**Abstracts of the 25th Annual Meeting of the Swiss Society of Spinal Surgery (SGS)**

# Rapid Fire Session

### Comparison of Sagittal Spinal Alignment of Patients with symptomatic Lumbar Spinal Stenosis with Healthy Controls: A Systematic Review and Meta-Analysis

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**Objective:** Symptomtatic lumbar spinal stenosis (sLSS) is associated with changes in spinal posture. However, exact differences in sagittal spinal alignment compared to healthy controls remain unclear. The aim of this study was to systematically review the literature and summarize sagittal spinal alignment parameters in patients with sLSS and healthy individuals.
**Methods:** A systematic literature search was conducted using Embase, Medline, and the Core Collection of Web of Science. Two-armed studies reporting sagittal alignment parameters measured in standing position using radiography in patients diagnosed with LSS and in healthy control groups were included. For the meta-analysis, pooled estimates were calculated using a random-effects model, and heterogeneity was assessed using the $I^2$ statistic.
**Results:** Overall, eleven studies were included, comprising 674 patients with sLSS and 734 healthy controls. Compared to controls, patients with sLSS had significantly:
- Smaller lumbar lordosis: Mean difference = -8.9°, 95% CI [-12.9, -5.0]; $I^2$ = 85%
- Smaller sacral slope: Mean difference = -5.2°, 95% CI [-9.1, -1.3]; $I^2$ = 93%
- Greater pelvic tilt: Mean difference = 7.3°, 95% CI [4.7, 9.9]; $I^2$ = 87%
No significant difference was found in pelvic incidence: Mean difference = 1.3°, 95% CI [-1.9, 4.6]; $I^2$ = 84%.
**Conclusion:** This meta-analysis shows that patients with sLSS exhibit characteristic changes in sagittal alignment, including reduced lumbar lordosis and sacral slope, and increased pelvic tilt. These findings suggest compensatory pelvic retroversion aimed at maintaining sagittal balance despite spinal pathology. The absence of significant change in pelvic incidence indicates functional, not structural, adaptation.
However, high heterogeneity across studies limits generalizability and points to the need for standardized research. Understanding these alignment changes is clinically relevant for both diagnosis and treatment planning in sLSS patients.

### Pre-to postoperative changes in trunk kinematics reflect changes in paraspinal muscle activity in patients with lumbar spinal stenosis

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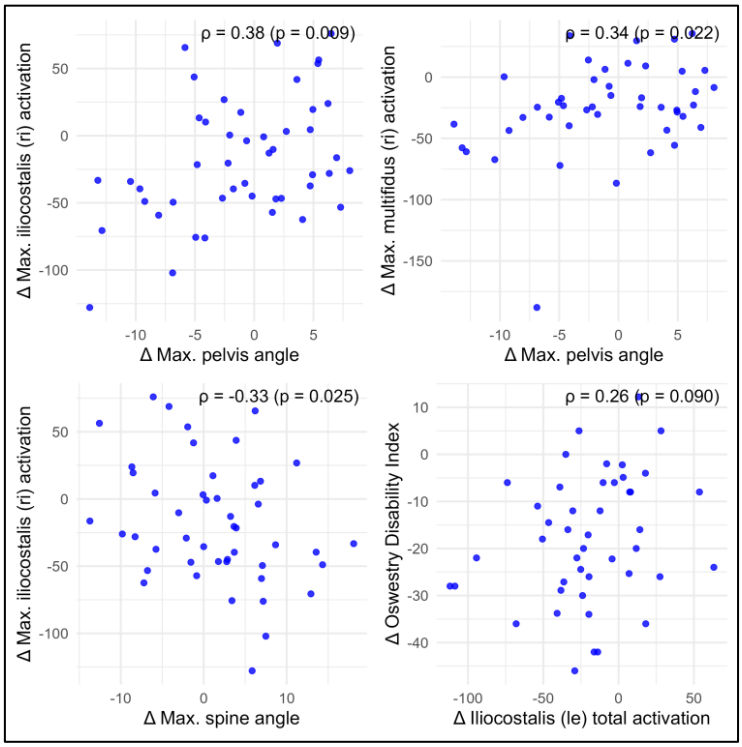
**Objective:** Surgical outcomes in patients with lumbar spinal stenosis (LSS) often focus on symptom relief. Limited research has addressed changes in trunk kinematics and paraspinal muscle activity during

gait following surgery. We aimed to assess pre- to postoperative changes in symptoms, trunk and pelvis kinematics, paraspinal muscle activation patterns, and explore associations between changes.
**Methods:** 54 patients with LSS (34m/20w; age 70.7±10.0 years; BMI 26.5±4.4 kg/m²) underwent gait analysis and completed the Oswestry Disability Index (ODI) questionnaire 11±12 days preoperatively and 1-year postoperatively (378±24 days). Kinematic data were recorded using a 3D motion capture system, and electromyography (EMG) was used to assess muscle activation of the longissimus, iliocostalis and multifidus muscles. EMG signals were normalized to peak activation during a modified Biering-Sörensen test at each visit. Maximum and range of motion (ROM) were extracted for thorax, spine, and pelvis angles. EMG variables included maximum and total activation (integrated signal over whole gait cycle). Pre- vs. postoperative differences were tested using Wilcoxon signed-rank tests. Associations between pre- to postoperative changes (Δ) were assessed using Spearman's rho (ρ).
**Results:** Postoperative assessments revealed significant decreases in ODI total score (median difference -19, p<0.001) and increases in ROM for the pelvis (+0.1°, p=0.039), thorax (+0.1°, p=0.008), and spine (+0.5°, p=0.001). Total muscle activation of all paraspinal muscles decreased significantly (left iliocostalis: -20%, p<0.001; left longissimus: -17%, p<0.001; left multifidus: -17%, p<0.001). Correlation analysis revealed positive associations between changes in maximum pelvis angle and changes in maximum activation of the right iliocostalis and multifidus (ρ=0.38; ρ=0.34), and negative associations between spine angle and right iliocostalis (ρ=-0.33). Change in ODI score was neither significantly associated with change in kinematics nor muscle activation (Fig. 1).
**Conclusion:** Changes in pre-to postoperative muscle activation were associated with pelvis and spine angle, but not thorax angle, suggesting that pelvic motion plays a key role in modulating muscle activity during gait after surgery.




**The Impact of Ambient AI on Clinical Documentation: A New Era in Medical Record-Keeping**

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**Objective:** Clinical documentation imposes a significant administrative burden on healthcare professionals. Physicians spend a considerable amount of time entering data into EHRs, reducing their

time with patients, increasing the risk of burnout and contributing to medical errors. To address these challenges, innovative solutions such as ambient artificial intelligence (AI) scribes have been developed. These tools automate clinical documentation by transcribing and summarizing physician-patient interactions, allowing clinicians to focus more on patient care.
**Methods:** We conducted a comparative study involving two groups of physicians in our department of orthopedic surgery, HFR-Fribourg. The first group followed a traditional consultation and documentation workflow, including dictation, manual transcription, letter typing, and subsequent corrections. The second group utilized an ambient AI-powered system to assist in real-time documentation. We compared both approaches based on three key parameters: Cost efficiency, time to report completion and documentation quality.
**Results:** Our findings demonstrated a time savings of 14 to 20 minutes per report when using the AI-assisted system compared to traditional dictation. Additionally, the AI-driven approach resulted in a 94% reduction in costs. The reports generated by the AI system were of high quality, requiring minimal corrections, confirming the reliability and usability of AI-driven documentation.
**Conclusion:** The results of this study highlight the superiority of AI-assisted documentation over traditional methods. With lower costs, significant time savings, and improved workflow efficiency, AI-powered solutions allow physicians to devote more time to direct patient care rather than administrative tasks. The quality of the AI-generated reports was high, ensuring accurate and comprehensive documentation. Furthermore, the redistribution of secretarial tasks emerges as a critical advantage, as secretarial staff can be reassigned to more strategic or patient-centered administrative functions. However, it is essential to implement oversight mechanisms to ensure the accuracy, reliability, and security of AI-driven documentation systems. Continuous monitoring and evaluation of AI development are necessary to, maintain quality control, and safeguard patient confidentiality. Future research should focus on refining AI models, assessing long-term adoption.

### Machine Learning–Based Prediction of In-Hospital Mortality in Spondylodiscitis: A Multicenter Retrospective Analysis

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**Objective:** Spondylodiscitis is a severe spinal infection characterized by a heterogeneous clinical presentation and significant in-hospital mortality. Current risk stratification tools offer limited predictive power. This study investigates the potential of machine learning to identify predictors of in-hospital mortality using routinely collected clinical data.
**Methods:** In this retrospective multicenter study conducted across five European centers between 2018 and 2023, clinical data from 191 patients diagnosed with spondylodiscitis were analyzed . After excluding cases with missing survival outcomes, 170 patient datasets were included for model development . A random forest classifier was trained to predict binary in-hospital mortality based on 15 clinical variables, including age, BMI, Systemic Inflammatory Response Syndrome (SIRS) und Quick Sequential Organ Failure Assessment (QSOFA), active malignancy, diabetes, drug and steroid use, and treatment modality. The dataset was randomly split into training (75%) and test (25%) sets. Model performance was assessed using accuracy on the held-out test set, and feature importance was evaluated via mean decrease impurity and permutation-based analysis.

**Results:** The model achieved an accuracy of 76.7% on the test set, indicating moderate predictive performance. Key predictors of in-hospital mortality included age, BMI, QSOFA score, active cancer, alcohol use, diabetes, and treatment type. While treatment modality was not among the top-ranked features , it contributed to model accuracy. The confusion matrix revealed 32 true positives, 1 true negative, 10 false negatives, and 0 false positives. Attempts to predict hospital length of stay resulted in poor performance (accuracy: 20%), highlighting the need for additional data or alternative modeling approaches for this outcome.
**Conclusion:** This study demonstrates that a machine learning approach using routinely available clinical variables can moderately predict in-hospital mortality in patients with spondylodiscitis. These findings support further refinement and prospective validation of the model to enhance clinical decision-making and individualized risk assessment.

**Power-Drill Fluoroscopy-Controlled Freehand vs. Navigation-Assisted Pedicle Screw Placement: A Propensity Score-Matched Retrospective Cohort Study**

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**Objective:** Precision in spinal instrumentation is critical in preventing neurological injury and hardware failure. While freehand (FH) and navigation-assisted (NA) techniques are well-studied, power drill-assisted methods remain underreported. This study compares the accuracy of power-drill fluoroscopy-controlled FH (PFH) versus power-drill fluoroscopy NA-assisted pedicle screw placement.
**Methods:** This propensity score-matched retrospective cohort study evaluated PFH versus NA pedicle screw insertion in degenerative thoracolumbar spinal pathologies. Only patients with postoperative CT scan were included.. Pediatric, cervical, and non-degenerative cases were excluded. Matching was based on demographic variables. Accuracy was assessed and dichotomized using CT-based Gertzbein-Robbins classification (A=accurate, B–E=inaccurate), comparing complication rates and surgical parameters. A generalized linear mixed model was utilized for within-patient clustering to estimate accuracy determinants.
**Results:** Among 1,102 screened cases, 528 had follow-up CT imaging. A total of 49 patients (314 screws) in the PFH and 61 patients (262 screws) in the NA were identified. Stratified per patient, screw inaccuracies were higher in the NA group (31% vs. 19%). Thirty-five patients per group have been matched in the final analysis (224 vs. 154 screws). PFH demonstrated higher screw accuracy (Gertzbein Robbins A: 94.3% vs. 84.3% and 91.4% vs. 85.3%, $p<0.01$, pre- and postmatched) and a 66.7% lower likelihood of any revision surgery on 12 months follow-up (5.71% vs. 17.14%, $p=0.26$) compared to NA. Radiation dose (mGy·cm²) was 65% lower in PFH compared to NA (8,378.43±5,302.08 vs. 23,793.02±13,161.81, $p<0.0001$). Pedicle screws were found to be longer in the PFH group (5.08±0.54 vs. 4.9±0.44; $p<0.001$), while osteoporosis was associated with lower screw accuracy (OR 0.43, 95%CI 0.2-0.92; $p=0.02$).
**Conclusion:** PFH pedicle screw placement demonstrates higher overall accuracy compared to NA-assisted techniques with less radiation exposure in our cohort. PFH seems to be a viable, effective alternative to NA with reduced dependency on advanced imaging systems.

**Long-term Surgical and Radiological Outcomes Following Posterior Carbon fiber/PEEK Instrumentation for Thoracolumbar Spinal Metastases: A Retrospective Cohort Analysis of 66 case**

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**Objective:** Spinal metastases with symptomatic instability or epidural spinal cord compression (MESCC) often necessitate surgical intervention for stabilization and neurological preservation. Carbon fiber-reinforced polyetheretherketone (CF/PEEK) implants offer radiological advantages and promising biomechanical properties. Long term results on this implants are raley reported. This study evaluates the safety, efficacy, and outcomes of CF/PEEK-based posterior instrumentation in a heterogeneous cancer population.
**Methods:** A retrospective review of 66 patients who underwent posterior stabilization with CF/PEEK constructs for thoracolumbar spinal metastases between 2014 and 2018 was conducted. Lesion distribution included mostly the thoracic spine (63%). Primary tumors were heterogeneous, including multiple myeloma (12%), lung (12%), prostate (10%), and breast cancer (10%). The mean age was 64.6 ± 12.3 years, and 67% of patients were male. The average Spinal Instability Neoplastic Score (SINS) was 11.0 ± 2.8, with 83% of patients rated as (potentially) unstable. Instrumentation types included carbon fiber-reinforced rods in 63% of cases, titanium rods in 24%, and hybrid constructs in 1%. Ventral stabilization was additionally performed in 69% of patients. The median number of stabilized spinal segments was 4 (IQR 3–5), perioperative and oncological outcomes were assessed, including blood loss, operative time, fusion grades, hardware-related complications (e.g., screw loosening), and local tumor recurrence.
**Results:** Mean follow-up was 23 months [Range 0.5-152]. Postoperative fusion assessment showed the majority of patients achieved posterior grade 2–3 fusion (57%). Hardware complications were reported in 14% due to screw loosening, but no mechanical implant failures occurred. The overall minor and major complication rate was 69%, while 4% experienced excessive bleeding and 1% CSF leak. Local recurrence occurred in 22% of patients. Reoperations occurred in 6–11%, most commonly due to local recurrence or new spinal lesions.
**Conclusion:** Compared to other studies we could show higer complication rates with screw loosening in 14%, indicating persistent challenges in osteolytic environments, espacially in the longer term. CF/PEEK-based instrumentation offers a safe and functionally effective option for surgical stabilization in spinal metastases, with acceptable complication and hardware-related failure rates.

## Reconstructing the Past: Innovative Surgical Approaches for the Management of Kummell's Syndrome

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**Objective:** Kummell's syndrome, characterized by avascular necrosis following osteoporotic vertebral fracture, poses a significant challenge to surgeons, particularly in the treatment of vertebral deformities and associated chronic pain. Traditionally, vertebroplasty with bone cement has been used in the treatment, but it can exacerbate necrosis and does not restore bone structure. Therefore, we propose an innovative technique based on the use of osteoinductive materials aimed at regenerating bone tissue and stabilizing the vertebra.
**Methods:** We analyzed the outcomes obtained at our Institute in 11 patients who presented with highly symptomatic lumbar osteoporotic fractures type OF4, showing radiological signs of intravertebral avascular necrosis. The patients underwent a combined kyphoplasty procedure where, first, trabecular titanium spheres reconstructed by 3D printing with osteoinductive capacity (MT-Ortho Spheroplast) were inserted into the vertebra via a transpedicular approach to recreate the bone structure. This was subsequently reinforced with monosegmental fixation using the Safeorthopaedics Sycamore system. Clinical and radiological follow-up was currently conducted at 10 months, based on pain reduction (VAS scale), functional improvement (ODI index), and restoration of vertebral stability (radiological imaging).
**Results:** All patients reported significant pain reduction at 6 weeks post-op, with VAS scores decreasing from a preoperative mean of 7 (+/-1) to 2 (+/-1), remaining stable at 3 months. Vertebral height restoration was achieved in 90% of cases, but among these, 55% (6/11 cases) showed morphological worsening of kyphosis during follow-up, with one case requiring surgical revision. No significant

intraoperative complications were observed. From 3 months post-op, osteoblastic colonization with signs of fusion on X-ray and CT was visible, with complete fusion at 6 months.
**Conclusion:** This technique represents an innovative approach to managing Kummell's syndrome, overcoming the limitations of traditional vertebroplasty. The use of osteoinductive materials offers a dual benefit: bone regeneration and reduced risk of secondary avascular necrosis. However, large-scale application requires randomized clinical trials and long-term follow-up to confirm its efficacy and safety. Notably, radiological data showed progression of dorsolumbar kyphosis post-surgery, although it was asymptomatic.

**Sex Differences in Traumatic Spine Injuries: A Combined Retrospective and Scoping Review**

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**Objective:** Sex differences in medical conditions such as cardiovascular disease and drug response are increasingly recognized, but their relevance in spinal trauma remains poorly understood. While young men are more frequently affected by high-energy trauma, older women may sustain fractures due to lower bone quality. This study aimed to investigate sex differences in epidemiology, fracture characteristics, treatment, and outcome reporting in spinal trauma.
**Methods:** We conducted a retrospective cohort study over a 10-year period at a Swiss Level-1 trauma center, including 2,473 patients with traumatic vertebral fractures. Data included age, sex, fracture localization, severity, Hounsfield units (HU) on CT, and treatment modality. A complementary scoping review screened 5,177 studies on thoracic and lumbar burst fractures (AO types A3/A4), based on predefined inclusion criteria. The PCC framework guided assessment of sex as an analytic variable.
**Results:** Among the 2,473 patients, 65% were male and 35% female, with mean ages of 46 and 51.5 years, respectively. Women were more frequently affected in the occipitocervical (C0–C2) and thoracolumbar (T10–L2) regions, while men had more injuries in the subaxial cervical spine (C3–C7). Men were 1.25 times more likely to receive surgical treatment, although we tested as a cofounding factor that men sustained more severe fractures ($p<0.001$). Bone quality assessed by HU on CT was significantly lower in women ($p < 0.05$), and lower HU was associated with a higher likelihood of surgical therapy ($p < 0.001$). The scoping review revealed a strong underrepresentation of sex-specific analysis: only 2 of 301 included studies (less than 1%) reported sex-based differences in outcomes. Preliminary data also suggest that men had more severe injuries, while women more often received conservative treatment despite poorer bone quality.
**Conclusion:** Sex differences in spinal trauma are evident in fracture patterns, bone density, and treatment decisions. Women had poorer bone quality yet were less likely to undergo surgery. Men had more high-impact injuries and more frequently received surgical treatment. The literature shows a striking lack of sex-specific analysis, underlining the urgent need for further research to improve personalized and equitable treatment strategies.