FM45  Short anterior correction of double major adolescent idiopathic scoliosis compared to standard posterior technique

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**Introduction:** Short anterior correction is an accepted method of treatment for single thoracic curves as well as for single thoracolumbar and lumbar curves in adolescent scoliosis (AIS). For double major curves the standard technique is fusion of both curves from posterior. The purpose of this study was to compare the novel technique of anterior short correction of double major curves to standard posterior pedicle screw instrumentation.

**Methods:** 19 consecutive patients with a double major AIS were treated surgically either by standard posterior pedicle screw instrumentation (n=11) or by anterior short instrumentation (n=8). All patients were followed at least 2 years (mean 5.6±3 years, range: 2 to 10 years) clinically, radiographically and with pulmonary function tests. Patients` satisfaction was assessed with SRS-24 questionnaire.

**Results:** The curves were similar, the upper curves being 54±7° and 59±13°, lower curves being 63±15° and 55±9° in the anterior and posterior group, respectively. The upper curve correction was 77% in the posterior group and 52% in the anterior group. The lower curve correction was 79% in the posterior group and 56% in the anterior group. The amount of fused vertebrae was 7.6±0.7 in the anterior and 12±1 in the posterior group. The preoperative pulmonary function (%FVC) of 70-79% remained unchanged to the last follow-up in both groups. Patients` satisfaction assessed by SRS-24 questionnaire was high in both groups without statistical difference (SRS score range 98-101 at the last follow up).

**Conclusion:** Significantly less motion segments were fused to achieve a satisfactory correction through anterior instrumentation in double major curves of AIS. Pulmonary function and patients` satisfaction were comparable in anterior and posterior techniques.
FM46  Incidence and Risk Factors for Early Adjacent Vertebral Fractures after Balloon Kyphoplasty for Osteoporotic Fractures - Analysis of the SWISSspine Registry

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**Purpose:** The SWISSspine registry was launched in 2005 to assess the safety and effectiveness of balloon kyphoplasty (BKP). In the meantime, repeated reports on high rates of adjacent vertebral fractures (ASF) after BKP of vertebral insufficiency fractures were published. The causes for ASF and their risk factors are still under debate. The purpose of this study was to report the incidence and potential risk factors of ASF within the SWISSspine registry dataset.

**Methods:** The SWISSspine data points are collected perioperatively and during follow-ups, with surgeon- and patient-based information. All patients documented with a monosegmental osteoporotic vertebral insufficiency fracture between March 2005 and May 2012 were included in the study. The incidence of ASF, potential predictors (patient age, gender, fracture location, cement volume, pre- and postoperative segmental kyphosis) and influence on quality of life (EQ-5D) and back pain (VAS) were analysed.

**Results:** A total of 375 patients with a mean follow-up of 3.6 months were included. ASF was found in 9.9% (n=37) and occurred on average 2.8 months after surgery. Preoperative segmental kyphosis >30° was found to be a significant predictor for ASF (p=0.023). Further on, patients with ASF had significantly higher back pain at the final follow-up. No further predictors for ASF were revealed in the adjusted analysis.

**Conclusions:** The findings suggest that patients with a preoperative segmental kyphosis >30° are at high risk of ASF within three months after the index surgery. In case of an ASF event, back pain levels are significantly increased.
FM47 Reduction of cement leakage by sequential PMMA application

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Introduction: Cement leakage is the most common complication of percutaneous cement augmentation of the spine (vertebroplasty/kyphoplasty) which, if present, can cause severe complications like pulmonary embolism. The viscosity of the polymethlymethacrylate (PMMA) cement is one main factor of the aetiology of cement leakages. Different application techniques can influence the viscosity of the PMMA cement using the temperature gradient between body and room temperature. The aim of this study was to evaluate different augmentation techniques ("all-in-one", "2-step","sequential") concerning their ability to avoid cement leakage and concerning optimal cement distribution in a standardized leakage model.

Material and Methods: For this study standardized vertebral body models with a preformed leakage-path, simulating a ventral vein, were used. 3 different injection techniques of 6ml PMMA were defined: "all-in-one" (application of 6ml PMMA in one single step), “2-step” (application of 1ml PMMA within 30s, 1 Min of holding time, application of 5ml PMMA), and sequential (sequential application of 0.5ml PMMA, 1 Min holding time between the application steps). The application was performed via an 8Gauche standard vertebroplasty needle in a 37,5°C water bath at a room temperature of 19°C. Standard PMMA vertebroplasty cement was used (Vertecem+, Synthes, Bettlach, Switzerland). The application was started 4 Min after the mixing process as suggested by the company. The leakage was assessed using a zonal graduation of the applicated cement in a standard x-ray (1:intraspongious (=no leakage), 2: extraspongious/ intracortical (=small leakage), 3: extracortical (=great leakage)). There were two leakage-paths estimated per vertebral body.

Results: There were 10 vertebral body models used per groups. Leakage was significantly reduced in the "sequential" group (2/20 leakages) compared both other groups ("All-in-one" 20/20 leakages , “2-step”: 15/20 leakages) (Chi-Square 36,5; P< 0,0001). Compared to the “sequential” group the risk of leakage (Odds Ratio) was 171-times higher in the "All-in-one"-group, and 27-times higher in the “2-step” group.

Discussion: The sequential cement augmentation is a safe method to avoid leakage in the vertebral body model. Using the temperature gradient between body and room temperature accelerates the polymerization progress of the PMMA cement in the vertebral body. By using sequential application of small cement amounts possible leakage paths were blocked before reapplication of the low-viscous cement. In how far these results are reproducible in clinics is topic of ungoing studies.
FM48  Prophylactic adjacent segment vertebroplasty during kyphoplasty in single segment osteoporotic vertebral fractures – A radiographic analysis

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Introduction: Percutaneous kyphoplasty (PK) is an option to treat painful osteoporotic compression fractures. The most frequently observed complications are adjacent segment fractures (ASF). Little information exists about the benefit of prophylactic cement augmentation of the adjacent vertebrae. Thus, it was the aim of this study to investigate the benefit of prophylactic vertebroplasty (PV) in single segment osteoporotic vertebral fractures treated with PK.

Methods: From January 2007 to August 2012, all consecutive patients treated with PK for painful osteoporotic single segment compression fractures were included for this retrospective study. Patients were treated, according to surgeon’s preference, with PK alone or with additional PV of the adjacent segment(s). General data of all included patients (gender, age, hospital stay, fracture level, complications) was taken from medical records and operation protocols. The radiographic assessment consisted of plain lateral radiographs preoperatively, immediately postoperatively, at 3 months and at final follow-up. The fractures were classified analog to the AOSpine classification system and the segmental kyphosis angle was measured on each radiograph. The occurrence of new vertebral fractures was assessed for patients with and without PV.

Results: A total of 60 patients met the inclusion criteria. 2 patients died and 7 patients had incomplete follow up. 52 (87%) patients (45 females) with a mean age of 73.5 years (rage Y-Y) and a mean total follow-up of 401 days (range) were included for the analysis. In most of the patients (71%) the fracture was between Th10 and L2. 23 patients were treated with PV and 29 with PK only. The two groups did not differ significantly concerning age, gender, hospital stay, fracture location, segmental kyphosis, follow-up and complications.

Comparing the two groups: a fracture through the primary treated vertebra (kyphoplasty) was found in 5 (22%) of the PV and in 3 (10%) of the PK group (p=0.1). An ASF was found in 43% (10 pat.) of the PV and in 21% (6 pat.) of the PK group (p=0.07). Remote fractures occurred in 1 (4%) patient of the PV and in 4 (14%) patients in the PK group (p=0.7).

Conclusion: Prophylactic vertebroplasty of adjacent vertebra could not lower the risk of ASF in patients with single segment osteoporotic vertebral fractures. Therefore it’s benefit is questionable considering possible complications and higher costs.
FM49 The patient’s perspective on the outcome of surgery for lumbar degenerative scoliosis.

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Introduction: The treatment of degenerative lumbar scoliosis (DLS) represents an increasing challenge, with the demand for surgery rising but the indications for appropriate treatment remaining controversial. Most studies to date have only examined outcome from the clinical and radiological perspective; few have evaluated patient-orientated outcomes. We examined patient outcomes in a consecutive series of patients being treated for DLS by simple decompression, limited fusion, or full correction with longer constructs.

Material and Methods: Our local spine surgery database (part of the Eurospine Spine Tango Registry) was used to acquire the data from patients with DLS as the main pathology undergoing first-time surgery at least 12 mo ago, using decompression (D) and/or fusion (F) as the operative procedure. Pre-operatively and at 12 mo follow-up (FU), patients completed the multidimensional Core Outcome Measures Index (COMI; 0-10); at 12 mo FU, global outcome was rated on a Likert-scale and dichotomised as “good” and “poor”.

Results: 175 patients took part (121 (69%) women, 54 (31%) men). 83/175 (47%) patients underwent D alone at 1 to 5 levels (mean±SD, 2.2±0.8 levels), while 92/175 (53%) patients underwent F of 1 to 7 levels (2.6±1.5), 79% with D and 21% without. 53 patients had short F (1-2 segments) and 39 had long F (≥3 segments). The D group was significantly (p<0.0001) older (76±7y) than the F group (66±11y) and had higher comorbidity (p=0.0001). All groups benefited significantly from surgery without significant difference between them: improvement in COMI was 3.2±2.9 for D, 3.5±3.1 for short F and 3.2±3.2 for long F (p=0.84); good global outcome was 68% for D, 79% for short F and 78% for long F (p=0.39). Patient-rated complications were not significantly different between the groups (p=0.99).

Discussion: Despite the high complexity of the disease, patient-orientated outcomes were similar to those reported using the same instruments in conditions such as lumbar stenosis and degenerative spondylolisthesis. There was a tendency for better results in the short fusion patients; this should be further investigated in larger groups. In conclusion, both decompression and fusion for DLS yielded similarly good results from the patient’s perspective. This most likely reflects careful and appropriate patient selection. Further analyses are warranted to identify baseline variables predicting the 20-30% cases with poor outcome.
Relationship between sedimentation sign and morphological grade in symptomatic lumbar spinal stenosis

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Introduction: There is no consensus on the radiological classification of lumbar spinal stenosis (LSS). Dural sac cross sectional area has been the main radiological measurement used in clinical practice but it does not always correspond to the degree of entrapment of the neural structures. The morphological grading of stenosis based on the rootlet/cerebrospinal fluid relationship as seen on axial MRI images and comprised of 4 grades (A to D) has been shown by its proponents to carry a prognostic value with C and D grades being strong predictors of failure of conservative measures. Simultaneously another research team described the sedimentation sign, measured also on axial MRI images but at the level of the pedicle adjacent to the maximal stenosis level with a view to discriminate patients with neurological claudication from asymptomatic subjects. The aim of the present study was to find the relationship between those two radiological descriptions.

Material and methods: A total of 137 patients divided in three groups were included in this study. The first two groups comprised 110 patients with symptomatic LSS of whom 69 were treated surgically and 41 conservatively. A control group of 27 subjects with low back pain and no claudication (LBP) constituted the third group. We examined MRI images using Osirix software and studied the morphological grade of stenosis at disc level and looked for evidence of positive sedimentation sign, the latter being measured above or below the level of maximal stenosis, at pedicle level.

Results: No patient with grade A morphology had a positive sedimentation sign, while it was present in 58% of those with grade B stenosis. In patients with grade C and D stenosis the sedimentation sign was positive in 69% and 76% of cases respectively.

The sedimentation sign was positive in 66% (46/69) of the surgically treated patients, in 39% (16/41) of the conservatively treated patients and only in 8% (2/25) of the LBP patients.

Comparing patients with symptomatic LSS (both surgically and conservatively treated) and LBP subjects, we found that the presence of a sedimentation sign in the LSS group has a sensitivity of 56%, a specificity of 93%, a positive predictive value 97% and a negative predictive value of 34%. The presence of a positive sedimentation sign carried an odds ratio (OR) of 16 between those two groups.

In the group of patients with LSS who were either treated surgically or conservatively the presence of a sedimentation sign in the surgical group carried a sensitivity of 66%, a specificity of 60%, a positive predictive value 74 % and a negative predictive value of 52%. The positive sedimentation sign carried an OR of 3.13 between the two LSS groups.

We found the presence of C or D morphological grades in 97% (67/69) of the surgical group, in 41% (17/41) of the conservative group and in 18% (5/27) of the LBP group. The presence of a C
or D grade was a strong predictor of surgical treatment in the LSS group with an OR of 47 (P<0.001).

**Discussion:** In this cohort of patients we found that the presence of a C or D stenosis grade was a stronger predictor of failure of conservative treatment than the presence of a positive sedimentation sign. Even though the sedimentation sign might be useful in identifying patients belonging to a claudicating or non-claudicating population, it might be less useful in deciding which patient needs surgical treatment. Additionally, since it is measured at pedicle level it is probably not suited in deciding which levels need to be surgically decompressed.
**FM51 ALIF L5/S1 with stand-alone-cages: long term follow up**

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**Introduction:** Anterior lumbar interbody fusion (ALIF) is associated with low approach-dependent morbidity and shows good mid-term results (1). Few long-term results have been published, especially for stand-alone cages.

**Material/Methods:** In a retrospective study, all patients who had undergone monosegmental ALIF L5/S1 from 2003–2008 were clinically and radiologically re-assessed. Two different cages with and without fixed angle (SynFix (SF)/ Syncage (SC) both Synthes, Switzerland) fixation were used as stand-alone implants. Radiological analysis concerning bony fusion and adjacent segment degeneration (ASD) was assessed using standard radiographs including functional x-rays. For clinical outcome assessment standard questionnaires of the Spine Tango data bank (ODI, SF-12, EQ-5D, COMI) and a questionnaire based on Grob et al (2) was used.

**Results:** 54 patients could be included in the study (mean age 49.3 years ± 11.1, range 25 – 84, male: 28, female: 26). Mean follow-up-time was 55.87 months (±18, range 28 – 102). Signs of stable bony fusion was observed in 92.3% (48/52) of the patients. In the functional x-rays 95.9% (47/49) were judged as stable. Radiological signs of ASD, in terms of decreasing disc height, was found in 17% (8/47). The revision rate during the FU period was 12.5% (7/54) (3x pseudarthrosis L5/S1, 1x persisting remaining disc protrusion L5/S1, 1x unclear persisting radicular pain without radiological correlation). Symptomatic ASD caused re-intervention in 2 cases. Compared to pre-operative, at final follow-up back pain improved in 89%, leg pain in 93% of patients. 82% stated global subjective improvement. 93% would undergo the surgery again. In some sub-items (SF-12: body pain; COMI: postoperative leg pain (Wilcoxon = 0.020), Grob: quality of life (Fisher = 0.023) + work ability (Fisher = 0.009)) the outcome in the SF group was significantly better compared to the SC group. There was no correlation between radiological and clinical outcome.

**Discussion:** Stand-alone monosegmental ALIF L5/S1 shows favorable long-term results. Fusion rate is high. The rate of re-operations, especially caused by symptomatic ASD, is low. No correlation between radiological fusion and clinical outcome could be shown. Results are good concerning postoperative development of pain, quality of life and work status. Even though a tendency towards better results SF group could be show, due to the small sample number in the subgroups these findings should be interpreted carefully. The relevance of fixed-angel fixation of stand alone cages for the long-term outcome, as discussed before studies (1), should be evaluated in larger cohort studies.


Introduction: Chronic LBP (cLBP) is a complex and poorly understood problem and its management represents a major challenge to our healthcare systems. The relative efficacy of surgery over non-operative care for the treatment of cLBP remains controversial, and little is known of the long-term outcomes. This study compared the clinical outcome at long-term follow-up (LTFU) (average 11.4 (range 8-15) years) of patients who were randomized to either spinal fusion or non-operative treatment in three multicentre randomized controlled trials.

Methods: Participants were 473 patients with cLBP of at least 1 year’s duration who were all considered candidates for spinal fusion. Treatment comprised lumbar spine fusion (instrumented or non-instrumented) or non-operative treatment (multidisciplinary cognitive-behavioral and exercise rehabilitation program). The primary outcome was the Oswestry Disability Index (ODIv2.1) score measured at LTFU. Secondary outcomes included VAS pain scales, pain frequency, pain medication use, work status, quality of life (EQ-5D), satisfaction with care, and global treatment outcome.

Results: 140/242 patients randomized to receive surgery and 121/231 randomized to receive non-operative care were available for LTFU. The intention-to-treat analysis showed no statistically or clinically significant differences between treatment groups for ODI scores at LTFU (adjusted for age, sex, smoking habit, previous surgery, duration of LBP and baseline ODI): the mean adjusted treatment effect of fusion was -1.4 points on the 0-100 ODI scale (95% confidence interval, -6.2 to 3.4). An as-treated analysis similarly demonstrated no advantage of surgery (treatment effect, -0.6 points on the ODI (95% CI, -5.8 to 4.5). There were no significant group differences for any of the adjusted values for the secondary outcomes.

Discussion: After an average of 11 years follow-up, there was no difference in patient self-rated outcomes between fusion and non-operative treatment for cLBP. The results suggest that, given the increased risks of surgery and the lack of deterioration in non-operative outcomes over time, the use of lumbar fusion in cLBP patients should not be favored in healthcare systems where combined physical and psychological programs are available.
FM53  What score on the Oswestry Disability Index indicates a satisfactory symptom state?

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Introduction: The achievement of a given change-score, e.g. a 15-point reduction on a 0-100-scaled instrument, is often used to indicate clinically-relevant change after spine surgery. However, the achievement of such a change 1) depends on the initial preoperative score and 2) does not indicate whether a satisfactory symptom state is ultimately reached. The achievement of an absolute score equivalent to a satisfactory symptom state may be a more stringent measure of success; we quantified this score for the Oswestry Disability Index (v2.1).

Methods: 532 patients undergoing lumbar spine surgery completed the ODI and the Core Measures Outcome Index (COMI) at various times up to 4y after surgery. The COMI item: “if you had to spend the rest of your life with the symptoms you have right now, how would feel about it?” was responded to on a 5-point Likert scale from “very satisfied” to “very dissatisfied”. Two receiver operating characteristics (ROC) analyses were used to derive cut-off scores for ODI that best predicted being 1) at least “satisfied” and 2) “very satisfied” with the symptom state.

Results: 114/532 (21%) patients were “≥satisfied” and 43 (8%) “very satisfied” with their symptom state. The ROC area under the curve was 0.89 (95% CI, 0.86-0.92) for “≥satisfied” and 0.94 (95% CI, 0.92-0.96) for “very satisfied” indicating the ODI discriminated well. The ODI-score cut-off predicting a “≥satisfied state” was ≤ 29 points (sens, 88% and spec 75%) and a “very satisfied state”, ≤ 14 points (sens, 86% and spec 89%).

Discussion: Whilst change scores show the achievement of improvement after surgery, they may give a more optimistic view than when the proportion of patients achieving a satisfactory state is examined. In the absence of valid “norm values” for condition-specific questionnaires, the % patients reaching an ODI score equivalent to a satisfactory/very satisfactory state might represent a more appropriate criterion when assessing the success of surgery.
FM54 Perforations and Bacterial Contamination of Microscope Covers after Spine Surgery

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**Background:** Recent studies pointed out the possible role of bacterial shedding by surgical microscopes. The aim of this study was to determine the integrity of microscope covers after spinal surgery and to assess a possible correlation with the amount of bacterial contamination.

**Methods:** A prospective study of 25 consecutive spinal interventions with the use of a surgical microscope was performed. To assess for potential perforations of the microscope covers, these were filled with water after surgery and the presence of water leakage in three zones (objective, ocular, control panel) was documented. Microbiological smears were taken from each of the covers at the same locations before and after surgery. To determine our institution's wound infection rate after decompressive spinal surgery with use of a microscope, we retrospectively identified 265 patients that had undergone these interventions during the two years preceding the aforementioned investigation.

**Results:** One small perforation in 1/25 covers was observed which did not lead to bacterial contamination; 3/75 smears from 25 covers showed postoperative bacterial contamination, two in the ocular zone and one in the optical zone, without proof of a cover perforation. The infection rate in our clinical series of 265 patients was 1.1%.

**Conclusions:** Both, the rate and quantity of contamination and especially the occurrence of cover perforation were rather low. Infections after decompressive spinal surgery with use of a microscope were rare. Thus, the use of a surgical microscope with a foil cover is associated with an acceptable risk of infection.
**FM55 The lumbar Spines of Professional Beach Volleyball Players - High Incidence of Spondylolysis**

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**Background:** Beach volleyball is an Olympic overhead sport since 1996. Many professional players suffer from low back pain. It is not much known which clinical and imaging findings are normal and which are associated with symptoms.

**Hypothesis:** Due to the high rate of low back pain in professional beach volleyball players there is a high incidence of pathological findings in the magnetic resonance tomography, such as degeneration of the intervertebral discs, injuries, pars fractures and spondylolysis compared to the normal population.

**Study Design:** Cross-sectional study

**Methods:** During the Beach Volleyball Grand Slam 2012 Tournament in Klagenfurt, Austria, 29 professional male players underwent a questionnaire-based interview (Roland Morris, SF 36) and a complete physical and neurological examination of their spine, including a MRI of their lumbar spine.

**Results:** The mean age of the athletes was 28.2 years. 86.2 % suffered low back pain, 62.1% during the last year, and 31% during the last 4 weeks. The intensity of pain, rated with the visual analogue scale (VAS 0-10 points) was median 3 points. 25 of 29 (86%) players showed degeneration of intervertebral discs (Pfirrmann Grade > II). Spondylolysis was found in 6 of 29 (13.8%) players. 5 of these 6 had a defect of the pars interartikularis in LWK 5. 6.9% showed a spondylolisthesis Meyerding Grade I.

Only 21% used NSAR on a regular basis, 50 % underwent medical treatment such as PT. All players were fully competitive at the time of examination.

**Conclusion:** The prevalence of spondylolysis and degeneration of the intervertebral disc in professional beach volleyball players is 13.8 %, respectively 86%. This is significantly higher than in the normal aged matched population. Most of the examined, fully competitive players, have suffered low back pain but only few had to intermit training or tournament caused by pain. Therefore, abnormal clinical and imaging findings in the lumbar spine of beach volleyball players should be interpreted with care.

**Keywords:** lumbar spine, degeneration, lower back pain, professional; sports injury; overuse; volleyball; beach volleyball;
FM56 Clinical & radiological mid-term results of pedicle subtraction osteotomy in 7 patients with previous single level lumbar surgery and global sagittal imbalance

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Introduction: Sagittal balance of the spine is a concept which allows a global biomechanical approach of spinal pathologies. Recent literature has defined different spino-pelvic balance groups, inferring appropriated therapeutic approaches. In this prospective series of 7 patients we outline how disregarding spine balance during previous “simple” lumbar surgery has led to serious pain and disability, necessitating complex corrective surgery a few years later.

Method: 7 patients were admitted for monitored pedicle subtraction osteotomy (PSO) and long fusion for invalidating low back pain (LBP) and global sagittal imbalance as measured by several spino-pelvic parameters including spino-sacral angle (SSA). All had undergone previous posterior single level lumbar decompression and/or fusion, within the last 5 years, and retrospectively felt no improvement. Various perioperative parameters were analyzed. Oswestry disability Index (ODI) and LBP VAS questionnaires were filled up preop and at latest follow up (FU). Radiologic parameters of sagittal balance and magnitude of correction were compared between preop and latest FU, on standing full-spine low-dose XR.

Results: 7 patients undergoing a PSO were included for analysis, mean age 66 (57-78), 6 women, 1 man. Latest mean follow-up was 10 month (range 6-24m). Mean OR time was 383min (210-540), mean estimated blood loss (EBL) 2008ml (360-3500). Mean preop ODI was 65%, mean postop ODI was 32% (p<0.05). Mean preop LBP VAS was 8.6/10, postop 2.7/10 (p<0.05). Mean preop spino-sacral angle (SSA: holistic measure of sagittal balance) was 109°, mean postop 123° (normal=130°+/−8°), showing restoration of balance. Complications: one patient suffered from ischemic cervical myelopathy with an EMS score of 13/16 (mild impediment), all the others from anemia necessitating blood transfusion. One patient has persistent LBP and insufficient lordosis correction with pseudarthrosis and will need further surgery.

Discussion: Spinal sagittal balance is a capital factor not to be ignored when planning spine surgery. Failure to take it into account can lead to short time benefit, functional deterioration and the need for significant complex corrective surgery as in these 7 patients. Restoring their sagittal balance was correlated with functional and symptom improvements of the patients at 10 month FU.