none.

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NECK PAIN RESPONSE TO OPERATIVE INTERVENTION IN PATIENTS WITH DEGENERATIVE CERVICAL MYELOPATHY: RESULTS FROM THE MULTICENTER INTERNATIONAL PROSPECTIVE AOSPINE STUDIES

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Background context: Decompressive surgery is increasingly recommended for the treatment of degenerative cervical myelopathy (DCM) as it effectively halts neurological progression and improves functional impairment, disability, and quality of life. Despite the high incidence of neck pain in patients with DCM, there is a paucity of high-quality, prospective studies evaluating the impact of surgery on neck pain outcomes.
Purpose: The objectives of this study are to assess neck pain outcomes at 6, 12 and 24 months following surgery for DCM.
Study design/setting: Ambispective cohort study.
Patient sample: From 2005 to 2011, 757 patients with DCM were enrolled in either the AOSpine CSM-North America or CSM-International study at 16 global sites. All patients underwent surgical decompression of the cervical spine and were assessed at 6, 12 and 24 months post-operatively. A total of 664 patients had complete pre-operative pain scores and 497 had pain outcomes at 24-month follow-up.
Methods: As part of the NDI questionnaire, patients were asked to rate their neck pain as none, very mild, moderate, fairly severe, very severe or the worst imaginable. Frequencies and percentages were used to describe pain outcomes at 6, 12 and 24 months following surgery. Paired t-tests were conducted to determine differences in mean NDI pain intensity scores between baseline and 24 months post-operatively. As a further analysis, the percentage of patients who exhibited an improvement, no change, or regression in pain scores was computed for each pre-operative pain intensity group. The association of pre-operative pain severity on improvement in pain was evaluated by univariable logistic regression to derive an odds ratio and 95% confidence interval.
Results: Compared to the pre-operative incidence of neck pain (79.2%, n = 526), neck pain was less frequent at 6 months (67.1%, n = 380), 12 months (60.3%, n = 324), and lowest at 24 months (52.1%, n = 259). Pain intensity was significantly lower 24-months after surgery (mean NDI 1.83–1.32; 0.96–1.13; $p < 0.0001$). Whereas pre-operatively 130 patients (19.6%) rated their pain as fairly severe, 64 (9.6%) as very severe, and 13 (2.0%) as worst imaginable, at 24 months, only 32 (6.4%) indicated fairly severe, 14 (2.8%) very severe, and 3 patients (0.6%) worst imaginable. At 24-month follow-up, 263 (67.6%) patients exhibited improvement in their neck pain intensity score by at least one point, with 156 (40.1%) reporting no pain at all. Patients who reported more severe neck pain pre-operatively were more likely to have experienced improvement at 24 months (OR 1.8, 95% CI: 1.4 to 2.3, $p < 0.0001$).
Conclusion: To our knowledge, this is the first multi-center, international study to demonstrating significant improvements in neck pain up to 24 months after surgical decompression for DCM. Further studies are needed that evaluate important predictors of improvement in neck pain.
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TEN-YEAR OUTCOMES OF ONE- AND TWO-LEVEL CERVICAL DISC ARTHROPLASTY: RESULTS FROM A U.S. MULTI-CENTER STUDY

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Background: Short- and mid-term studies have shown the effectiveness of cervical disc arthroplasty (CDA) to treat cervical disc degeneration. Upon completion of the 7-year U.S. Food and Drug Administration (FDA) study, follow-up continued on a subset of CDA patients out to 10 years.
Purpose: The purpose of this study is to report the 10-year outcomes of a multicenter experience with cervical arthroplasty for 1- and 2-level pathology.
Methods: This was a prospective study of patients treated with CDA at one- or two contiguous levels. Upon completion of the 7-year post approval study, follow-up continued to 10 years for consenting patients at 9 high-enrolling centers. The primary inclusion criteria were cervical degenerative disc at one or two contiguous levels and no prior cervical operations. Outcome measures included NDI, VAS neck and arm pain, patient satisfaction, secondary surgery (removals, revisions, reoperations, or additional fixation) and adverse events. Radiographic endpoints included segmental and global range of motion, sagittal alignment, adjacent level degeneration (ALD) and heterotopic ossification (HO).
Results: Ten-year follow-up was obtained from 187 of 231 eligible patients (81%). The longest follow-up was 11.2 years. There were no significant differences in preoperative characteristics between these patients and the original FDA cohort. Ten years after CDA, patients continued to show significant improvement from baseline NDI, VAS neck and arm pain, and neurologic function. Outcomes at 10 years were improved from 7 years for NDI at one (14.2 vs 18.7; $p = 0.12$) and two levels (15.6 vs 19.7; $p = 0.02$). Comparable results were observed for neck and arm pain. There were no significant differences in outcomes between 1- and 2-level CDA at 10 years. Segmental flexion–extension range of motion remained significantly higher ($p < 0.01$) than preop ROM. Segmental and global ROM, and sagittal alignment were maintained from 7 to 10 years. Clinically relevant ALD at 10 years was not significantly different from the 7-year incidence ($p > 0.05$). The incidence of clinically relevant HO at 10 years was not significantly different from the 7-year incidence for 1-level (30.7% vs 29.6%; $p = 0.88$) or 2-level (41.7% vs 39.2%; $p = 0.70$) CDA patients. Only 2 subsequent surgeries were reported after 7 years. One patient underwent supplemental fixation at the index level 9.5 years after CDA. The other case was ACDF at a non-adjacent level unrelated to the CDA. Total incidence of subsequent surgery after 10 years was 4.7% at the index level and 3.5% at an adjacent level.
Conclusions: At 10-years, both 1- and 2-level CDA demonstrate sustained improvement of NDI, pain scores, range of motion and sagittal alignment compared to baseline. Progression of ALD and HO from 7 to 10 years was minimal. Our results through 10 years demonstrate that CDA continues to be a safe and effective surgical treatment for patients with 1- or 2-level cervical degenerative disc disease.

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CERVICAL SPINE ANOMALIES WITHIN THE 22Q11.2 DELETION SYNDROME: RISK AND SCREENING

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Introduction: The 22q11.2 deletion syndrome (22q11.2DS), previously known as the DiGeorge syndrome or velocardiofacial syndrome, is the most common microdeletion syndrome occurring in ~ 1:3000–6000 children and ~ 1:1000 pregnancies. This deletion results in a variation of clinical features; including congenital cervical spine anomalies. Based on small case series, the prevalence of cervical spine anomalies is 90.5–100% and radiological screening including flexion extension X rays for all patients with 22q11.2DS is recommended. Yet, the clinical significance of these anomalies and the effect of screenings remains unclear. The objective of this study is to identify the prevalence of cervical spine anomalies in 22q11.2DS in a large cohort including clinical implications.
Methods: All consecutive patients (at least 5.5 years old) with a confirmed 22q11.2 deletion evaluated between January 2014-November 2018 were included. The cervical spine radiograph reports were reviewed for cervical anomalies. Moreover, the need for cervical MRI was determined. Demographics and associated features were analysed (gender, age, congenital heart defect). The means, standard deviation and Odds Ratios (OR) were calculated.
Results: A total of 127 patients with 22q11.2DS were included. The mean age was 10.3 years and 48% were male. Sixty-six percent had at least one cervical spine abnormality. A correlation was found between male patients and congenital cervical spine anomalies (OR: 2.26). Based on the cervical radiographs, four patients (3%) required a cervical MRI; one due to a block-fusion, in order to determine the articulation between C1 and C2 and three because of possible instability. These patients underwent a flexion–extension MRI revealing a stable spine. Nevertheless, one patient that was not thought to have instability developed neurological symptoms without significant trauma, years after initial screening, and required cervical spondylodesis.
Conclusion: In this study we found that the majority (66%) of 127 patients with 22q11.2DS had some cervical anomaly. A higher prevalence was found in male patients. The majority of the anomalies can be regarded as insignificant, since they have no clinical implications. In three patients a flexion–extension MRI was considered necessary based on the radiograph which however indicated a stable spine Unfortunately the radiological screening could not prevent the occurrence of neurological symptoms in one of our patients.
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COMPARISON OF DURAL GRAFTS IN CHIARI MALFORMATION TYPE I DECOMPRESSION SURGERY

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Abstract.
Background: Suboccipital bony decompression with duroplasty, to recreate a proper CSF flow between the cranial vault and the spinal canal, is one of the surgical techniques used for Chari malformation type I treatment. For duroplasty, autologous or non-autologous grafts can be used. The aim of this study was to compare the neurological outcomes and complication rates in surgically treated patients depending upon the type of graft used for duroplasty.
Materials and methods: We present a retrospective analysis of 85 patients (65 female and 20 male; mean age 41.7 years) who were surgically treated for Chiari type I malformation from 2003 to 2018. All patients underwent suboccipital bony decompression with duroplasty. Autologous grafts (fascia or epicranial aponeurosis) were used in 40 cases and non-autologous grafts (Dural-repair®, Duragen® or Duragen Plus®) in 45 cases. The long-term outcomes were evaluated with the use of the Chicago Chiari Outcome Scale (CCOS). Complications taken into consideration were CSF leakage, cerebellar subsidence, hematoma, aseptic meningitis, and purulent cutaneous fistula. The average follow-up period was almost 6 years (range 3 to 187 months).
Results: In the group with autologous grafts (AG), 28 (70.0%) patients had significant improvement and stabilization of symptoms, while 12 (30.0%) others deteriorated in the long term. In comparison with the non-autologus group (NG), the results were 35 (77.8%) and 10 (22.2%), respectively ($p = 0.46$). Mean CCOS for the AG group was 12.27 (functional outcome) and was comparable with the NG group (12.33). Excellent or functional outcome occurred in 27 (67.5%) cases in the AG group and in 33 (73.3%) in the NG group. Impaired or incapacitated outcome occurred in 13 (32.5%) and 12 (26.7%, $p = 0.64$) cases, respectively. Complication rates in both groups were similar: 7.5% in the AG group and 6.7% in the NG group ($p = 1$). Six patients had complications, 4 of them (66.7%) required reoperation, 2 in each group (5.0% in the AG group vs 4.4% in the NG group, $p = 1$). CSF-related complications (pseudomeningocele) occurred in 3 patients, including 1 (2.0%) in the NG group and 2

(5.0%, p = 0.60) in the AG group together with cerebellar subsidence. In the remaining 3 patients, hematoma (2.2%) and purulent cutaneous fistula (2.2%) in the NA group and aseptic meningitis (2.5%) in the AG group were treated.
Conclusions: There are no significant differences in clinical outcomes and complication rates depending on the type of graft used for duroplasty in patients with Chiari type I malformation, and both autologous and non-autologous grafts can be safely used.
Disclosures: author 1: none; author 2: none; author 3: none; author 4: none.

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PLASTICITY OF THE BRAIN AND PROGNOSTIC PREDICTION IN EVALUATING SPONTANEOUS BRAIN ACTIVITY FOR CERVICAL MYELOPATHY: A RESTING-STATE FMRI STUDY

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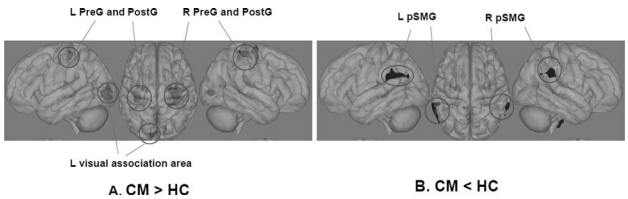
Introduction: Our previous results indicated functional connectivities using resting-state functional MRI (rs-fMRI) between the visual association area and the right superior frontal gyrus as potential biomarkers for postoperative gain in the 10-second test in patients with cervical myelopathy (CM). In the present study, we aimed to investigate the plasticity in the brain and the capability of prognostic predication by calculating the amplitude of low-frequency fluctuation (ALFF) using rs-fMRI to measure the spontaneous brain activity.
Methods: Twenty-eight patients (14 men and 14 women; mean age of 66.5 years) with CM and 28 age- and sex-matched healthy controls (HCs) underwent rs-fMRI (twice for CM patients, before and six months after cervical decompression surgery). The following three statistical analyses were conducted: (i) ALFF comparisons between preoperative CM and HC; (ii) postoperative ALFF changes in CM; and (iii) correlation analysis between preoperative ALFF and clinical scores. Clinical outcomes in the CM group was assessed using the 10-second test, the Japanese Orthopaedic Association extremity motor (JOA-UEM) score, and Japanese Orthopaedic Association Cervical Myelopathy Evaluation Questionnaire upper-extremity function (JOACMEQ-UEF) score before and 6 months after surgery.
Results: Neurological examination 6 months after surgery revealed a significant improvement in the 10 s test, the JOA-UEM, and the JOACMEQ-UEF ($p < 0.001$). The CM group had a significantly higher ALFF in the bilateral primary sensorimotor cortices (the precentral gyrus and postcentral gyrus) and left visual association area compared with the HC group. In contrast, the CM group had a significantly lower ALFF in the bilateral posterior supramarginal gyrus (Figure). After masking based on the difference in preoperative ALFF (CM > HC), the decrease of ALFF was observed in the bilateral primary sensorimotor cortices and left visual association area postoperatively. In correlations between preoperative ALFF and clinical score changes in the CM group, the bilateral frontal pole and the left inferior frontal gyrus region (pars opercularis) showed significantly positive correlations with the JOACMEQ-UEF.
Conclusion: Preoperative higher ALFF and postoperative decrease of ALFF in the primary sensorimotor cortices may explain plasticity of the brain for CM patients. Moreover, similar changes in the visual association area may demonstrate plasticity in the preoperative decreased functional connectivities between the visual association area and the right superior frontal gyrus which was observed in our previous study. Our analyses indicated that the bilateral frontal pole and the left inferior frontal gyrus showing significantly positive correlation with JOACMEQ-UEF may be potential biomarkers to predict postoperative recovery.
<Figure Legends>.

R, right; L, left; PreG, precentral gyrus; PostG, postcentral gyrus; pSMG, supramarginal gyrus (posterior division).



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A CLINICAL PREDICTION MODEL FOR THE RECOVERY OF WHIPLASH-ASSOCIATED DISORDERS

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Background: Whiplash-associated disorders (WAD) is the most common traffic injury. However, predicting the prognosis of WAD is challenging for health care providers, insurers and policy makers. Our inability to predict who will recover from WAD limits our ability to identify patients who are at risk of developing persistent pain and disability. Clinical prediction models are tools developed to assist clinicians with the prediction of clinical outcomes. However, few clinically relevant validated models are available to assist clinicians predict the recovery of patients with acute WAD.
Objective: We aimed to develop an evidence-based clinical prediction model to predict self-reported recovery and insurance claim closure from WAD.
Study design and setting: Our study included two cohorts of patients with acute WAD (21 days). The development cohort included 4923 participants from Saskatchewan and the validation cohort included 340 participants from Ontario. The outcomes were self-reported recovery and time to claim closure within the first year after the injury. The candidate predictors was selected from a systematic review of the literature. We used Cox regression to build models in a cohort of Saskatchewan adults. The models were internally validated using bootstrapping and externally validated in Ontario cohort (n = 340). We used C-statistics (95% CI) to describe predictive ability.
Results: Participants from both cohorts were similar at baseline. Two-thirds of participants were female, half were married, most were employed (84.1%) and most presented shortly post-collision (9 days in Saskatchewan [range 0–21]; 6 days in Ontario [range 0–25]). Participants had a mean age of 38.3 (s.d. 15.1) years in Saskatchewan and 40.5 (s.d. 13.2) years in Ontario. The mean baseline neck pain was 6.5/10 (s.d. 2.1) in Saskatchewan and 5.7/10 (s.d. 13.2) in Ontario

and the 12-month follow-up rate was 84.4%in Saskatchewan and 78.8% in Ontario. Finally, median time to self-reported recovery was similar (95 days in Saskatchewan and 98 days in Ontario). Our prediction model for self-reported recovery included prior traffic-related neck injury claim, expectation of recovery, age, percentage of body in pain, disability, neck pain intensity and headache intensity (C = 0.64; 95% CI 0.63–0.65). The prediction model for claim closure included prior traffic-related neck injury claim, expectation of recovery, age, percentage of body in pain, disability, neck pain intensity, headache intensity and depressive symptoms (C = 0.64; 95% CI 0.63–0.65).
Conclusion: Our prediction models are useful to health care practitioners and insurers because they can predict time to recovery and time-to-claim closure. Although their predictive ability is could be improved, their performance is better than chance. Considering that the predictive ability of clinical judgment alone is unknown, using our predictive model could improve clinical care.
Disclosures: author 1: grants/research support; Ontario Ministry of Finance and the Financial Services Commission of Ontario, other financial report; Canadian Institutes of Health Research-Canada Research Chair Program; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none.

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RESULTS OF THE SURGICAL TREATMENT OF ATLANTOAXIAL METASTATIC TUMOURS; A SINGLE CENTRE CASE SERIES OF 35 CONSECUTIVE PATIENTS

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Introduction: Tumours of the cervical spine are rare in comparison to the thoracic and lumbar regions. tumours at the atlantoaxial region are difficult to be surgically accessed because of their location and complex anatomic relations.
Materials and methods: A retrospective review of the surgical records in a single spine surgery centre between 1994 and 2016 was performed. A series of 35 consecutive patients who were surgically treated for metastatic atlantoaxial tumours was identified. The imaging studies and medical records were evaluated. The location and extent of the tumour were defined., and the surgical management was analysed.
Results: There were 23 males, and 12 females, the mean age at surgery was 50.7 ± 12.5 years. C2 affection was in 20 cases, C1 in 8 cases, while in 7 cases both C1 and C2 were affected. In 6 patients a preoperative incomplete neurological deficit was recorded (ASIA (C) in 4 patients and cervical myelopathy in 2 patients), while in 29 patients the indication of surgery was cervical pain and instability with pathological fractures. Preoperative mean VAS was 7.6 ± 2.1 and NDI was 18.4 ± 4.3. The surgical approach was combined anterior trans-oral tumour resection with decompression of the spinal cord and posterior cranio-cervical fixation in 21 cases, and in 14 cases posterior tumour resection and fixation was performed. The mean operative time was 247 ± 60.6 min and the mean blood loss was 700 ± 435 ml. There were no intraoperative complications, The primary tumour was bronchial carcinoma in 10, breast cancer in 6, renal cell carcinoma in 4, plasmacytoma in 4, tongue angioleomyoma in 3, Prostate Cancer in 3, colon carcinoma in 3 patients, and in 2 patients the primary tumour was not identified. the mean follow-up was 18 ± 12 months. 8 patients (22.8%) died due to advanced malignancy within the first 6 months after surgery, they had other metastatic lesions on presentation. 2 weeks postoperatively the VAS was significantly improved to 3.7 ± 2.8 and NDI to 10.8 ± 4.3 (p = 0.03 and 0.05 respectively). Neurological improvement was observed in 3 of the 6 patients. Reoperation was necessary in 4 patients, three of them underwent a second anterior transoral resection after primary posterior only approach, and in one patient posterior revision was performed due to wound dehiscence. The mean documented survival rate was 18 ± 12 months, that could be significantly more because many patients did not attend the recommended follow up visits.
Conclusions: Surgical treatment of the atlantoaxial metastasis is safe and significantly improves the quality of life of the affected patients. Transoral approach provides excellent access and visualisation of the anterior elements of the atlas and axis vertebrae which are most commonly affected regions in metastatic cranio-cervical disease. Life expectancy of the patients are not negatively affected through the surgical intervention in case of cranio-cervical metastasis.
Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: royalties; Company = Medicon eG, Tuttlingen, Germany.

MINIMAL INVASIVE SPINE SURGERY (MISS), NEW TECHNIQUES

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DOES PERCUTANEOUS LUMBOSACRAL PEDICLE SCREW INSTRUMENTATION PREVENT LONG TERM ADJACENT SEGMENT DISEASE?

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Introduction: Percutaneous pedicle screw augmentation of lumbar interbody fusion procedures is an increasingly popular minimally-invasive technique that avoids disruption of the posterior soft tissue stabilizers. Adjacent segment disease (ASD) is a well-known complication of spinal fusion. The rate of ASD requiring revision surgery may be lower than those of traditional lumbar fusions with open pedicle screw procedures due to preservation of lumbar stabilizers. There is a paucity of addressing this hypothesis of great importance in the management of common spinal pathology. Additionally, abnormal sagittal plane configuration of the spine following lumbar fusion has been hypothesized to increase the rate of ASD as well.
Purpose: To evaluate patients who underwent lumbar fusion with minimally-invasive percutaneous lumbosacral pedicle screw instrumentation and specifically asses: (1) proportion revised secondary to ASD and, (2) risk factors for revision secondary to ASD including a) demographics and, b) pelvic incidence (PI) and lumbar lordosis (LL) mismatch.
Methods: A retrospective review from 2004 to 2014 was performed to identify patients who underwent anterior, lateral, or minimally-invasive transforaminal lumbar interbody fusion with percutaneous pedicle screw placement with a minimum follow-up of 5 years. Patients were divided into two cohorts: those who underwent revision surgery secondary to ASD and those who did not require further surgery. Demographics, ASA grading, number of levels fused and number of revisions secondary to ASD were recorded. Pelvic measurements were performed using postoperative sagittal radiographs and patients with PI-LL mismatch > 10 degrees were noted. Standard binomial and categorical comparative analyses were performed between cohorts.
Results: 419 consecutive patients were included with a mean follow-up of 6.5 years (range 5–12). Overall revision proportion for any

reason was 7.4% (n = 31). Of these patients, 20 were revised secondary to ASD, a proportion of 4.77%. Patients revised secondary to ASD had a mean time to revision surgery of 2.5 years. The revision rate secondary to ASD was found to be 0.73% per year. Patients who developed ASD were younger (50.5 ± 12.5 years) than those who didn't (56.9 ± 11.5 years) (p = 0.015). There was no difference in number of spinal levels fused between patients with ASD (1.6 ± 1.5) and the remaining cohort (1.4 ± 0.7). There was a higher percentage of patients with PI-LL mismatch in the ASD cohort (22.2% v 18.8%) however, this was not statistically significant (p = 0.758).
Conclusion: Adjacent segment degeneration in this population appears to be lower than previously published rates of adjacent segment disease. This may be related to the greater preservation of the posterior stabilizing elements of the lumbar spine during percutaneous pedicle screw placement, although further investigation is warranted.
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PERCUTANEOUS CORRECTION USING LATERAL INTERBODY FUSION AND COMPLETELY PERCUTANEOUS PEDICLE SCREW FIXATION FOR ADULT SPINAL DEFORMITY WITH DUAL ROD ROTATION TECHNIQUE AND REVERSE CANTILEVER TECHNIQUE. TECHNICAL NOTES

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Introduction: Conventional open corrective surgery for adult spinal deformity (ASD) generally produces substantial clinical results. There is, however, concern about the development of high surgical complication rates. In recent years, minimally invasive surgery (MIS) has been applied to ASD in an effort to reduce the high complication rates associated with open correction. The aim in this study was to describe a new percutaneous correction which consisted of lateral interbody fusion (LIF) and completely percutaneous pedicle screw (PPS) fixation for ASD using both dual rod rotation technique and reverse cantilever technique, and to evaluate the clinical results of this MIS method.
Methods: This method was applied to thirty-nine consecutive patients with ASD. The patients with a multilevel bony fusion or a severe malunion were excluded from this group. The mean age was 71 years old (range, 42–83 years). The mean of 7.9 intersegmental levels were fused. Operative time, surgical blood loss, pre- and postoperative global radiographic parameters were investigated. In addition to these data, complications were also evaluated.
Surgical methods: First, LIF in lumbar spine was performed in lateral decubitus position. After that, L5/S1 TLIF should be done. All pedicle screws were inserted percutaneously, and iliac screws were inserted too. The rods, bended in ideal alignment, were threaded from the caudal to the cranial. After inserting the rod within the all extender sleeve, the end caps were inserted into all sleeves leaving a little space. By rotating and pushing the caudal end of the rod, the lower thoracic spine was levered up, gaining ideal lumbar lordosis along the alignment of the rod (dual rod rotation technique and reverse cantilever technique).
Results: The average operative time was 398 min (range, 265–658 min) and the average surgical blood loss was 497 g (range, 100–1795 g). Pre- and postoperative coronal Cobb angle were 45 degrees and 11 degrees and LL were corrected from 8 to 50 degrees. PI-LL mismatch decreased from 43 degrees to 1 degree, SVA decreased from 144 mm to 10 mm, and PT was corrected from 33 degrees to 18 degrees. There were no intraoperative complications identified during the surgical procedures. Thigh numbness and weakness were observed postoperatively in seven patients, but these symptoms resolved in all cases within six months. Four patients were revealed rod fractures, and three patients were made reoperation.
Discussions: The severe spinal deformity could be corrected percutaneously. The reasons are an indirect posterior facet release by LIF procedure and an original corrective procedure with rod rotation technique and reverse cantilever technique.
Conclusions: The novel MIS method for ASD was reported. This method is original and less invasive surgery to obtain a balanced spine.
Disclosures: author 1: consultant; ZIMMER BIOMET, KYOCERA.

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VERTEBRAL AXIAL ROTATION IN PATIENTS WITH LUMBAR DEGENERATIVE SCOLIOSIS: SURGICAL IMPLICATIONS FOR OBLIQUE LUMBAR INTERBODY FUSION

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Objective: Patients with lumbar degenerative scoliosis (LDS) are major subjects who will benefit from oblique lumbar interbody fusion (OLIF). Vertebral axial rotation coupled with LDS might change the distance of oblique corridor and induce improper cage position or increase the risk of contralateral root injury during orthogonal maneuver. This study aimed to investigate changes of oblique corridor in patients with LDS and determine proper working angle with respect to the direction of vertebral axial rotation during OLIF procedure.
Methods: To minimize confounding effects of age, body weight, height, and body mass index, propensity score-matched control groups were enrolled. Distance of oblique corridor and rotational angle of the left or right apex group were measured on axial T2 MR images and then compared with those of propensity score-matched control group.
Results: Fifty-five patients of the left apex group and 57 patients of the right apex group were compared with equal number (55 or 57) of patients of the propensity score-matched control group. The distance of oblique corridor in the left apex group was shorter than that in the control group at levels of L1-2 and L2-3 (16.72 ± 6.02 vs. 18.94 ± 5.73, p = 0.050 and 17.07 ± 6.58 vs. 20.52 ± 6.33, p = 0.006, respectively). In contrast, the distance of oblique corridor in the right apex group was longer than that of the control group at level of L2-3 (24.58 ± 8.53 vs. 21.49 ± 5.96, p = 0.027). For the rotatory angle of vertebral body, patients of the left apex group showed vertebral body rotating to the left side from L1-2 to L5-S1 (p = 0.000, 0.000, 0.000, 0.011 and 0.025, respectively). In contrast, in the right apex group, the vertebral body rotated to the right side at level of L1-2, L2-3, and L3-4 (all p = 0.000).
Conclusions: In the left apex group, the oblique corridor was decreased from psoas overlap and coupled axial rotation to the left side might increase the risk of contralateral nerve root injury during orthogonally working. Thus, surgeons should pay attention to the state of coupled vertebral axial rotation of LDS for OLIF procedure.

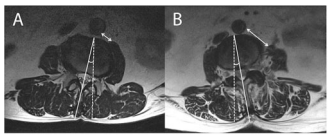

Figure 1. (A; left rotation of vertebra) and the right apex group (B; right rotation of vertebra). On both images, the oblique corridor was defined as the distance between the lateral border of aorta or the nearest iliac vessel and the anteromedial aspect of the psoas muscle (line with an arrow on both ends). Please note the different width of the oblique corridor between the left and right apex group. The rotational angle of vertebral body was referred to the angle formed by two lines: the vertical reference line (dotted line) and the line that passed through the center of the disc and the base of the spinous process. The value of rotational angle was regarded negative when the angle was created on the left side of the reference line (A) while it was considered positive when it was formed on the right side of reference line (B).

Disclosures: author 1: none; author 2: none.

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CEMENT DISCOPLASTY FOR THE MANAGEMENT OF LUMBAR SPINE PSEUDO-ARTHROSIS IN ELDERLY PATIENTS; A LESS INVASIVE ALTERNATIVE APPROACH

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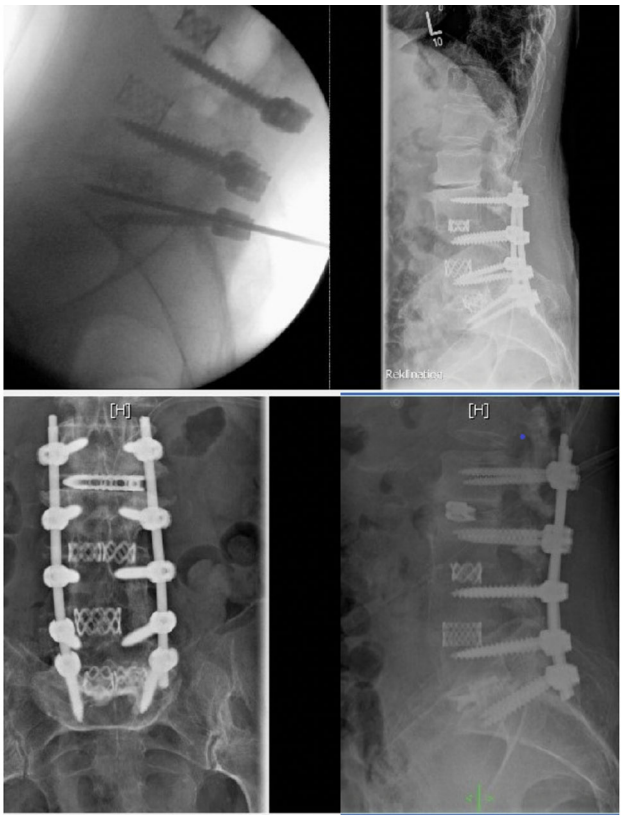
Introduction: Symptomatic pseudo-arthrosis after lumbar spine fusion in elderly patients is associated with pain and reduction of the quality of life. Surgical revision through antero-posterior or posterior approach is associated with complications especially in those multi-morbid patients. Recently, there are reports about percutaneous cement injection (discoplasty) in case of symptomatic degenerative spondylosis in elderly patients aiming to avoid fusion surgeries.

The aim of this work: Was to evaluate the results of cement discoplasty in lumbar and thoraco-lumbar symptomatic pseudo-arthrosis after posterior lumbar inter-somatic fusion (PLIF) in patients above 65 years.

Materials and methods: From january 2011 to December 2017, 45 above 65 years patients with symptomatic pseudo-arthrosis after lumbar spine fusion were treated in our department through percutaneous cement injection in the affected disc space. Indications of the procedure were; persistent lumbar pain despite 6 months of conservative therapy, failure of radiological fusion in x-ray and CT scan up to 12 months postoperatively, presence of gas in the disc space in CT (vacuum phenomena), and absence of neurological deficits. The operation was done using 2 perpendicular X-ray devices using a transpedicular approach. A high viscosity bone cement is used in all patients. Assessment of the results included clinical evaluation (VAS and NDI) and radiological assessment using x-rays and CT scan.

Results: There were 30 females and 15 males. The mean age was 74 ± 4.5 years. The most common affected level was L5/S1 in 20 cases followed with L4/5 in 10 cases. Discoplasty was performed after a mean of 14 ± 6.3 months. The mean preoperative VAS was 7.5 ± 4.2 and ODI was 26 ± 8. Additional cement augmentation of the adjacent vertebrae was performed in 17 patients. Cement injection was done in one level in most of the cases, in 7 cases 2 levels injection was done, and in 3 cases 3 levels. Asymptomatic paravertebral cement leakage occurred in 7 cases (15.5%). In 14 (31%) cases additional extension of the instrumentation was necessary. The mean postoperative follow up was 32 ± 18 months. At the end of follow up VAS improved significantly to 3.5 ± 2.3 ($p = 0.02$) and ODI improved to 16.3 ± 4.8 ($p = 0.001$). Reoperation was indicated in 2 patients after a mean of 6 months due to persistence of the symptoms and loosening of the screws, and they were surgically managed with anterior fusion and posterior revision and extension of the fixation to lower lumbar levels.

Conclusions: Cement discoplasty offers a less invasive surgical solution in elderly patients with symptomatic lumbar pseudo arthrosis. Discoplasty significantly reduces the symptoms, reduces the rate of anterior revision, and improves the quality of life of the affected patients.



Disclosures: author 1: none; author 2: none; author 3: royalties; Company = Medicon eG, Tuttlingen, Germany.

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THORACOSCOPIC VERTEBRAL BODY TETHERING FOR ADOLESCENT IDIOPATHIC SCOLIOSIS: MINIMUM 2 YEARS RESULTS OF PATIENTS REACHING SKELETAL MATURITY

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Background: Growth modulation with VBT has been reported to be safe and effective. This is the first report with ≥ 2 years' f-up, in which all patients reached skeletal maturity.

Purpose: The aim of the study was to show VBT is a safe and effective growth modulation technique.

Material-methods: Data were collected preoperatively, before discharge, and at each follow-up. Demographic, perioperative, clinical, radiographic data and complications were recorded. Respiratory function tests were done at preop and 1 year postop. Surgical and total f-up correction percentages were calculated. Descriptive statistics are given.
Results: 14 Lenke 1 patients (14F, 12.3 ± 0.9 years) with a mean f-up of 28.9 (24–54) months were included. Preoperatively, all but 2 pts were premenarchal (median Sanders: 3 (2–5), median Risser: 0 (0–3)). The mean preop main thoracic (MT) curve was 45.4° (36–59°). Mean preop upper thoracic (UT) and lumbar (L) curves were 27.5°(14–44°) and 32.3° (22–42°), respectively. A mean of 7.3 (7–9) levels were tethered (UIV: T5/T6, LIV: T11/T12/L1). Mean surgical time was 233 ± 71 min. Mean EBL was 55 ± 41 ml. Mean initial correction rates were 34%, 54% and 49% for UT, MT and L curves, respectively. Following initial gain in height, patients grew 6.4 (2–16) cm on average, where 7 (− 5 to 15) mm was between UIV-LIV. This growth was reflected into spontaneous f-up correction. Last f-up correction rates were 44%, 78% and 83% for UT, MT and L curves, respectively. Preop mean hump of 12° was reduced to 5.4° at final f-up. No significant changes were noted in kyphosis and lordosis measurements. Mean forced vital capacity increased from 2350 to 2858 ml at 1 year (range of change, 20–1220 ml). All patients reached skeletal maturity (Sanders 7). Pulmonary complications (14%) were 1 atelectasis that resolved with physical therapy, and 1 pulmonary effusion that required readmission (7%). Mechanical complications were 2 overcorrection (14%) one of which was accompanied by LIV screw loosening. No tether breakages were observed.
Conclusions: VBT enabled spontaneous correction while allowing growth. Spontaneous corrections in the non-operated upper thoracic and lumbar levels were also noted. All overcorrections were observed in Sanders 2 patients. Sanders 3–5 patients possess a lesser risk of mechanical complications. VBT resulted in improved pulmonary functions. Overall pulmonary and mechanical complications rates were 14% each.
Disclosures: author 1: grants/research support; DEPUY, consultant; Globus; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: none; author 9: none; author 10: none.

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SURGICAL COMPLICATIONS OF ANTERIOR VERTEBRAL BODY GROWTH MODULATION FOR SKELETALLY IMMATURE PATIENTS WITH IDIOPATHIC SCOLIOSIS

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Introduction: Anterior vertebral body Growth Modulation (AVBGM) has been shown the potential to correct scoliosis while maintaining spine flexibility.
Purpose of the study: Our hypothesis was AVBGM is an effective procedure with little perioperative and early postoperative risk. The objective of this study was to report a minimum 2-year outcomes and surgical complications of AVBGM in skeletally immature patients.
Methods: Fifty-three patients (50 female, 3 males) who underwent surgical treatment between Dec 2013-Jan 2017 were included; all enrolled in a prospective database of idiopathic scoliosis treated with AVBGM. Inclusion criteria were: idiopathic scoliosis, Lenke type 1A, 1B, 1C, 2A and 2B. Patients with Lenke 3A or syndromic scoliosis were excluded. Patient demographics, perioperative data, radiographic outcomes and post-op complications are reported.
Results: Mean follow-up was 33.4 ± 7.9 months. Preoperatively, 42 patients were Risser stage 0, five stage 1, two stage 2 and four stage 3. Mean age at surgery was 12 ± 1.3 years with an average of 7.2 ± 0.8 vertebrae tethered per patient. Average Cobb angle was 49.4 ± 11 pre-op, 25.4 ± 11 at 2 months, 17 ± 12.4 at 16 months and 16 ± 12.6 at last FU. Revision surgery was performed in 6 patients: 1 tether removal due to overcorrection, 1 lumbar tether added due to distal curve progression, 1 tether replaced due to breakage, 1 patient for screw repositioning and 2 revised to a posterior spinal fusion due to progression. 16 (30%) of the patients had a suspected broken tether. Two patients had overcorrection that didn't require revision. Two patients had pneumothorax, which developed after drain removal and resolved spontaneously. Two patients had a blood patch for small dural tear recognized post-op.
Conclusion: This prospective study found a re-operation rate of 11% with otherwise good clinical and radiological outcomes. Understanding the surgical indications of AVBGM for progressive idiopathic scoliosis is critical to have higher success rate of non-fusion treatment in the future. Although not necessarily requiring surgery, 16 patients were suspected to have a broken cable. AVBGM is an effective procedure with only 11% risk of revision at two years follow up for young growing patients with idiopathic scoliosis.
Disclosures: author 1: grants/research support; DePuy Synthes Spine, Medtronic, EOS-Imaging, Spinologics, K2M, consultant; DePuy Synthes Spine, EOS-Imaging, stock/shareholder; Company = Spinologics, royalties; Company = EOS-Imaging; author 2: none; author 3: none; author 4: none; author 5: grants/research support; Optina Diagnostic (MITACS Acceleration Grant); author 6: none.

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PROSPECTIVE MULTICENTER STUDY OF A MULTISTEP SCREW INSERTION TECHNIQUE USING PATIENT-SPECIFIC SCREW GUIDE TEMPLATES FOR THE CERVICAL AND THORACIC SPINE

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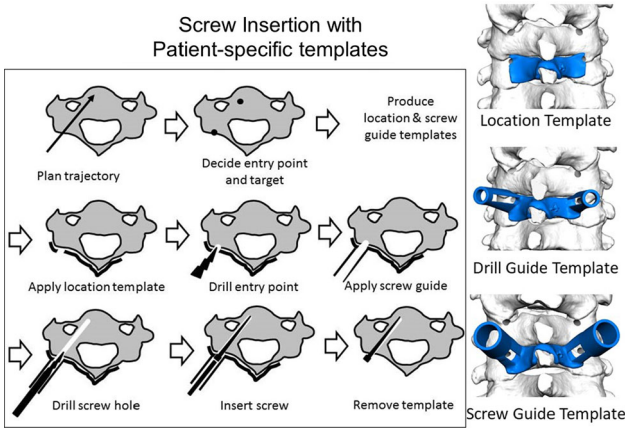
Background: Pedicle screw fixation is a standard procedure for spinal instrumentation, however, screw insertion carries the risk of injury to neuronal and vascular structures. To evaluate the efficacy of a patient-specific screw guide template system (SGTS) for inserting screws, the authors conducted a prospective clinical study of a multistep screw insertion method using SGTS for the cervical and thoracic spine.
Methods: Preoperative bone images of the computed tomography (CT) scans were analyzed using 3D/multiplanar imaging software, and the screw trajectories were planned. Plastic templates with screw-guiding structures were created for each lamina using 3D design and printing technology. Three types of templates were made for precise multistep guidance, and all the templates were specially designed to fit and lock onto the lamina during the procedure. In addition, plastic vertebra models were generated and preoperative screw insertion simulation was performed. This patient-specific SGTS was used to perform the surgery and CT scanning was used to postoperatively evaluate screw placement.
Results: Enrolled to verify this procedure were 103 patients with cervical, thoracic or cervicothoracic pathologies. The SGTS were used to place 813 screws. Preoperatively, each template was found to

fit exactly and to lock onto the lamina of the vertebra models. In addition, intraoperatively, the templates fit and locked onto the patient lamina, and the screws were inserted successfully. Postoperative CT scans confirmed that 801 screws (98.5%) were accurately placed without cortical violation. There were no injuries to the vessels or nerves.
Conclusions: The multistep, patient-specific SGTS is useful for intraoperative pedicle screw navigation in the cervical and thoracic spine. This method improves the accuracy of pedicle screw insertion and reduces the operating time and radiation exposure during spinal fixation surgery.



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THE ULTRASONIC BONE SCALPEL (UBS): HOW SAFE IS IT IN SPINAL SURGERY?

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Introduction: The UBS is gaining popularity for applications in spinal surgery. There may be reservations about its safety. We report our experience of using UBS in spinal surgery.
Material and method: From 2016 to 2018, UBS (Misonix) was used by the senior author in a variety of spinal operations. Complications were prospectively collected.
Results: UBS was used in 146 patients (47 M, 99F) with age range 8–86 (average 32.6 years). UBS was used in 49 patients for degenerative conditions of which there was 7 anterior cervical discectomy (12 levels), 12 posterior decompressions (21 levels), 30 posterior decompression and instrumented fusion (66 levels) including 22 Transforaminal interbody fusions (TLIF) (39 levels). UBS was used in 10 adult spinal deformities (ASD) correction including 4 Pedicle subtraction osteotomies (PSO). UBS was used in 87 paediatric deformity surgeries including 69 Adolescent idiopathic scoliosis, 9 Neuromuscular, 2 congenital, 4 revision of EOS and 3 Scheuermann's Kyphosis. In this group UBS was used to perform 884 modified in situ modified chevron osteotomies, 31 rib osteotomies, 3 PSO, 3 hemivertebra excision and division of 2 congenital bars. Overall 4 complications (2.7%) were directly related to the use of UBS. There was 1 Dural tear (0.69%), 1 haemothorax (0.69%) and 2 (1.36%) Loss of MEP monitoring with no neurological sequalae.
Conclusion: Use of UBS in spinal surgery appears to be relatively safe with low level of acceptable complication. However, initial appropriate level of training and supervision is required to keep the complications low.
Disclosures: author 1: none; author 2: not indicated; author 3: none; author 4: none; author 5: none.

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CHARACTERISTIC SIGNS OF CAUDA EQUINA IN THE PATIENTS WITH SPINAL ARTERIOVENOUS FISTULA: CAUDA EQUINA OCCUPATION RATIO AS A NEW MARKER FOR THE CLINICAL EVALUATION

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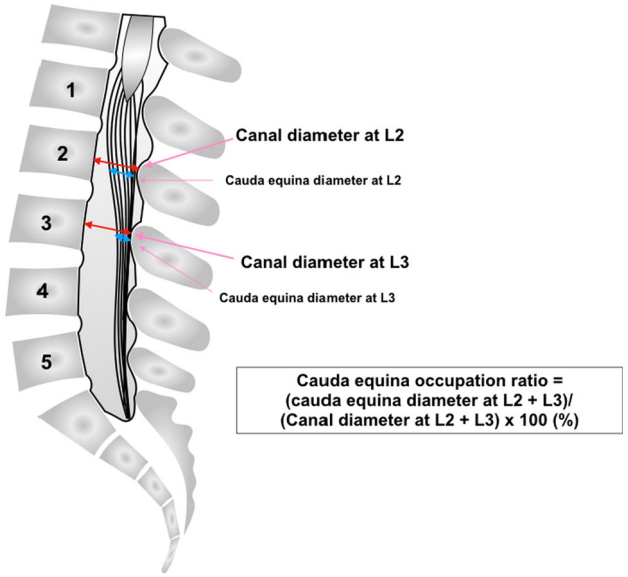
Background: Spinal dural arteriovenous fistula (SDAVF) is often overlooked during its diagnosing process due to its rarity and non-specific characters. Initial MRI screening is important for ruling out the other diseases as well as adequate treatment. Intramedullary T2-weigted signal hyperintensity and perimedullary flow voids has been considered as typical MRI findings for SDAVF, however, their characteristics signs of cauda equina has rarely discussed in the literatures. The objective of this study is to access the MRI findings of the patients with SDAVF and evaluate the efficacy of morphological change of cauda equina for the diagnosis of SDAVF.
Materials and methods: We retrospectively analyzed clinical charts and radiological findings from 20 patients with SDAVF treated at our institutions. We set the occupation ratio of the cauda equina compared to the sagittal canal diameter of the lumbar spine as cauda equina occupation ratio (CEOR) in this study. The CEOR were measured from the patients with SDAVF and compared with 21 age- and sex-matched asymptomatic individuals.
Results: There were 18 male- and 2 female patients with their age between 48 and 86 years old (average 65 years). Location of the fistula was 10 in thoracic, and 10 in lumbar spine. The mean CEOR was 56.0 $\pm$ 7.8% in the preoperative MRI study. There was no significant difference between the preoperative CEOR and the level of fistulas or preoperative neurological signs. The mean postoperative CEOR was 37.1 $\pm$ 7.4% and was significantly smaller than preoperative data ($p = 0.000$). Comparing the patients with SDAVF and controls revealed that the CEOR was significantly larger in preoperative SDAVF patients than in the controls ($p = 0.000$). Postoperative CEOR in SDAVF patients was smaller than the controls, however, their difference was not significant ($p = 0.14$).
Conclusions: The CEOR in the patients with SDAVF was larger preoperatively than control and normalized after successful occlusion of the fistula. These results indicate that the CEOR is useful parameter for the preoperative examination and the postoperative evaluation for the patients with SDAVF.



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ADULT DEFORMITY, GROWING SPINE

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HOW TO PREDICT RADIOGRAPHIC COBB ANGLE FROM CLINICAL MEASURES IN IDIOPATHIC SCOLIOSIS: RESULTS FROM A GEOMETRICAL STUDY

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Background/introduction: When assessing a patient affected by Idiopathic scoliosis, the clinical measures are helpful to define the need for radiography and a consequent treatment. Nevertheless, a precise correlation between clinical and radiological parameters has not been set. The usual 7° Angle of trunk rotation (ATR) threshold for screening could lead to underdiagnose in a specialized conservative setting. The ATR and the hump height (HH) are complementary measures of the same Idiopathic Scoliosis (IS) prominence.

Purpose of the study: The aim of the study was to combine the complementary measures of the prominence given by the ATR (degrees) and the hump height (mm) in order to predict the Cobb degrees and consequently guide the radiographic prescription.

Materials and methods: Cross-sectional evaluation of 7591 consecutive first consultations patients of a tertiary level clinic specialized on spinal deformities.

Inclusion criteria: age 4–18, IS, first consultation, x-rays within 3 months, no previous bracing. Study Group: 5550 consecutive patients with prescribed x-ray for ATR $\geq$ 5° (22.8% males; age 12.7 $\pm$ 2.5; 23.9 $\pm$ 13.2°). Uncontrolled Group: 2041 pupils with ATR $<$ 5° who already had a radiograph. Subgroups: sex, curve location and age. We checked correlation between °Cobb and ATR, HH, their sum and the geometrical measures of the triangle identified by HH and ATR (hypotenuse inclination). We ran forward/backward stepwise regressions, and adjusted for the covariates age, familiarity, BMI, sex, menarche, aesthetics. A histogram, quantile plot and Akaike Index Criterion (AIC) were used to verify the models. The ROC curve was used for the best cut off to predict °Cobb.

Results: Curves below 10°–20° were 10–44% for 5° ATR, and 5–31% for 7° ATR, respectively. Using 7° instead of 5° would lead to miss 574 patients $>$ 20° and 135 $>$ 30°. In the $<$ 5° group we found 20% $>$ 20° and 4% $>$ 30°. We developed models for ATR, HH, SUM, and area since they correlated with ° Cobb (0.61–0.67; r2 0.38–0.45). They all performed well, with HH the best. The covariates didn't change the crude coefficient (Table). When HH is above 10, it is 0.17 more likely to find a curve exceeding 20 Cobb degrees (CI95% OR 0.17–0.18). The area under the ROC curve was 0.70, with 75% sensitivity, 65% specificity, 61% positive and 78% negative predictive values.

Conclusion: In a tertiary level institute, a 5° ATR threshold is better than 7° to identify conservative patients. In a specialized setting using 7° instead of 5° ATR for radiograph prescriptions lead to miss 10% patients $>$ 20° and 2.5% $>$ 30°. Hump Height allows better prediction (cut-off 10 mm). ATR, HH and Sum are good predictors of the expected Cobb angle at X-rays.

Cobb prediction		Crude coef. (95% CI)	p value
ATR		0.17(0.17-0.18)	<0.001
Adjusted		0.17(0.17-0.18)	<0.001
	Age (years)	0.07(0.04-0.11)	<0.001
	BMI	-0.11(-0.14—0.09)	<0.001
	Asimmetry	0.36(0.16-0.56)	<0.001
HH in mm		0.33 (0.32-0.34)	<0.001
Adjusted		0.33 (0.32-0.34)	<0.001
	Age(years)	0.22(0.16-0.28)	<0.001
	BMI	-0.16(-0.20—0.11)	<0.001
	Sex	-0.45(-0.78—0.13)	0.007*
SUM		0.50(0.48-0.51)	<0.001
Adjusted		0.51(0.49-0.52)	<0.001
	Age(years)	0.30(0.21-0.38)	<0.001
	BMI	-0.28(-0.35—0.21)	<0.001
	Sex	-0.51(-1.00—0.03)	0.039
Area		17.36(16.77-17.95)	<0.001
Adjusted		17.60(16.92-18.29)	<0.001
	Age(years)	14,53(16.93-18.08)	<0.001
	BMI	-6.60(-9.47—3.73)	<0.001
	Sex	-38.65(-58.75—18.55)	<0.001
	Asimmetry	-21.57(-43.11—0.03)	0.05

Disclosures: author 1: none; author 2: not indicated; author 3: none; author 4: none; author 5: none; author 6: stock/shareholder; Company = ISICO.

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CONCOMITANT LOW-GRADE ISTHMIC SPONDYLOLISTHESIS DOES NOT AFFECT THE COURSE OF AIS

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According to the literature, scoliosis with spondylolisthesis in the same patient occurs in 6.2–43% of cases. The data, however, is scars and inconclusive. No information on clinical impact or outcome is available. Purpose of the study was to determine the prevalence of this pathology and to investigate if the presence of isthmic spondylolisthesis affects the course and/or the outcome of adolescent idiopathic scoliosis (AIS).

This is a single institution's retrospective comparative study based on radiographs, patient records, the National Inpatient Registry (NIR), and PROMs (ODI, modif. SRS-24, WHOQoL, NRS for pain). Mean primary clinical follow-up time was 4.4(4.3)y, clinical follow-up rate 95%. Surgery data from the NIR, follow-up mean 25.4(2.8)y. Radiographic measurements were performed by a single experienced spinal radiologist. Ethical approval was obtained from the authorities.

Overall,1531 consecutive patients with AIS, aged mean 13.9(1.8)y, had whole spine radiographs, primary curve mean 29.2(11.5)°. Of them,120(7.8%) had a low-grade isthmic L5-slip of mean 15.0(8.3)% (Study group = S, n = 120). The distribution of the curve types of scoliosis in the Study group was comparable to the curve types in the remaining 1411 patients with AIS only: thoracic 65.0/61.9%, thoraco-lumbar 26.7/24.7%, lumbar 8.3/13.3% (p = 0.292).

A Control group was pair-matched for age, gender, Cobb angle, apex level of the main curve. During the matching process, patients' data like history, symptoms, mode of treatment and outcome were hidden. For two patients, no adequate pair was found (Control group = C, n = 118).

χ statistics and t-tests were applied. Significance threshold was set at $P < 0.05$.

At baseline, the Study group and the Control group were fully comparable. At admission, back pain interfering with ADL had 4.2% of the Study group and 1.7% of the Control group, at clinical follow-up 2.6/4.2% resp.(n.s.).

Between the groups S/C, there was no significant difference concerning scoliosis treatment: observation 38.3/45.8%, bracing in 48.3/46.6%, surgery in 10.8/10.2%.

The results of bracing and of scoliosis surgery were equally satisfactory in both groups. The response rate for PROMs was 54.9/45.1% after mean follow-up of 26.4(2.8)y. Responders and non-responders were comparable at baseline concerning age, gender, Cobb angle, slip%, pain and follow-up time. Outcomes were comparable between the groups: ODI: 5.6/6.2%; modified SRS-24:93.9/91.9; WHOQoL:Physical 81.0/78.5; Psychological 75.2/71.5; Social 76.3/75.0; Environment 81.9/78.7; NRS-back pain 2.6/2.1 leg pain 1.3/1.4.

In the Study group, 12/120(10%) patients had fusion for spondylolisthesis.

In a consecutive series of 1531 teenagers with AIS, the prevalence of low-grade isthmic L5- spondylolisthesis was 7.8% The presence of spondylolisthesis did not influence the curve type of AIS. There was no difference in treatment (bracing/surgery)of the scoliosis. Concomitant spondylolisthesis did not affect the course or long-term outcome of AIS.

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HEALTH-RELATED QUALITY OF LIFE OF IDIOPATHIC SCOLIOSIS; COMPARISON OF UNTREATED PATIENTS, SURGICALLY TREATED PATIENTS AND NORMAL CONTROLS

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Introduction: There is uncertainty about treatment effects of AIS patients' long term quality of life. The aim of this study is to evaluate and compare of health related quality of life (HRQOL) in untreated AIS patients with min 5 years f/up after diagnosis, surgically treated AIS patients with more than 5 years f/up and normal control.

Methods: 209 surgically treated patients (Mean age 25 years and BMI 20.4) (G1 105 patients; Cobb $\geq 50°$, G2 104 patients; Cobb $< 50°$) with posterior surgery and min 5 years f/up, 97 untreated patients (Mean age 27 years and BMI 21.3) (G3; Cobb $\geq 20°$ and had min 5 years f/up after diagnosis), 68 normal controls (G4; mean age 28 years and BMI 22) were included. SRS-22r questionnaire domains (Pain, self-image, function and mental health) were used to measure HRQOL. One-way ANOVA were performed for statistical analysis.

Results: Surgically treated patients (G1 and G2) had significantly higher scores than untreated and normal control (pain; $p < .01$ and self-image; $p < .05$) according to SRS22r pain and self- image domains. Normal controls' scores were much better than untreated patients (pain; $p < .01$ and self-image; $p < .05$). According to function domain; surgically treated patients' (G1 and G2) scores were significantly higher than untreated patients ($p < .001$) but similar with normal controls ($p = 0.414$). For mental health domain; surgically treated patients' (G1 and G2) had higher scores than both untreated patients and normal controls. Whereas untreated patients and normal controls' outcomes were similar ($p = 0.304$). Subgroup analysis of surgically treated patients (Cobb $\geq 50°$ vs Cobb $< 50°$) did not show any difference for all SRS-22r domains ($p > 0.05$) Table 1.

Conclusion: Surgically treated patients showed significantly higher scores on the self-image, function, pain and mental health domains than untreated patients and normal controls. Surgically treated patients have similar functionality with normal controls but better than untreated patients. Comparison of surgically treated patients according to Cobb angle ($\geq 50°$ vs $< 50°$) did not show any differences for all domains.

Table.1		Group	N	Mean	SD
Pain	Surgically treated (≥50°)	G1	105	22.02	2.87
	Surgically treated (<50°)	G2	104	21.93	2.59
	Untreated	G3	97	15.41	2.29
	Normal Controls	G4	68	18.95	5.82
Self-Image	Surgically treated (≥50°)	G1	105	20.42	3.53
	Surgically treated (<50°)	G2	104	20.41	3.38
	Untreated	G3	97	15.12	3.87
	Normal Controls	G4	68	18.58	5.76
Function	Surgically treated (≥50°)	G1	105	22.07	2.98
	Surgically treated (<50°)	G2	104	22.35	2.51
	Untreated	G3	97	18.49	3.97
	Normal Controls	G4	68	21.15	5.89
Mental Health	Surgically treated (≥50°)	G1	105	19.39	2.88
	Surgically treated (<50°)	G2	104	19.42	3.60
	Untreated	G3	97	15.70	2.61
	Normal Controls	G4	68	16.72	5.84

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BACK PAIN AND QUALITY OF LIFE AFTER SURGICAL TREATMENT USING PEDICLE SCREW INSTRUMENTATION FOR ADOLESCENT IDIOPATHIC SCOLIOSIS AT 5-YEAR FOLLOW-UP. COMPARISON WITH HEALTHY CONTROLS AND PATIENTS WITH UNTREATED IDIOPATHIC SCOLIOSIS

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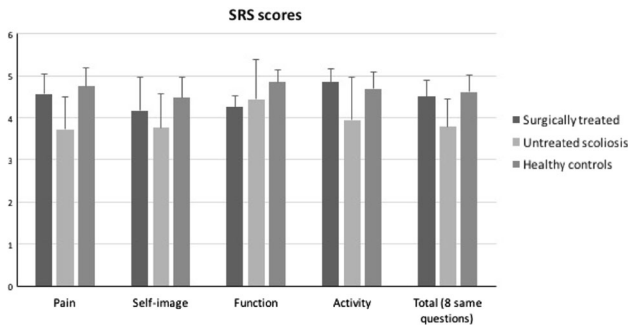
Background: Posterior spinal fusion with pedicle screws represents the golden standard surgical treatment for adolescent idiopathic scoliosis. However, it remains unclear whether this improves back pain and health related quality of life in the long-term as compared with untreated patients.
Purpose: To evaluate back pain and quality of life at minimum five-year follow-up as compared with untreated patients and healthy population.
Methods: Fifty-five consecutive adolescents undergoing posterior pedicle screw instrumentation for adolescent idiopathic scoliosis by a single orthopedic surgeon were prospectively enrolled. At a minimum of 5-year follow-up, 49 patients completed SRS-24 questionnaire and data on reoperation. Pain and quality of life parameters were compared to 49 age and gender matched individuals with untreated adolescent idiopathic scoliosis and 49 healthy controls.
Results: Major curve averaged 53° preoperatively and 12° at 2-year follow-up. One reoperation (pedicle screw removal) was needed due to a new neurological deficit (transient). The untreated individuals with idiopathic scoliosis had a mean (range) major curve of 28° (range, 10°–61°). Eight (16%) of these subjects had a main curve exceeding 40°. The SRS-24 pain, self-image, function, and total scores improved significantly from preoperative to 5-year follow-up ($p \leq 0.016$). The pain score improved from 4.1 to 4.3 at 5-year follow-up ($p = 0.003$). There was no correlation between the pain scores and preoperative major curve, instrumentation below L1 or postoperative rib hump. Surgically treated patients had significantly better scores in the pain, activity, and self-image domains of the SRS-24 questionnaire at 5-year follow-up as compared to untreated patients ($p \leq 0.01$), and their scores of pain, self-image, and activity approximated the scores of healthy controls, except for function score which was significantly lower ($p < 0.001$) (Fig. 1).
Conclusion: Posterior spinal fusion with pedicle screws improves back pain and health related quality of life as compared to patients with untreated adolescent idiopathic scoliosis. Health-related quality of life is at similar level as in the healthy controls except for function which is significantly lower.



Disclosures: author 1: grants/research support; Finska Läkaresällskapet, Svenska Kulturfonden, Lastentautien tutkimussäätiö, Orionin tutkimussäätiö; author 2: none; author 3: none; author 4: none; author 5: grants/research support; Swedish research Council, Stockholm County Council, Medtronic, Philips healthcare; author 6: grants/research support; Medtronic, K2M via Innosurge, consultant; Medtronic.

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DOES A LEVELED LOWEST INSTRUMENTED VERTEBRA (LIV) LEAD TO BETTER OUTCOMES AT 5 YEARS FOLLOWING PSF WHEN ENDING AT L3 VS. L4?

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Introduction: Fusion distally to include L4 has been shown to generate less than ideal results, with long-term disk degeneration under the fusion. Thus, the decision to include L4 remains difficult. There may be unrecognized benefits of extending the fusion distally to include L4.
Purpose of this study: The objective of this project was to determine if leveling the LIV independent of the level fused played a role in midterm outcomes (5 years post-op). Our hypothesis was that leveling the LIV to $< 5°$ will result in a difference in outcome for patients fused to L4 vs. L3 at 5 years post-op.
Methods: Retrospective case–control analysis of prospectively collected data. All patients of all curve types with a fusion either to L3 or L4 with pre-op and 5 year post-operative visits were included. Chi square and CART analysis was performed to determine if leveling the distal fusion level to a tilt $< 5°$ would result in animprovement meeting minimally clinically important difference (MCID) for both the SRS-22 pain and self-image domains.
Results: 380 patients were identified. When looking at pain (MCID = ≥ 0.20) and self-image (MCID ≥ 0.98), leveling of the LIV showed greater rate of improvement for both (Table). CART showed that for Pain, leveling the LIV was more impactful than extent of fusion with a 63% rate of improvement compared to 44% when not leveled. When LIV tilt was $\geq 5°$, patients with a fusion to L4 did not improve as much (41%) as patients fused to L3 (46%). For self-image, extent of fusion was of primary impact; L4 vs L3 (68% vs. 56% improvement respectively). When stopping at L3, leveling the LIV resulted in 61% vs. only 52% improvement when not leveling the LIV.
Conclusion: Surgeons often try to avoid extending the fusion down to L4 based on the risk of disk degeneration under the fusion. In our cohort, overall leveling the LIV $< 5°$ resulted in greater improvements in SRS-22 pain and self-image scores. Different interactions between LIV and LIV tilt existed based on SRS domain. Leveling the LIV was of primary importance for an improved MCID pain score, regardless of fusion extent. Whereas for self-image, LIV extent (longer fusion) was more impactful on an improvement in score. The decision to include L4 in the fusion does not always result in poor outcomes. When L3 cannot be leveled, very careful consideration should be given to include L4.

	Percent MCID improvement	
LIV tilt/LIV	Pain	Self-Image
Level L3	61%	61%
Level L4	70%	82%
Not level L3	46%	52%
Not level L4	41%	62%
p	**0.007**	**0.015**

Disclosures: author 1: grants/research support; DePuy Synthes Spine, Medtronic, EOS-Imaging, Spinologics, K2M, consultant; DePuy Synthes Spine, EOS-Imaging, stock/shareholder; Company = Spinologics, royalties; Company = EOS-Imaging; author 2: grants/research support; Depuy Synthes, Nuvasive, K2M, EOS Imaging, royalties; Orthopediatrics, Nuvasive, K2M; author 3: royalties; Company = Biomet, LWW; author 4: grants/research support; Depuy Synthes Spine; author 5: grants/research support; member GSSG, CSSG, HSG, consultant; orthobullets, other financial report; Teaching: depuy, medtronic, nuvasive, zimmerbiomet; author 6: grants/research support; Alphatec Spine, DePuy Synthes Spine, EOS Imaging, K2M, Mazor Surgical Technologies, Medtronic, Nuvasive, Orthopediatrics, Zimmer, Setting Scoliosis Straight Foundation, consultant; Cubist, DePuy Synthes Spine, EOS Imaging, K2M, stock/shareholder; Electrocore, royalties; DePuy Synthes Spine, K2M, Theime Publishing, other financial report; DePuy Synthes Spine, Setting Scoliosis Straight Foundation, International Pediatric Orhtopedic Think Tank, K2M, Scoliosis Research Society, employee; Rady Children's Specialists of San Diego.

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STRUCTURAL PROXIMAL THORACIC CURVE INFLUENCES BOTH STATIC AND DYNAMIC PULMONARY FUNCTION IN AIS PATIENTS

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Summary: Previous research pointed out that structural proximal thoracic curve influences pulmonary function in AIS patients. However, it is not clear whether it affects respiratory response to exercise. We compared PFTs and exercise performance in AIS patients with different Lenke types and revealed that structural proximal thoracic curve negatively affected both static and dynamic pulmonary function, and the influences were correlated to the severity of the proximal thoracic curve.

Hypothesis: Structural proximal thoracic curve negatively affects static and dynamic pulmonary function in AIS patients.

Design: Retrospective study of prospectively collected data.

Introduction: Previous research has shown that structural proximal thoracic (PT) curve influenced pulmonary function, but there is no evidence on whether it affects exercise capacity or cardiopulmonary response. Our study aims to investigate whether structural PT have an effect on exercise performance in AIS patients.

Methods: A total of 151 patients with AIS were included. Radiographic parameters were measured. Patients underwent pulmonary function testing (PFT) and cardiopulmonary exercise testing (CPET) pre-operatively. One-way ANOVA and Pearson correlation test was used.

Results: Twenty-two male and 129 female, with an of 14.2(11–17) years were included. The numbers of patients with Lenke Type 1–6 were 43, 47, 15, 8, 32 and 6, respectively. The average Cobb angles of proximal thoracic (PT), thoracic and lumbar curve were 33.3 ± 11.6, 48.0 ± 15.8 and 43.4 ± 14.0 degrees, and with flexibility of 29.7%, 41.8% and 65.5%, respectively. One-way ANOVA and post hoc analysis discovered that patients with Lenke type 2 had significantly worse FEV1 than those with Lenke type 5, both in actual value (2.4 ± 0.5L vs 2.7 ± 0.6L, P = 0.048) and in percentage value (81.9 ± 15.4% vs 94.2 ± 10.2%, P = 0.003). There was negative correlation between PT and FEV1 in percentage value (r = − 0.305, P = 0.002). In CPET, there was no significant difference in the six types in any of the parameters related to exercise performance, including oxygen intake (P = 0.853), work load (P = 0.964) and maximal heart rate (P = 0.951). Patients with Lenke type 2 had significantly lower tidal volume (Vt) in percentage value than those with Lenke type 5(57.5 ± 12.0% vs 67.2 ± 14.3%, P = 0.026). However, the total minute ventilation in each type was similar in actual (P = 0.618) and in percentage value (P = 0.423). There was negative correlation between PT and Vt in percentage value (r = − 0.305, P = 0.002).

Conclusion: Structural proximal thoracic curve negatively affects static and dynamic pulmonary function, but it does not influence exercise performance in AIS patients.

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THE SURGICAL OUTCOME OF HEMIVERTEBRA EXCISION AND SHORT SEGMENT FUSION TREAT FOR UNDER 5 YEARS OLD CONGENITAL SCOLIOSIS: TEN YEARS FOLLOW UP

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Background: Full segmented hemivertebra with large growth potential and lead to the early rapid progress of spinal deformity. Hemivertebral resection and fixation is an effective method for the treatment of congenital spinal deformity. But there were few studies focusing on the long term follow-up of the surgical outcome of undergoing hemivertebra resection and short-segment fusion for congenital hemivertebrae under 5 years old .

Objective: To evaluate the effect of hemivertebra excision and short segment fusion for congenital scoliosis under 5 years old and its impact on spinal growth.

Methods: Twenty patients under 5 years old with hemivertebra deformity underwent hemivertebra resection and short-segment fusion between 2004 and 2008, were retrospectively reviewed. All cases were one level full segmented hemivertebra and coronal main curve > 35°and received a minimum 10-year follow-up. Clinical and imaging data were collected for statistical analysis.

Results: Mean follow up was 11.8 years. There were 12 cases of thoracic hemivertebra and 8 cases of lumbar hemivertebra, mean aged 3.8 years (range, 2.4–5 years). Mean fused segments were 2.1. The

Cobb angle of coronal main curve was 39.7° (35–54°) before surgery, 5.4°(0–13°) after surgery, and 6.3°(2–16°) at final follow-up. At final follow-up, the thoracic kyphosis angle of thoracic hemivertebra group and lumbar hemivertebra group were 22.4°(6–35°) and 25.6° (8–38°), respectively; the lumbar lordosis angle of lumbar hemivertebra group with 72.1° (58–80°) was significantly larger than thoracic hemivertebra group with 35.5°(24–46°). The SVA of thoracic hemivertebra group and lumbar hemivertebra group were 1.32 cm and 2.1 cm. The height of fixed segmental vertebral body, transverse and longitudinal diameter of fixed segment spinal canal is 92%, 93%,87% of adjacent segment, respectively.

Conclusion: Hemivertebra excision and short-segment fusion for congenital scoliosis under 5 years old can achieve reliable fixation, satisfactory deformity correction and maintained for a long term. It has no significant impact on vertebra growth in fixed segment but there is more likely to lead to increased lumbar lordosis in lumbar hemivertebra patient, which may be related to tethered effect on spine during spinal growth.

Keywords: hemivertebra deformity, under 5 years old, surgical outcome.

Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: none; author 9: none.

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MORPHOLOGICAL ANALYSIS OF 112 RESECTED HEMIVERTEBRAE FROM A DEVELOPMENTAL PERSPECTIVE

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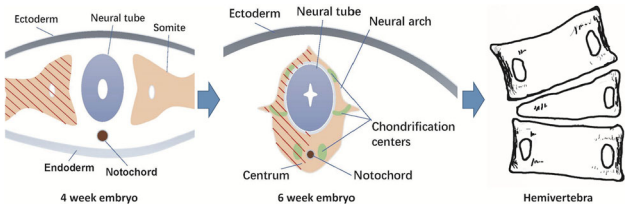
Unilateral malformation of somite and chondrification center at 4th and 6th week of embryo stage respectively leads to hemivertebra (HV). Various degree of development in the remaining half results in different type of HV. This retrospective comparative image study explored the correlation between morphology of HV and severity of deformity. The hypothesis was that certain type of hemivertebra grows faster and causes more severe deformity than others.

Patients with isolated HV (no segmentation failure, normal adjacent vertebra) treated by a single surgeon from 2001 to 2017 were enrolled. Coronally, HV was categorized into two types according to whether the width extend across the central vertical line (CVL) of lower adjacent vertebra (LAV) on X-ray. Sagittally, the HV position was divided into lateral and posterolateral group according to whether HV extended ventrally to anterior half of column. Lateral height around HV was measured on convex side. Analysis of covariance was used to adjust the influence of age.

A total of 112 patients met inclusion criteria (mean age 10.0 ± 6.0 years, 63 male and 49 female). All patients underwent HV resection with fusion from 2 to 12 levels. Compensatory curve occurred in 38 (33.9%) patients, and intraspinal anomaly in 24 (21.4%). There were 48 HV in thoracic region (T2-11), 30 in thoracolumbar (T12-L1), 31 in lumbar (L2-4) and 3 in lumbosacral area. 58 HVs had associated rib. The cobb angle (CA) of scoliosis and kyphosis was correlated with age ($r = 0.415$ and 460, $P < 0.001$, Pearson). Wider HV had larger coronal CA and SVA compared to those within CVL ($P = 0.047$ and 0.014). Though direct comparison showed no difference, after adjusting by age, HV with lateral height ratio (LHR) larger than 0.9 cause larger coronal CA (estimated mean, 50.5 ± 2.0° vs. 46.6 ± 2.6°, $P = 0.002$). On the contrary, after adjusting, sagittal position of HV didn't affect the magnitude of CA ($P > 0.05$). Posterolateral HV was associated with larger AVT than lateral HV ($P = 0.029$).

HV with width over CVL of LAV, LHR over 0.9 and posterolateral position may lead to more severe deformity, and should be intervened more aggressively. After taking patient age into consideration, this morphological study indicated that in isolated hemivertebra, larger transverse width, higher convex lateral margin and posterolateral position were related to faster deformity progression.



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SEVERE PEDIATRIC DEFORMITY SURGERY HAD FREQUENT INTRA-OPERATIVE MONITORING ALERTS BUT A LOW RATE OF PERMANENT DEFICITS AT 2 YEARS

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Background/introduction: Surgical treatment of severe pediatric spinal deformity is challenging and can have a high risk of neurological injury. We investigated the incidence of intra-operative monitoring (IOM) alerts during surgery and the development of new neurological deficits in a prospective multi-center cohort. There was a 43% incidence of IOM alerts. However, after addressing the alerts intra-op, only 2 patients had a new neurologic deficit at 2 years. Sagittal deformity angulation (S-DAR) is associated with IOM alerts and new neurologic deficits. This study analyzed the safety, efficacy and durability of surgery at minimum of 2 years.

Purpose of the study: The purpose of this study was to evaluate the frequency of IOM alerts during surgery for severe pediatric deformity and determine the incidence of new permanent deficits at 2 years postoperative.

Materials and methods: Patients with severe spinal deformity with minimum curves of 100° or planned vertebral column resection (VCR) were followed for a minimum of 2 years postoperative. We studied x-ray parameters, IOM changes, postoperative deficits and recovery at minimum 2 years.

Results: 228/312 patients enrolled had a minimum 2 years follow-up (quality of life questionnaires and x-rays). 110/228 patients had a VCR and 1 a pedicle subtraction osteotomy. 212 had a posterior-only approach and 16 a combined anterior/posterior. 228 patients had a total of 272 procedures including all stages; IOM alerts occurred in 102/272 procedures (38%). 98 patients (43%) had a total of 147 IOM alerts. An analysis was completed between a VCR, ant/post, coronal deformity angulation (C-DAR), S-DAR, and any IOM alert, SSEP,

TCeMEP, or both. Only S-DAR was predictive for any IOM alert ($p < .0001$). The common triggering events were 3 column osteotomies (N = 34), correction maneuvers (N = 30), hypotension (N = 25), implant and instrumentation placement (N = 20 and 19 respectively). Some alerts had multiple triggering events. 209 patients had a normal preoperative exam. 190 patients remained neurologically normal postoperative; 19 had new deficits. At 2 yrs postoperative, 16/19 with new deficits returned to normal, 2 continued to have a deficit, and 1 was lost to follow-up. Analysis between ant/post, VCR, C-DAR and S-DAR indicated that S-DAR was associated ($p = 0.0035$) with a new post-operative deficit. 19 patients had a neurologic deficit preoperative; postoperative 6 improved to normal, 12 continued to have a deficit and 1 had a partial recovery. At 2 yrs, 13/19 with deficits preoperative totally recovered, 3 partially, 2 were the same, and 1 was lost to follow-up.

Conclusion: Pediatric patients with severe deformity had a 43% incidence of IOM alerts but after addressing the alerts intraop, only 2 had new deficits at 2 years. 16/19 patients with preop deficits improved or recovered. Neural monitoring should be mandatory in these cases. Sagittal DAR is associated with IOM alerts and new neurologic deficits.

Associations with neurological alerts during surgery.

Count		Response	Effect	Bivariable Odds Ratio, 95% CI and P-value				Multivariable Odds Ratio, 95% CI and P-value			
N 0	N 1	Variable		Odds Ratio	LCL	UCL	P-val	Odds Ratio	LCL	UCL	P-val
152	120	any_alert	A_P	0.402	0.110	1.190	0.1233	0.466	0.123	1.447	0.2128
152	120		C_DAR	1.022	0.982	1.064	0.2836	1.027	0.983	1.073	0.2420
151	120		S_DAR	1.068	1.037	1.101	<.0001	1.073	1.040	1.108	<.0001
152	120		VCR	1.009	0.620	1.640	0.9709	0.752	0.423	1.323	0.3256
108	12	SSEP_alert	A_P	3.184	0.150	27.398	0.3334	7.100	0.302	78.752	0.1302
108	12		C_DAR	1.058	0.957	1.175	0.2790	1.069	0.973	1.184	0.1717
108	12		S_DAR	1.026	0.963	1.090	0.4107	1.014	0.950	1.081	0.6734
108	12		VCR	2.116	0.635	7.559	0.2249	2.705	0.704	11.610	0.1540
44	76	TCeMEP_alert	A_P	0.568	0.066	4.868	0.5781	0.364	0.040	3.269	0.3351
44	76		C_DAR	0.972	0.911	1.034	0.3643	0.961	0.900	1.025	0.2331
44	76		S_DAR	0.972	0.933	1.012	0.1721	0.976	0.933	1.018	0.2586
44	76		VCR	0.676	0.318	1.434	0.3065	0.650	0.282	1.488	0.3074
88	32	Both_alert	A_P	0.914	0.044	7.440	0.9389	1.078	0.051	9.308	0.9501
88	32		C_DAR	1.009	0.943	1.080	0.7999	1.010	0.942	1.082	0.7856
88	32		S_DAR	1.021	0.978	1.066	0.3467	1.020	0.976	1.069	0.3789
88	32		VCR	1.123	0.491	2.541	0.7802	1.033	0.417	2.511	0.9435

All alert types are categorized as ever vs. never for each patient (across surgeries if in stages).

Associations with development of new neurological deficits among patients with normal neurological status preop.

Count		Response	Effect	Bivariable Odds Ratio, 95% CI and P-value				Multivariable Odds Ratio, 95% CI and P-value			
N 0	N 1	Variable		Odds Ratio	LCL	UCL	P-val	Odds Ratio	LCL	UCL	P-val
21	227	Neurological	A_P	.	.	.	.	.	.	.	.
21	227	Neurological	C_D	0.969	0.898	1.043	0.4074	0.969	0.900	1.044	0.3945
21	227	Neurological	S_D	0.935	0.892	0.978	0.0035	0.935	0.890	0.980	0.0055
21	227	Neurological	VCR	0.860	0.350	2.186	0.7436	1.157	0.424	3.352	0.7794

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TERMINAL COMPLEMENT COMPLEX (TCC): A POSSIBLE TARGET FOR INTERVERTEBRAL DISC DEGENERATION THERAPEUTICS

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Introduction: Inflammation is known to contribute to disc degeneration (DD). However, there is limited knowledge regarding a possible involvement of innate immunity. Terminal complement complex (TCC) immunopositivity was previously observed in human pathologic intervertebral discs (IVD)1, but the information is scarce. The present work aims to understand if TCC plays a specific role in the development and progression of DD.

Methods: Disc tissues were collected post-mortem from: 1) healthy donors, considering 2 different age groups (Young, 5F/6 M, age 7 ± 7; Elder, 4F/4 M, age 67 ± 14); 2) patients with scoliosis (Sc, 8F/3 M, age 15 ± 4) displaying no signs of degeneration; and 3) patients with DD (23F/16 M, age 64 ± 12, Pfirrmann grade 3–5), with ethical approval and patients' informed consent. TCC deposition was investigated in nucleus pulposus (NP), annulus fibrosus (AF) and endplate (EP). Randomly selected Sc and DD patients' AF, NP and EP expanded cells (passage 2–5) were analyzed for gene expression of TCC-inhibitors CD46, CD55 and CD59. Surface expression of TCC, CD46, CD55 and CD59 was analyzed by FACS in fresh and expanded cells. In vitro, cellular TCC deposition was stimulated by 5% human serum medium supplementation (containing components C5 to C9, necessary for TCC formation) and analyzed by ELISA. Serum-free medium was used as control. TCC's lytic activity was measured in the supernatants by erythrocytes lysis test. Statistical analysis was performed with Kruskal–Wallis test.

Results: A significantly higher frequency of TCC + cells was detected in the NP of DD compared to Elder and Sc groups ($p < 0.05$), and in the EP of both Young ($p < 0.001$) and DD ($p < 0.05$) compared to Elder (Fig. 1). Moreover, Young donors presented a significantly higher frequency of TCC + cells in the EP versus NP ($p < 0.05$). No correlations with age or degeneration degree in DD were observed. Overall, the frequency of TCC +, CD46 +, CD55 + and CD59 + AF, NP and EP cells significantly increased with time in culture, becoming similar for Sc and DD cells in passages 2–5. CD46, CD55 and CD59 expression was also similar between Sc and DD cells. Moreover, in presence of human serum, no significant differences were observed between DD and Sc groups for AF, NP or EP expanded cells regarding TCC deposition and cell lysis.

Discussion: These data suggest that TCC is formed in NP cells of strongly degenerated samples, whereas it is detected in the EP of both Young and DD groups, which might correlate with vascularization. Moreover, although TCC deposition can be induced in vitro, AF, NP and EP cells isolated from tissues derived from patients with different pathologies seem to lose their native phenotype with time in culture. Further studies are ongoing to understand which microenvironmental factors can activate TCC deposition and if there is a possible functional relevance of the complement system in DD, being a target for new therapeutic approaches. Reference: 1. Gronblad et al., Spine, 2003.

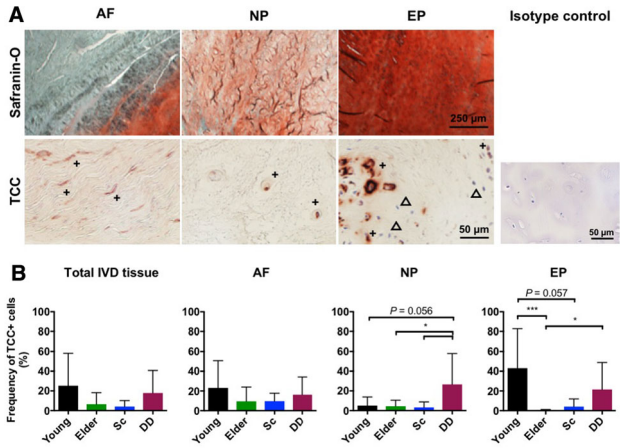

Figure 1. Histopathological analysis of IVD tissue. (**A**) Representative images of IVD tissue collected during surgery, from patients suffering from disc degeneration (DD), stained for safranin-O (proteoglycans are stained *red*, while Fast Green counterstains the non-collagen sites) and for TCC, displaying cells positive (+) and negative (Δ) for TCC deposition, in the different IVD regions: annulus fibrosus (AF), nucleus pulposus (NP) and endplate (EP). (**B**) Frequency (%) of TCC+ cells in healthy IVD tissues collected *post-mortem* from Young (n=11) and Elder (n=8) donors, and during surgery from patients suffering from Sc (n=11) and DD (n=39). **P*<0.05, ****P*<0.001. Kruskal-Wallis test.

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ARTIFICIAL INTELLIGENCE-BASED ADULT SPINAL DEFORMITY RISK–BENEFIT CLASSIFICATION: HIERARCHICAL CLUSTERING OF 1245 PATIENTS AND SURGERIES WITH MACHINE-BASED LEARNING AND SIMPLIFIED DECISION TREES

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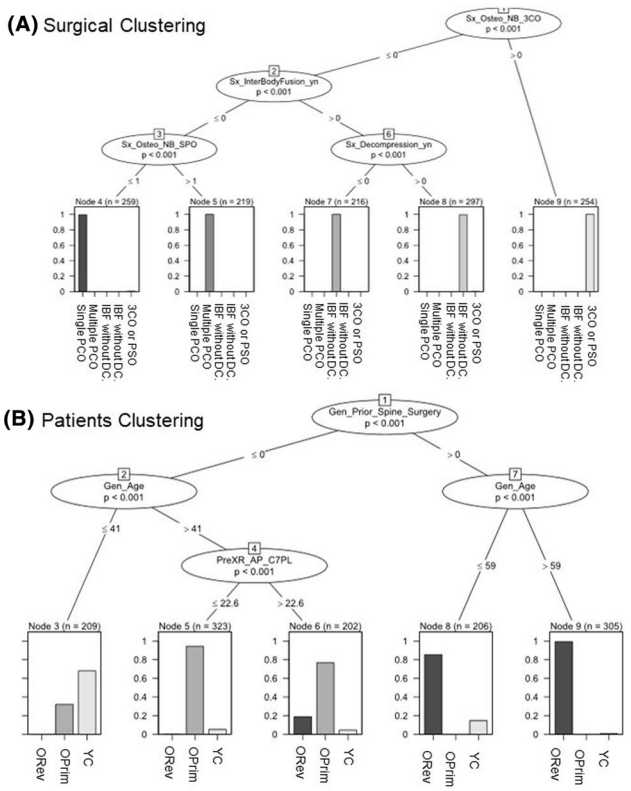
Introduction: The Schwab-SRS ASD Classification is based on disability scores and the sagittal plane and is limited by the lack of preoperative information on associated risk or outcome. Unsupervised learning has classified ASD patients and surgeries based on risk and benefit. The combination of AI-based unsupervised learning and expert cluster interpretation will yield a risk–benefit ASD classification which does not require computer access. We aimed to improve the analysis with more than twice the 2-yr follow-up sample size and filter the results by reducing the number of groups to enable point of care clinical application.

Methods: Two prospective cohorts were queried for surgical ASD patients with baseline, 1-yr, and 2-yr SRS-22/SF-36v2 data. Dendrograms were fitted, one with surgical features and one with patient characteristics. Both were built with Ward distances and optimized with the gap method. Normalized 2-yr improvement and major complications (MC) were computed for patient and surgery clusters. Patient clusters and surgery types were filtered to enhance interpretability and back walked to provide a decision tree.

Results: 1245 patients were included (mean 55.7 yrs; 77.6% female) in this analysis. The 3 patient types were: Young Coronal (YC, n = 200), Old Primary (OPrim, n = 527), and Old Revision (ORev, n = 516). 5 surgical types were drawn: 3-column osteotomy (PSO/3CO, n = 254), interbody fusion (IBF with [n = 296] or without decompression [n = 216]), single PCO [n = 258], and multiple PCO [n = 219]. The figure shows normalized improvement in outcomes and cumulative incidence of MC based on patient type and surgical plan.

Conclusion: Unsupervised hierarchical clustering can identify data patterns that may guide preoperative decision making by predicting outcomes and MC. In addition to creating a novel AI-based preop risk–benefit ASD classification, pattern identification may facilitate treatment optimization by educating surgeons on which treatment patterns yield optimal improvement with lowest risk.



(C) Risk-Benefit Grid

		Single PCO	Multiple PCO	IBF without DC.	IBF with DC.	PSO-3CO
Sample		N=46	N=69	N=72	N=138	N=191
ORev	+	24.3	40.8	28.5	35.2	40.3
	-	47.8	46.4	43.1	50.7	57.6
Sample		N=101	N=94	N=133	N=151	N=48
OPrim	+	33.5	35.1	31.8	36.7	39.5
	-	32.7	37.2	38.3	40.4	37.5
Sample		N=111	N=56	N=11	N=7	N=15
YC	+	14.9	18.87	24.61	9.2	22.3
	-	9.9	14.3	27.3	57.1	40

+ : Normalized (%) Improvement in SRS22 total score, - : Incidence (%) of Major Complications

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SPINO-PELVIC ALIGNMENT AFTER SHORT SEGMENT TRANSFORAMINAL LUMBAR INTERBODY FUSION (TLIF)—IS CORRECTION POSSIBLE AND WORTHWHILE?

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Introduction: Sagittal alignment is governed by radiological parameters such as pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS) and lumbar lordosis (LL). Matching LL and PI, and a low Global Alignment and Proportion (GAP) Score influence both clinical outcome and the risk of revision in long fusion. The influence of short transforaminal lumbar interbody fusion (TLIF) on the sagittal profile is equivocal. This retrospective study aimed to evaluate the magnitude of the change in segmental and regional lordosis in short segment TLIF (1–3 segments), and its effect on spino-pelvic alignment and prospectively evaluated clinical outcome.

Materials and methods: From our local spine outcomes database (linked to the Spine Tango Registry), we identified 196 patients with no coronal deformity > 20° and no previous spine surgery who had undergone TLIF (1–3 segments) for degenerative spinal disorders in 2012. The following were measured on standing lumbar spine radiographs taken before and six weeks after surgery: PI, PT, SS, LL, L4-S1 lordosis, fused segments lordosis (FSL), and remaining unfused segments lordosis (RSL). Based on these measurements, spino-pelvic alignment (PI-LL) and L-GAP-Score were assessed, and patients were categorized as PI-LL balanced, unbalanced, or uncompensated and L-GAP proportioned, moderately disproportioned or severely disproportioned. The Core Outcome Measures Index (COMI) was used to assess patient-rated outcome pre-, and 2- and 5-years post-operatively.

Results: TLIF was performed in 1 segment in 140, 2 segments in 50 and 3 segments in 6 patients. 106 patients had degenerative spondylolisthesis, 32 isthmic spondylolisthesis, and 58 osteochondrosis. The radiological measurements (PT, SS, LL, L4-S1) showed no significant differences, pre- to postoperatively. FSL was increased from 21.9 ± 10.4° pre- to 23.4 ± 9.2° postoperatively (1.3 ± 4.5° per fused segment) (both $p < .01$); however, the proportion of patients in the PI-LL and L-GAP-Score categories showed no significant differences. There was a low but significant correlation between the increase in FSL and the decrease in RSL ($R = -0.285$, $p < .01$). The COMI improved significantly from 7.2 ± 1.7 at baseline to 2.5 ± 2.5 and 2.8 ± 2.5 at 2- and 5-years' postoperatively, respectively (each $p < .01$). Patients were more likely to achieve the minimal clinically important change (MCIC) in COMI score at 5 years' postoperatively with FSL > 3 (87.9%) than with FSL < 3° (72.6%) ($p = .03$).

Conclusion: Short segment TLIF can increase lordosis within fused segments, and reduce compensatory mechanisms in the unfused lumbar spine. A good clinical outcome is achieved for the majority of patients at five-years' follow-up independent of spino-pelvic alignment. An increase of lordosis in the fused segments of more than 3 degrees appears to be associated with better clinical outcome.
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RISK FACTORS FOR IMMEDIATE ENDPLATE INJURY AFTER MINIMALLY-INVASIVE LATERAL LUMBAR INTERBODY FUSION

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Introduction: Immediate endplate injury (EpI) after minimally-invasive lateral lumbar interbody fusion (MIS-LLIF) is quite common and can lead subsequent cage subsidence and deterioration of surgical outcomes. The purpose of this study was to identify risk factors for immediate EpI after MIS-LLIF.
Methods: One hundred eighty-six patients underwent MIS-LLIF and posterior instrumentation for degenerative lumbar diseases with one-staged or two-staged manner between 2012 and 2017. All surgeries were performed with the same manner by a single surgeon. Age, sex, BMI, and BMD were recorded. On preoperative standing X-ray, coronal disc angle, and each sagittal disc angle in neutral, flexed, extended positions were measured. Also, anterior and posterior disc heights were measured on lateral neutral X-ray. Other radiographic parameters including osteophyte formation, Kellgren-Lawrence grading, facet degeneration grading, endplate sclerosis were assessed. EpI was defined as compromise of bony endplate with more than 1 mm. recorded on immediate postoperative X-ray. All parameters were analyzed statistically regarding endplate injury at each disc level.
Results: 372 discs underwent MIS-LLIF in 186 patients and 76 levels (20.4%) showed EpI. Among them, 67 had single-side injury and 9 had both-side injury. One case with two adjacent EpI showed vertebral body fracture leading to early revision. The incidences were similar for each level. When periodic analysis was performed for each 100 levels, the incidences were steady from the first period to the last one. BMD of vertebrae with EpI was not different from BMD of vertebrae without EpI. The differences between cage height and disc height were also not different according to EpI. Multivariate regression analysis demonstrated that sagittal disc angle in extension, gender, and endplate sclerosis were correlated with EpI. Bone mineral density was not correlated with EpI.
Conclusion: The incidence of EpI was 20.4% and showed steady tendency. The smaller sagittal disc angle in extension, female gender, and endplate sclerosis was correlated with EpI The development of EpI is correlated with various factors: surgeon-related, patient-related, and implant-related. In this study, there was no learning curve and no significant correlation between EpI and implant dimensions. Immediate postoperative EpI seemed not to be procedure-related, but to be patient-related. At the beginning of this study, authors had expected that bone mineral density might be correlated with EpI, however, no significance was noted. When performing MIS-LLIF, spine surgeons should check X-ray thoroughly and pay more attention to female patients with smaller sagittal disc angle in extension.
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THE SCIATICA-GILL TRIAL: ISTHMIC SPONDYLOLISTHESIS: DECOMPRESSION WITH VS. WITHOUT INSTRUMENTED FUSION: A RANDOMIZED CONTROLLED TRIAL

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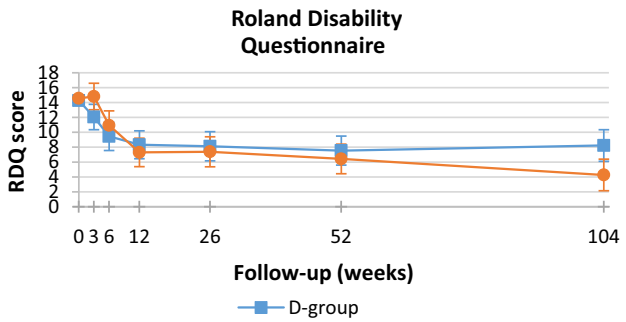
Background: The most advocated surgical technique to treat symptoms of isthmic spondylolisthesis is decompression with instrumented fusion. A less invasive classical approach has also been reported, which consists of merely decompression.
Methods: We randomly assigned 84 patients with lumbar radiculopathy or neurogenic claudication due to a grade I or II isthmic spondylolisthesis to decompression (D) or decompression with instrumented fusion (DF). Scores on the Roland Disability Questionnaire, visual-analogue scale for back pain and for leg pain separately, and the patient's report of perceived recovery were evaluated as primary outcome parameters at 12 weeks and 2 years postoperatively. Secondary outcome measures were the proportion of repeat surgery for persistence of complaints, and the SF-36 functionality scale. Repeated-measures analysis according to the intention-to-treat principle was used.
Results: Between the 43 patients assigned to decompression and the 41 patients assigned to decompression and fusion, there was no significant difference in disability scores at 12 weeks follow up ($P = 0.32$ 95% CI [− 4.02 to 1.34]), nor in the other outcome measures. At 2 years follow-up, disability scores improved more in the fusion group (10.3 vs 6.0 points improvement ($P < 0.01$ 95% CI [− 7.3 to − 1.3]. Likewise, back pain ($P = 0.01$) and perceived recovery ($P = 0.04$) improved more in the fusion group. The cumulative probability for reoperation at 2-year follow-up was 47% in the decompression and 13% in the fusion group ($P < 0.01$).
Conclusion: In isthmic spondylolisthesis decompression with instrumented fusion resulted in significantly better outcomes and less re-operations compared to decompression without fusion. Nearly half of the patients who underwent only decompression needed secondary instrumented fusion during follow-up. Therefore, decompression alone is an inferior surgical technique for isthmic spondylolisthesis, and should generally not be offered as a first treatment option.



Disclosures: author 1: none; author 2: not indicated; author 3: grants/research support; Zimmer-Biomet, consultant; Zimmer-Biomet, Intrinsics, EIT, Silony, royalties; Company = EIT; author 4: not indicated; author 5: none; author 6: none; author 7: none; author 8: grants/research support; Medtronic, Paradigm Spine, Braun; author 9: grants/research support; Covidien sponsors a trial on legpumps in neurosurgical surgery. Ynske Meyes Fund sponsors a trial on epidural injections in sciatica. These are all investigator initiated trials. The payment is not made to my own account but to our research department. Board of CSRS Europe, faculty for EANS, CSRS, Eurospine and webinar for AO spine.; author 10:.

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LONG-TERM PROGNOSIS AFTER ANTERIOR DECOMPRESSION AND FUSION IN YOUNG ADULTS

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Anterior cervical decompression and fusion (ACDF) is the leading surgical treatment of cervical radiculopathy caused by disc herniation or spondylotic nerve root compression. ACDF procedures have been suggested to lead to accelerated degeneration of the adjacent cervical discs (adjacent segment disease, ASD). Occurrence of ASD is of particular interest when treating young individuals as the cumulative disease burden form degenerative cervical disease may become increasingly significant during their expectedly long lifetime. However, the overall impact a surgical intervention on life time prognosis for degenerative cervical disease is incompletely understood.

We retrospectively collected and analyzed the medical records of all patients between 18 and 40 years of age at the time of surgery who underwent ACDF due to degenerative cervical disease at Helsinki University Hospital between the years 1990 and 2005 (n = 476). The follow-up time was 12–28 years (median 17 years). The end points of the study were long-term outcome, satisfaction to the surgery, quality of life and long-term risk of reoperations. Questionnaires were sent to patients now at the end of the follow-up to asses overall neck symptoms at current time point and health related quality of life.

The most common complications were persistent dysphagia (2%) and dysphonia (4%). The incidence of postoperative haematomas was 1,4%. 24% of patients were re-operated at least once during the follow-up period (median time to the re-operation 5,5 years). Excluding early re-operations (< 28 days from the index surgery), the reoperation rate during the rest of the follow-up period was 19,5%. The 10-year total reoperation rate was 16,8% and 12,8% with early reoperations excluded. Altogether 23% of late reoperations (> 28 days) involved further decompression of the index level, 82% decompression of an adjacent level and 3% decompression of a non-adjacent level.

Statistically significant risk factors of needing at least one re-operation were male sex, central spinal cord compression, discectomy without implant as surgical technique, the primary operation done in acute setting and smoking at the time of the operation. Time to re-operation was analyzed with Kaplan–Meier analysis (Fig. 1).

In general, the satisfaction to the surgery was high. Now 12–28 years after the surgery, 92% of patients were still satisfied to the result of the surgery. 67% of patients were working, 7% were unemployed and 7% were on disability pension due to cervical problems. These proportions resemble that of the general population in Finland. Smoking was more common both now and at index time than in general population. Median NDI now was 12%, resembling closely that of general population. NDI was significantly higher among patients with spondylosis or clinical myelopathy and among patients operated more than once.

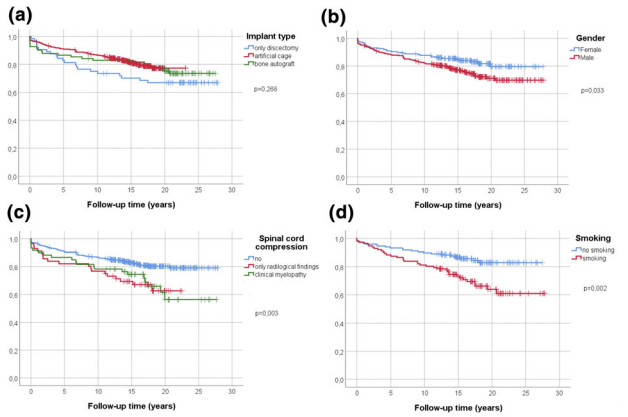

Figure 1: The proportion of patients, not undergone reoperation as function of time. Patients grouped by a) surgical technique according to discectomy alone or use of artificial cage or bone auto graft for fusion, b) gender, c) presence of no, radiological spinal cord compression only or radiological and clinical myelopathy and d) smoking status.

Disclosures: author 1: none; author 2: none; author 3: stock/shareholder; Company = Helsinki Hospital, employee; Company = Helsinki University Hospital; author 4: none.

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RISK FACTORS FOR REOPERATION FOR SURGICAL SITE INFECTIONS IN INSTRUMENTED SPINE TRAUMA PATIENTS

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Introduction: In the USA, it is estimated that 300,000–500,000 surgical site infections occur each year. These are associated with increased healthcare related costs. Few studies have looked specifically at surgical site infections in spine trauma. Rates in the literature suggest a 4–10% incidence of post-operative wound infection.
Purpose: To investigate the incidence of surgical site infections requiring surgical irrigation and debridement within 90 days of instrumented spinal stabilization in traumatic spine injuries and identify risk factors for re-operation.
Methods: After obtaining institutional IRB, spine trauma patients (> 18 years old), who underwent spine surgical fixation, at a level I

trauma center covering a four-state area were identified by searching CPT codes (22851, 22325, 22326, 22327) and linked with ICD-9 codes (codes beginning with 8) from January 2005 to October 2015. From the larger group, we then identified patients with CPT codes 998.59 or 996.67 who required a secondary irrigation and debridement, within 90 days of the index procedure. In this study, we did not include patients who had superficial infection managed nonoperatively. Incidence of reoperation and statistical analysis of the possible risk factors: age, body mass index (BMI), tobacco use, intravenous (IV) drug use, diabetes (DM) status, location of fracture, surgical approach, injury severity score, intensive care unit stay and hospital length of stay, was performed.

Results: 2276 adult patients underwent operative management of spine fractures between January 2005 and October 2015. The distribution of injuries by region were 637 (28%) cervical injuries, 887 (39%) thoracic, and 752 (33%) lumbar. 92% of the patients had a posterior approach, 6% anterior approach, and 2% a combined anterior/posterior. The overall incidence of irrigation and debridement for surgical site infections, within 90 days of instrumented spine trauma surgery, was 2.8% (64/2276). Patients who demonstrated a higher risk of undergoing irrigation and debridement for surgical site infection include: tobacco use ($p = 0.0123$), patients with intensive care unit admissions ($p = 0.041$), and patients with longer hospital lengths of stay ($p = 0.004$).

Conclusions: This study suggests that the incidence of irrigation and debridement for infection within 90 days of instrumented spine trauma surgery is 2.8%. This is lower than what has previously been suggested in prior studies. Tobacco use, longer hospital lengths of stay and intensive care unit admissions are risk factors correlated with increased risk for infections requiring a secondary irrigation and debridement.

Disclosures: author 1: other financial report; Globus; author 2: none; author 3: none; author 4: none; author 5: none.

TRAUMA, COMPLICATIONS

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TIME-DEPENDENT INTERPRETATION OF MECHANICAL COMPLICATIONS USING COX REGRESSION AND SURVIVAL ANALYSIS

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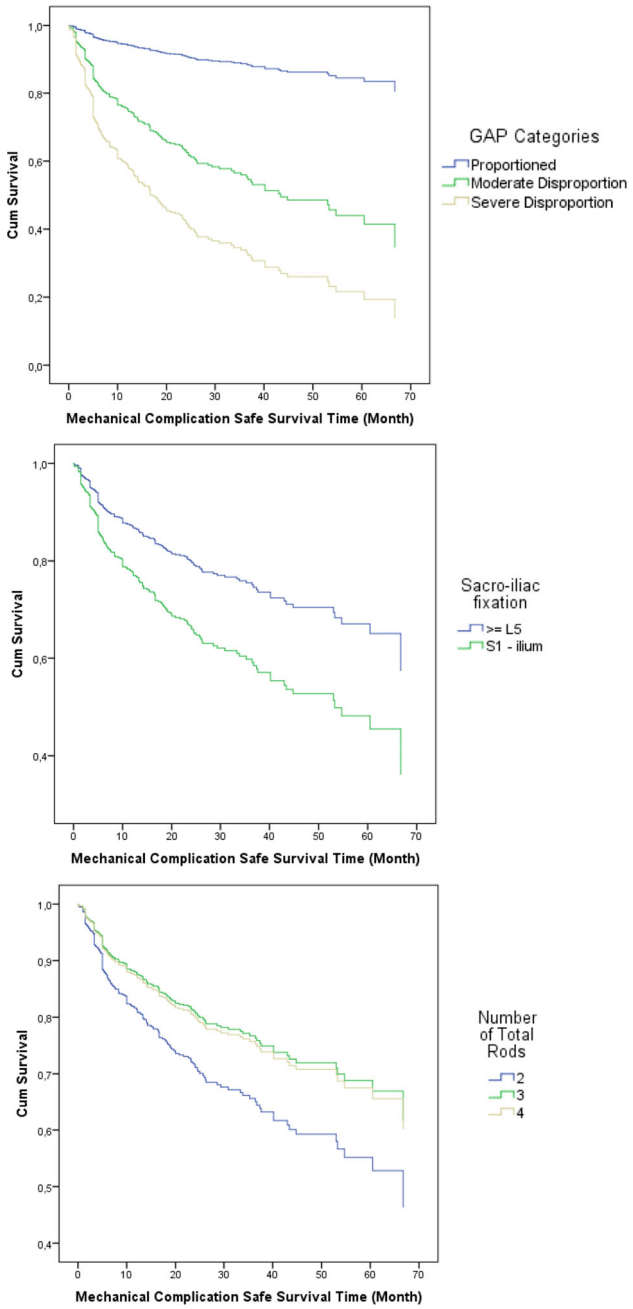
Background: Risk factors associated with mechanical complications after ASD surgery are multifactorial and plentiful (> 60 have been suggested). Duration of follow-up emerges to be one of the most important determinants.

Purpose: The aim of the study is to assess factors affecting the occurrence and timing of mechanical complications together in multifactorial Cox regression and survival models.

Material-methods: Inclusion: $\geq$ 4-level fusion. Univariate tests included 66 factors derived from preoperative (25 history, demographic, radiographic), operative (32 technique and implant-related data), and postoperative (9 radiographic) data. To avoid multicollinearity, correlations were assessed guided by clinical expertise. Multivariate Cox proportional hazards models were created to estimate survival time probabilities and predict independent factors affecting the occurrence and timing of mechanical complications.

Results: 697 patients (551F, 146 M, 53 $\pm$ 19 yrs) with a mean f-up of 29.5 (1.5–94) months were included. 29 factors were identified as significant and near significant ($p < 0.25$), and was included in multivariate analysis. Sagittal plane reconstruction quantified by the postoperative GAP Score, sacroiliac fixation, age, postoperative T10-L2 sagittal angle, the number of levels fused and the number of rods were most important factors. Moderately and severely disproportioned states displayed 4.9 (95% CI 3.1–7.8) and 8.7(95% CI 5.4–14), times higher Hazards Ratios, respectively ($p < 0.001$). Patient with sacroiliac fixation experienced 1.8 greater odds of incurring a mechanical complication compared to thoracolumbar fusions ($p = 0.01$). Rates of mechanical complications increased as age ($p = 0.004$), the number of levels fused ($p = 0.002$) and postoperative T10-L2 sagittal angle ($p = 0.009$) increases. Using double-rod constructs decreased the likelihood of incurring a mechanical complication ($p = 0.029$).

Conclusions: A total of 6 factors regarding demographics, technical details and sagittal radiographic measurements were identified affecting the occurrence and timing of mechanical complications. Survival graphs for the most important features were depicted. The postoperative GAP Score, sacroiliac fixation, age, postoperative T10-L2 sagittal angle, the number of levels fused and the number of rods were found to be independent factors affecting the occurrence and timing of mechanical complications.



Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: none; author 9: grants/research support; depuy synthes, consultant; depuy synthes, medtro, royalties; Company = clariance, Spineart, Alphatec; author 10: grants/research support; DEPUY, consultant; Globus; author 11: grants/research support: De Puy Sinthes; author 12: grants/research support: Depuy Synthes, Medtronic, royalties: AOSpine; author 13: grants/research support; DePuySpine, Medtronic; author 14: grants/research support: Depuy; consultant: Globus; author 15: grants/research support: DePuy Synthes and Medtronic. Additional support was provided through Project PI16/01283, funded by Instituto de Salud Carlos III and co-funded by European Union (ERDF/ESF).

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DOES MRI AID SURGICAL PLANNING IN PATIENTS WITH T10-L1 BURST FRACTURES AND INCOMPLETE SPINAL CORD INJURIES?

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The initial imaging of patients with thoracolumbar burst fractures and incomplete spinal cord injuries often starts with obtaining a CT scan. While surgical intervention is often recommended, obtaining an MRI prior to surgery is at the discretion of the surgeon. MRI has been shown to be useful in determining the extent of soft-tissue damage in spinal trauma.

Materials and methods: A survey of 127 spine surgeons was conducted to determine whether or not operative treatment plans were directly changed by the availability of MRI imaging studies in patients who had thoracolumbar burst fractures (T10-L1) and incomplete spinal cord injuries. The patients for this study (n = 10) were identified by searching the Department of Radiology's diagnosis database for the diagnosis of burst fracture and both CT and MRI studies that were obtained prior to any surgical interventions. The admission history and physical exam for each of these patients was also reviewed to determine whether or not an incomplete spinal cord injury was present at the time of initial evaluation. The axial and sagittal CT studies as well as the initial history and physical for each of these 10 patients were deidentified and presented to the surgeons participating in the survey. Each participant was then asked to formulate a surgical plan. Once a surgical plan was formulated based on the CT scan, they were asked whether or not an MRI was desired and why. The axial and sagittal T2 MRI scan images were then presented. The surgeons were then asked whether or not this altered their initial surgical plan.

Results: Of those surveyed, 68% were practicing as Orthopaedic and 32% as Neurosurgery trained spine surgeons. The majority (68%) of those responding to the survey have been in practice greater than 10-years. In the patient population presented, after reviewing the initial CT scan, 47% of respondents stated that they would like to obtain an MRI before proceeding to the operating room. This was desired to evaluate for discoligamentous injuries adjacent to the fractured segment, to determine if anterior only treatment is sufficient or due to suspicion of adjacent bony injury not evident on CT scan. After reviewing the MRI, 21% of all respondents stated that their previous surgical plan had been changed. Out of the 47% of respondents that desired an MRI scan after evaluating the CT scan, 44% stated that the results of the MRI led them to change their surgical plan.

Conclusion: The majority of the time (53%), respondents did not feel that an MRI was necessary for operative planning. Seventy-nine percent of the time, MRI made no difference in planned treatment. The MRI was most often desired due to it being the standard protocol of the treating institution or to evaluate the posterior ligamentous complex. In conclusion, the operative treatment of patients with thoraco-lumbar burst fractures is changed in 1 out of 5 patients by imaging the injured levels with an MRI.

Disclosures: author 1: other financial report; Globus; author 2: consultant; DePuy/Synthes; author 3: none; author 4: none:.

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SUBSIDENCE RISK OF VERTEBRAL BODY REPLACEMENTS USING A NEW BIOMECHANICAL IN VITRO TEST METHOD

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Introduction: Prevention of implant subsidence in osteoporotic (thoraco-) lumbar spines is still a major challenge in spine surgery. Different groups have examined the relationship between subsidence and several risk factors. In this study, a new biomechanical in vitro test method was developed to simulate patient activities such as climbing stairs, tying shoes or lifting heavy weights in order to determine the subsidence risk of vertebral body replacements (VBR) during physiologic loading conditions.
Methods: The study included 6 thoracolumbar (T11-L1) and 6 lumbar (L2-L4) human specimens. After dorsal stabilization and removal of the mid vertebra and adjacent discs, VBR with (a) round centrally located and (b) lateral end pieces with apophyseal support were implanted. The groups have been equally distributed regarding segment, BMD (mean (a) 67.8 mgCaHA/cm, mean (b) 64.1 mgCaHA/cm) sex and age (mean age (a) 72 and (b) 69 years). A new test method simulating several physiologic everyday activities was established in a custom-made dynamic 6 DOF loading simulator. The specimens were subjected to maximum axial loads corresponding to the intervertebral disc pressure during the simulated activity raised by 50 N each 100 cycles. Combined flexion–extension and lateral bending movements were applied at 0.5 Hz and increased stepwise by 0.25°, phase-shifted to the load increase. Prior to implantation, subsequently and after simulating 'climbing stairs', 'tying shoes' and 'lifting 20 kg', the range of motion (ROM) of the specimens was determined under pure moments of 3.75 Nm for osteoporotic lumbar spines, in all three motion planes. Additionally, subsidence depth was quantified through fluoroscope films. A mixed model with the significance level set to $\alpha = 0.05$ was established to relate subsidence risk to implant geometries and patients' activities.
Results: Generally, there is a clear trend of increased ROM following severe everyday activities (Fig. 1). The implants with apophyseal support (lateral end pieces) showed a less pronounced subsidence depth (estimated mean 'round': 3.2 mm vs. 'lateral': 0.4 mm). That led to a decrease of ROM in flexion–extension ($p < 0.1$) and significant increase ($p < 0.05$) in axial rotation.
Conclusion: In this study, a new biomechanical test method was developed that simulated physiologic activities to provoke and examine subsidence of VBR. Subsidence occurred most when lifting heavy weights, and into the ventral part of the caudal vertebra. The observed raise in ROM could be considered as a signal for higher risk of implant subsidence. Further on, the results indicate that lateral end pieces may better prevent from implant subsidence into the adjacent vertebrae, because of the additional lateral support of the cortical bone. Generally, patients that are treated with a VBR should avoid activities that create high loading on the spine.
Disclosures: author 1: not indicated; author 2: none; author 3: none; author 4: none; author 5: consultant; Aesculap; Medacta; Humantech;, royalties; Company = Aesculap; author 6: grants/research support; Signus, Neos, ApiFix, Spinol, 3D Matrix; author 7; author 8; author 9; author 10.

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RISK FACTOR ANALYSIS FOR PREDICTING KYPHOSIS REOCCURRENCE AFTER POSTERIOR SHORT-SEGMENT FIXATION IN THORACOLUMBAR BURST FRACTURE

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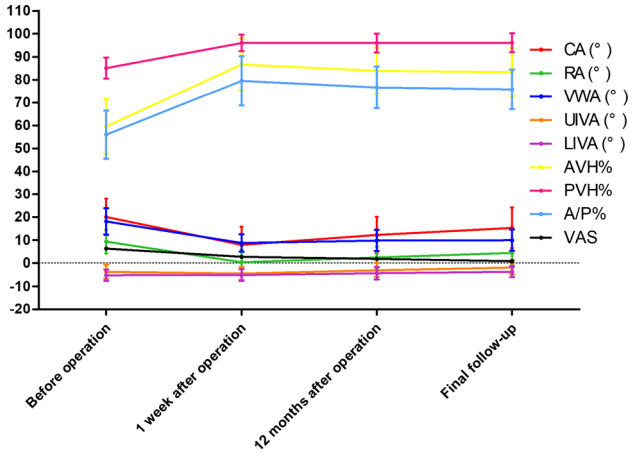
Objectives: To identify the thresholds of the risk factors predicting KR (kyphosis reoccurrence) after posterior short-segment fixation in thoracolumbar burst fracture.
Patients and methods: 169 (90 men and 79 women) patients were included in this study. Preoperative radiographic data comprising Cobb angle (CA), regional angle (RA), vertebral wedge angle (VWA), anterior vertebral height ratio (AVH%), posterior vertebral height ratio (PVH%), anteroposterior ratio (A/P%), upper intervertebral angle (UIVA), lower intervertebral angle (LIVA) and Visual Analogue Scale (VAS). Thoracolumbar Injury Classification and Severity (TLICS) score and clinical assessment including Load Sharing Classification (LSC) score, Body mass index (BMI). Patients were divided into KR group and none KR (NKR) group based on loss of CA correction $< 5^{\circ}$. The risk factors of KR before or after implant removal were analyzed, respectively.
Results: There were significant improvements in postoperative parameters compared with preoperative parameters, such as VAS ($P < 0.001$), CA ($P < 0.001$), VWA ($P < 0.001$), UIVA ($P = 0.02$), AVH% ($P < 0.001$), A/P% ($P < 0.001$), PVH% ($P < 0.001$). However, no significant difference was found between preoperative LIVA and postoperative LIVA ($P = 0.420$). The predictability of the multiple logistic regression analysis was assessed using the ROC curve and the area under the curve (AUC). The results showed that age (threshold value = 49.0, AUC = 0.828), BMI (threshold value = 24.0, AUC = 0.846) were good predictors; however, the predictabilities of preoperative AVH% (threshold value = 49.5, AUC = 0.348) and preoperative PVH% (threshold value = 85.5, AUC = 0.423) were unsatisfactory. Multivariable logistic regression analysis found only one significant risk factors for KR after implant removal: BMI ($P < 0.001$). However, preoperative AVH% ($P = 0.008$); however, preoperative AVH% was a protective factor for KR. The ROC cures showed that BMI (threshold value = 25.17, AUC = 0.871) was a good predictor; however, the predictability of preoperative AVH% (threshold value = 61.5, AUC = 0.317) was unsatisfactory.
Conclusions: The results of this study showed that SSPI-f was effective in the treating thoracolumbar burst fractures; the loss of correction was mainly found within 12 months after surgery. There were significant differences in risk factors of KR at different postoperative follow-up stages: age > 49 years, BMI > 24 were risk factors of KR before implant removal, while AVH% > 49.5% and PVH% > 85.5% were protective factors; BMI > 25.17 was a risk factor of KR, while AVH% > 61.5% was a protective factor. Among all these predictive factors, age and BMI were the most accurate factors.



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Disclosures: author 1: none; author 2: not indicated; author 3: none.

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SUBAXIAL CERVICAL SPINE FRACTURES-A COMPARISON OF OUTCOME AFTER ANTERIOR OR POSTERIOR SURGERY IN 375 PATIENTS

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Introduction: More than 50% of cervical spine fractures are located in the subaxial region. Some of these need surgical attention. There is no consensus in the literature regarding surgical approach. The aim of this study was to compare patient reported outcomes and complications after anterior or posterior cervical spine surgery.
Methods: Individuals who had been treated with either anterior or posterior surgery due to a subaxial cervical spine fracture between 2006 and 2016, and had at least one year follow-up were identified in the Swedish Spine register. Outcomes were Neck Disability Index (NDI) and EQ-5D-3L at minimum one year, and reoperations, mortality, and surgeon and patient reported wound complications within 90 days. Chi square tests were used for categorical comparisons. Analysis of co-variance with or without adjustment for potential co-variates (age, sex, follow-up time) were used for group comparisons of continuous variables.
Results: 171 individuals had undergone anterior surgery at a mean (SD) age of 49 (20) years, 204 individuals had undergone posterior surgery at a mean age of 60 (17) years ($p < 0.001$), with no difference in sex distribution ($p = 0.99$). Follow-up was 3.6 (2.1) years in the anterior group and 2.8 (1.7) years in the posterior group ($p < 0.001$). At the last follow-up, NDI was 23 (20) in the anterior group and 28 (21) in the posterior group (adjusted $p = 0.035$). EQ-5D index was 0.65 (0.34) in the anterior group and 0.56 (0.37) in the posterior group (adjusted $p = 0.14$). Within the first 90 days after surgery, no deaths occurred, 8 (5%) individuals in the anterior group and 9 (4%) individuals in the posterior group were reoperated ($p = 0.90$), and 9 (5%) individuals in the anterior group and 40 (20%) in the posterior group sustained a wound infection ($p < 0.001$).
Conclusion: Anterior surgery was associated with slightly lower neck disability and wound infection rate, but similar general quality of life when compared to posterior surgery in subaxial cervical spine fractures.
Disclosures: author 1: grants/research support; Swedish Research Council, Stockholm County Council, Medtronic, Philips Healthcare; author 2: none; author 3: none; author 4: none.

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SURGERY FOR SEVERE PEDIATRIC SPINAL DEFORMITY HAS A SIGNIFICANT RATE OF REVISION: A PROSPECTIVE MULTI-CENTER COHORT STUDY

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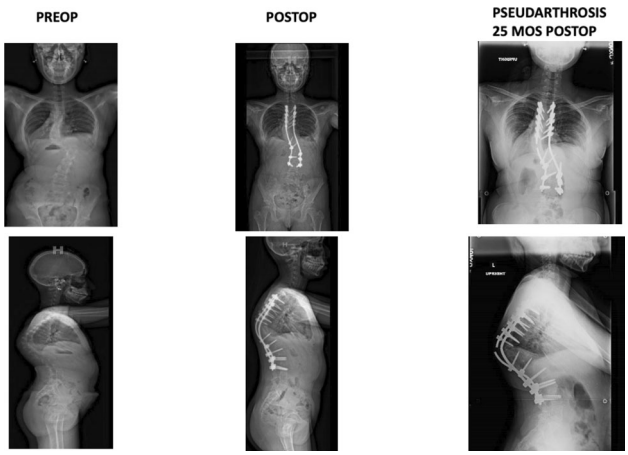
Background/introduction: Surgical treatment of severe pediatric deformity can be extremely challenging due to difficulties with instrumentation placement in small patients, stress on implants due to correction of severe deformities, and use of three column osteotomies. We investigated the instrumentation and fusion related complications in these complex spine deformity surgical cases.
Purpose of the study: The purpose of this study was to evaluate the frequency and timing of revisions related to instrumentation or fusion in patients with severe pediatric deformity.
Materials and methods: Patients with severe spinal deformity, classified as a minimum 100° or planned vertebral column resection (VCR), were included with minimum 2 years follow-up from 17 centers. Complications with or without revision due to pseudarthrosis, instrumentation failure, infection requiring instrumentation removal and progression of deformity were all analyzed.
Results: 228/312 patients had a minimum of 2 years follow-up. 29 patients (13%) had complications associated with instrumentation or fusion. 22 patients (10%) had 27 revisions. The average time for all revisions was 16 months (0–36) after index surgery; 3 patients were revised 2 times and 1 patient 3 times. The 27 revisions included 5 patients with loss of fixation, revised an average of 21 months postoperative (1–35). 4 patients with pseudarthrosis were revised an average of 21 months postoperative (13–28). 1 patient was revised for prominent instrumentation at 27 months postoperative, and 5 patients for deep infection between 1 and 27 months, average 15 months. 8 patients had revisions for deformity progression at an average of 13 months (1–36). 1 patient was revised for a mal-positioned screw a few days postop, and 1 patient at 12 months postop for implant/instrumentation failure. 8 patients had complications that did not require revision. These included 1 with prominent implants, 1 with a mal-positioned screw in the disc space, 3 had progressive deformity including proximal junctional kyphosis, 1 patient for implant prominence, 1 for loss of fixation, and 2 had implant failures .
Conclusion: Pediatric patients with severe spinal deformity are at significant risk for revision surgery at a rate of 13% within 2 years. The average time for revision surgery was 16 months postoperative but was necessary as long as 36 months after index surgery. Long term follow-up is necessary to evaluate failure in this patient population.



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SURGICALLY IMPARTED CHANGES IN THE POSITION OF THE JUNCTIONAL VERTEBRAE AFTER POSTERIOR SPINAL FUSION RELATES TO THE DEVELOPMENT OF JUNCTIONAL KYPHOSIS IN ADOLESCENT IDIOPATHIC SCOLIOSIS

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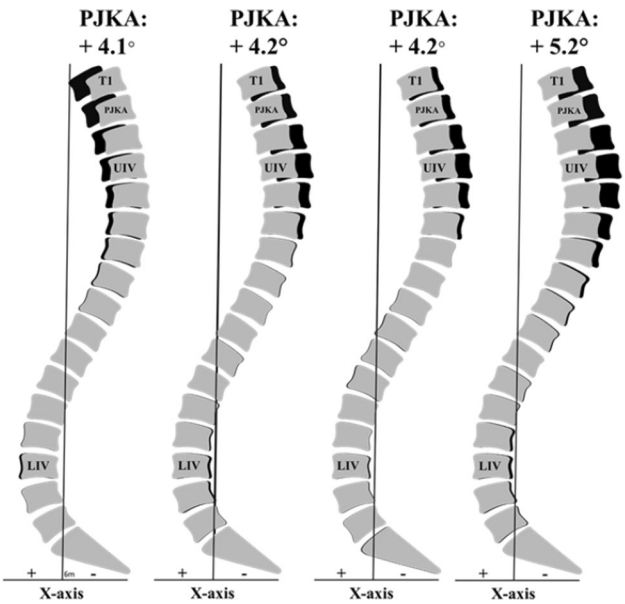
Introduction: The development of proximal junctional kyphosis (PJK) after posterior spinal fusion in adolescent idiopathic scoliosis (AIS) is a major problem. Changes in the global sagittal parameters as they relate to PJK have been reported after surgery, however the relationships between the changes in the upper-instrumented vertebra (UIV) during and after surgery and development of PJK have not been quantified.
Methods: Sixty AIS patients (with at least one year follow-up) who underwent posterior spinal surgery were included retrospectively. Global spinal parameters were calculated using three-dimensional (3D) models of the spine, additional parameters (PJK angle (PJKA), cervical lordosis angle (CL)) were measured manually before surgery and at three post-operative follow-ups. The 3D position of the vertebral body centroids was calculated for T1, UIV, and LIV at all time-points. The sagittal position of T1, UIV and LIV were correlated to the CL, PJKA, lumbar lordosis, and pelvic tilt.
Results: The PJKA increased significantly from pre-operative to first erect (FE) and the increase continued during the consecutive follow-ups (Fig. 1). The position of T1 and UIV were significantly more anterior at (FE) for patients who developed PJK. The posterior shift of UIV at last follow-up as compared to the pre-operative position was significant in both the PJK and non-PJK cohort. A larger anterior shift in UIV at first erect correlated with a larger T1 and UIV posterior shift at last follow-up. At the last follow-up a more posterior position of the UIV correlated with a larger angle of PJKA, $p < 0.05$. The lumbar lordosis decreased from pre-operative to FE and increased significantly between FE and all the consecutive follow-ups.
Conclusion: Both a larger anterior shift of UIV between pre-operative and first erect and a more posterior position of UIV at the last follow-up was correlated with a higher PJKA. A larger anterior shift in the position of the UIV after surgery was associated with a higher posterior shift of UIV at the last follow-up. The surgically induced changes in the UIV are an important parameter associated with development of PJK.
Figure legend: The changes in the sagittal profile from pre-operative (grey) and the consecutive follow-ups (black) from first erect (left) to two-year follow-up (right). T1 and the upper instrumented vertebra have moved anterior at first erect and have moved posterior at two-year follow-up. The proximal junctional kyphosis angle from pre-operative to the different time-points is shown.



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