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 aecting the occurrence and timing of mechanical complications together in multifactorial Cox regression and survival models.

MATERIAL-METHODS: Inclusion: ≥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, 146M, 53±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.

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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.

Material 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 a 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.

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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.

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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°. 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 unsatisifying. 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 curves 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.
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.

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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 1-27 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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PREOP

POSTOP

PSEUDARTHROSIS

25 MOS POSTOP
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 (Figure 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.