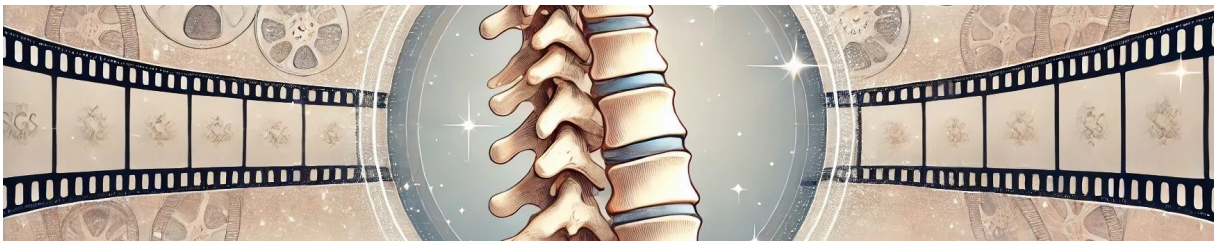

Abstracts of the 25th Annual Meeting of the Swiss Society of Spinal Surgery (SGS)

Clinical Research

Bone Health Optimization Before Spine Fusion: A Targeted Review of Evidence-Based Preoperative Strategies

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Objective: Osteoporosis and low bone mass are highly prevalent yet underdiagnosed among patients undergoing spine fusion surgery. Poor bone quality is a significant risk factor for pseudarthrosis, hardware failure, adjacent segment fractures, and revision surgery. Despite these risks, preoperative bone health assessment and treatment remain inconsistently applied in clinical practice. The aim of this review was to synthesize current evidence and guidelines regarding bone health optimization prior to spine fusion surgery and provide a practical protocol for risk assessment, diagnostic evaluation, and therapeutic intervention.
Methods: We conducted a targeted review of peer-reviewed literature (2015–2025) including clinical guidelines, consensus statements, systematic reviews, meta-analyses, and cohort studies relevant to bone health in spine surgery. Key sources included the Congress of Neurological Surgeons (CNS) guidelines, expert consensus from spine societies, and high-quality meta-analyses on pharmacologic treatments.
Results: Recent evidence supports the routine screening of spine surgery candidates ≥65 years old, or ≥50 with clinical risk factors, using DXA (Dual-energy X-ray absorptiometry) and/or opportunistic CT-based vertebral Hounsfield unit analysis. Vitamin D deficiency should be corrected preoperatively. Anabolic agents such as teriparatide are associated with significantly improved fusion rates and lower screw loosening rates in osteoporotic patients, with meta-analyses demonstrating superiority over antiresorptives in fusion-related outcomes. Non-pharmacologic interventions (e.g., calcium/vitamin D supplementation, smoking cessation, nutritional support) are foundational. The implementation of structured bone health optimization protocols has been shown to substantially increase the rates of preoperative screening and treatment.
Conclusion: Bone health optimization is a modifiable, evidence-supported strategy to reduce complications and improve outcomes in spine fusion surgery. A systematic approach incorporating risk screening, BMD (bone mineral density) assessment, and targeted therapy—initiated preoperatively and continued postoperatively—should be integrated into routine surgical planning. Adoption of these measures can help spine surgeons mitigate biomechanical complications and improve long-term surgical success.

Influence of frailty on clinical and radiological outcomes in patients undergoing transforaminal lumbar interbody fusion– analysis of a controlled cohort of 408 patients

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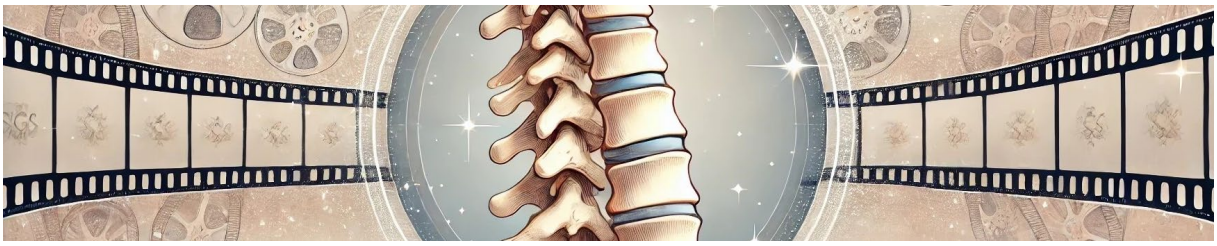
Objective: The concept of frailty has been recognized as an important issue which can influence postoperative outcomes. We aim to investigate the influence of frailty on clinical and radiological outcomes in patients undergoing transforaminal lumbar interbody fusion (TLIF) for degenerative spine disease.
Methods: A single-center, retrospective cohort study was conducted involving 408 patients in whom 506 expandable interbody devices were implanted. Patients were grouped into vulnerable/frail versus well/fit according to the Canadian Frailty Index.



Results: Frail patients were older and had larger number of fused segments (3.0 vs. 2.4 segments, p=0.009). In univariate analysis, frail patients were more likely to experience a postoperative adverse event (AE) until discharge (OR 1.89, 95%CI 1.22 – 2.92; p=0.004), three (OR 1.57, 1.07-2.3; p=0.021) and 12 months postoperatively (OR 3.77, 1.96-7.24; p<0.001). Following multivariable logistic regression analysis, frailty remained an independent risk factor for postoperative AE's at 12 months (OR 3.44, 95% CI 1.69–6.99; p=0.001).
Conclusion: Frailty negatively influenced the rate of AEs until 12 months while the odds of having a favorable outcome at any time remained unaffected in patients undergoing posterior spinal fusion with TLIF. Future efforts are needed to evaluate whether preoperative medical optimization or prehabilitation may positively impact patient outcomes.

Complication Rates and Reversal Strategies in Emergency Spine Surgery for Patients on Oral Factor Xa Inhibitors: A Systematic Review of the Last 10 Years

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Objective: Emergency spine surgery in patients on oral factor Xa inhibitors (FXa-I) such as apixaban, rivaroxaban, or edoxaban presents a clinical challenge. While rapid decompression is often critical to prevent permanent neurological deficits, bleeding concerns may delay surgery. Emerging use of reversal agents—including 4-factor prothrombin complex concentrate (PCC), andexanet alfa, and adjunctive agents like tranexamic acid—offers new options, but evidence remains limited. The aim of this review was to systematically assess complication rates, reversal strategies, and outcomes in emergency spine surgery performed within 24 hours of oral factor Xa inhibitor intake.
Methods: A systematic search of PubMed, Embase, Scopus, and the Cochrane Library was conducted to identify English-language studies (2015–2025) reporting emergency spine surgery in adults on FXa-Is. Eligible study designs included peer-reviewed original studies, case series, and case reports. Data extraction followed PRISMA 2020 guidelines and focused on reversal methods, intraoperative bleeding, transfusion requirements, and postoperative complications.
Results: Eight studies comprising 20 patients were included. Indications included trauma, spontaneous spinal epidural hematoma, spinal infection, and tumor or severe stenosis causing acute cord compression. All patients underwent urgent decompression and/or stabilization with hemostatic measures. In 83% of cases, PCC was administered preoperatively; tranexamic acid was used as an adjunct in selected patients. One patient received andexanet alfa. Intraoperative bleeding was typically minimal, with no reports of major hemorrhage or postoperative hematoma. No thromboembolic events were directly attributed to reversal agents. Neurological outcomes were favorable in most cases when decompression was not delayed.
Conclusion: Emergency spine surgery within 24 hours of FXa-I intake appears feasible and safe with appropriate hemostatic support. PCC, alone or with tranexamic acid, effectively mitigates bleeding risk. Though limited by small sample sizes, predominance of case reports and possible selection bias of the published cases, this review supports the prioritization of timely surgical intervention over prolonged anticoagulant washout in patients with acute neurological compromise. Higher-quality studies are needed to validate these findings.

The Swiss National Spinal Implant Registry (SIRIS Spine): Framework and Initial Insights

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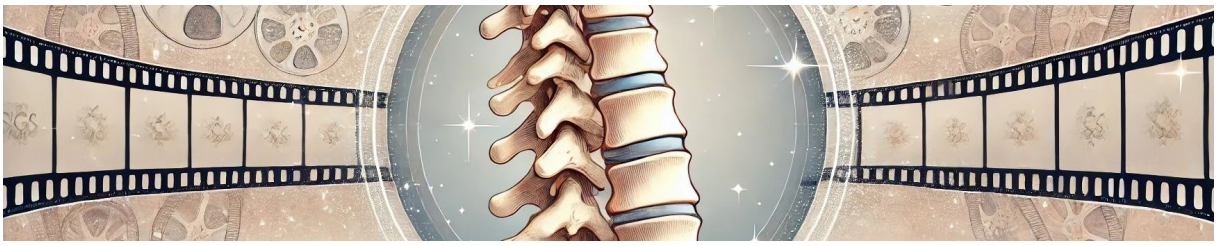

Objective: Spine surgery varies widely in practice, and robust data are needed to guide treatment decisions. National registries can support clinical and policy development by tracking outcomes and identifying trends. SIRIS Spine is the first mandatory nationwide spinal implant registry, launched in Switzerland to improve transparency and quality in spine care.
Methods: The registry is operated by EUROSPINE under the SIRIS Foundation, with data services provided by NEC Software Solutions. It is endorsed by Swiss professional societies and integrated into the national quality framework (ANQ) since 2021. Hospitals are required to report eligible surgeries and cover registration costs. Oversight is provided by a steering committee and scientific board. Data include demographics, surgical details, and implants. Patients can optionally complete electronic patient-reported outcome measures. Hospitals receive routine benchmarking reports.
Results: Initial inclusion focused on adults undergoing 1-2 level posterior lumbar fusion for degenerative or spondylolisthetic conditions (2021) and revisions, expanded in 2022 to include osteoporotic vertebral augmentations. From 2021-2023, 12,815 surgeries were reported from 91 hospitals, involving 11,789 patients and over 75,000 implants from 40 manufacturers. Degenerative disease was the most common indication (61.6%) followed by osteoporotic fractures (12.4%) and non-degenerative spondylolisthesis (5.4%), with a mean age of 66.8 years. Transforaminal lumbar interbody fusion was the most frequent technique (56.7%). Reoperation/revision rates were 6.9%, higher in older, obese, and higher-risk (higher category of American Society of Anaesthesiologists) patients.
Conclusion: SIRIS Spine shows that a nationwide implant registry is feasible and informative. Early results highlight the value of structured data in monitoring care quality. Next steps include simplifying inclusion and enhancing data reliability to support broader clinical use and international benchmarking.

Spinal Cord Injury in Severely Injured Patients: Results from the Swiss Trauma Registry

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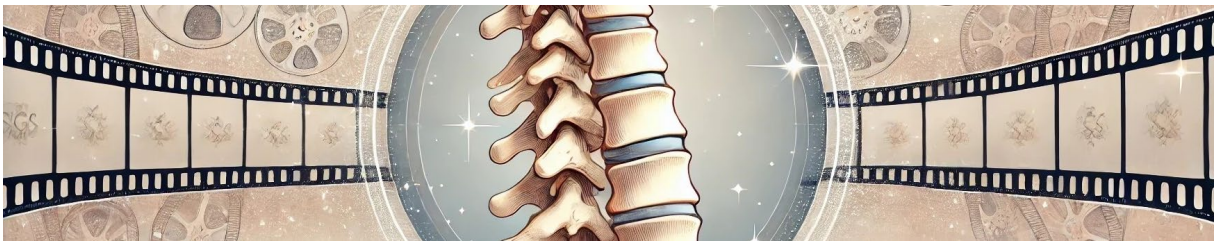
Objective: Traumatic spinal cord injuries (SCIs) in the context of severe trauma are rare, and patient demographics are infrequently reported. This study aimed to assess patient demographics in acute traumatic SCI in the context of severe injuries in Switzerland and to evaluate differences in demographics and outcomes stratified by timing of surgery.
Methods: We analyzed data from the Swiss Trauma Registry (STR) from 2015-2024. The STR includes patients with major trauma (injury severity score [ISS] ≥16 and/or abbreviated injury scale [AIS] head ≥3) admitted to any level-one trauma centre in Switzerland. We evaluated patient characteristics, complications, and hospital outcomes, which were further stratified by early (<24h) and late (≥24h) surgery.
Results: Among 24,328 patients, 6,819 (28%) sustained spinal injuries, and 383 (1.6%) had concurrent SCI with an incidence of 0.44 cases per 100'000 inhabitants. The median age was 52 years (IQR 31-70) and 73.6% were male. The primary causes were falls (63.1%) and road traffic accidents (29.6%). The in-hospital mortality rate was 4.7%. Late surgery patients more often had concomitant moderate or severe traumatic brain injuries (31% vs 14%, p=0.009) and were more likely to have no fractures or dislocations of the spine (22.8% versus 6.8%, p=0.001). Patients who underwent early surgery had shorter hospital stays (9d, [5-16] versus 16 d, [9-24]; F=13.92, p<0.001). Late surgery was associated with a higher likelihood of developing two and more complications (OR 2.57, 95% CI 1.18-5.63, p=0.018), including urinary tract infections (OR 12.13, 95% CI 2.76 – 53.41, p=0.001) and multiple organ failure (OR 12.99, 95% CI 1.64-102.83, p=0.015).
Conclusion: This study offers insights into the characteristics and outcomes of acute SCI care in severely injured patients. Despite its low incidence, the acute management of this patient population remains highly challenging. Our findings suggest early stabilization of spinal injuries in severely injured patients may reduce hospital stays and complications.



External Validation of the Timed Up and Go (TUG) Test in Spinal Tumor Patients – First results from the Swiss Spinal Tumor Register (Swiss-STR)

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Objective: Outcomes of patients after spinal surgery relies on subjective assessment, e.g. Patient related outcome measures (PROMs). The need for objective outcome measurements in spinal surgery has become more relevant in recent years. We aim to evaluate the validity of the Timed up and Go (TUG) test as an objective functional assessment tool in spinal tumor patients through its correlation with standardised outcome measures.
Methods: We conducted a prospective observational study with data from the Swiss Spinal Tumor Registry (Swiss-STR). Patients with spinal tumors and walking difficulty, due to neurological deficit or mechanical pain, undergoing surgery were included. All patients were preoperatively assessed completing both, objective functional tests, TUG, Karnofsky Performance Status (KPS); and subjective PROMs, Oswestry Disability Index (ODI), EQ-5D, Spine Oncology Study Group Outcomes Questionnaire (SOSGOQ2.0), and Visual Analog Scale (VAS). Pearson correlation coefficient (PCC) was used to assess the correlation between objective and subjective outcome measures. The values between 0 - 0.3 represent negligible, 0.3 - 0.4 weak, 0.4-0.7 moderate, and 0.7-1 strong correlations. P value of < 0.05 was considered to be statistically significant.
Results: Forty patients out of 73 primarily screened were included with a mean age of 60 years (45% females). Metastatic tumors were predominant (72.5%). Primary spinal tumors (27.5%) included sarcomas, ependymomas, solitary fibrous tumors (SFT), astrocytomas, and osteoblastomas. Subjective and objective measures included: mean TUG test time of 15.5 seconds, mean KPS of 73%, VAS pain score of 4.8, ODI of 41.1, SOSGOQ2 of 54.9, and EQ-5D index of 0.7. The TUG test showed moderate positive correlations with ODI ($r = 0.52$) and VAS ($r = 0.40$), indicating that higher TUG times are associated with greater pain and disability. Moderate negative correlations were seen with KPS ($r = -0.53$) and EQ-5D ($r = -0.51$), reflecting that better functional status and quality of life were associated with faster TUG times. All correlations were statistically significant.
Conclusion: External validation of the objective TUG Test showed a significant correlation with subjective outcome measures in perioperative spine tumor patients. The results support the TUG Test as a valid and useful tool, an appealing addition to routine clinical assessment in spinal tumor management.

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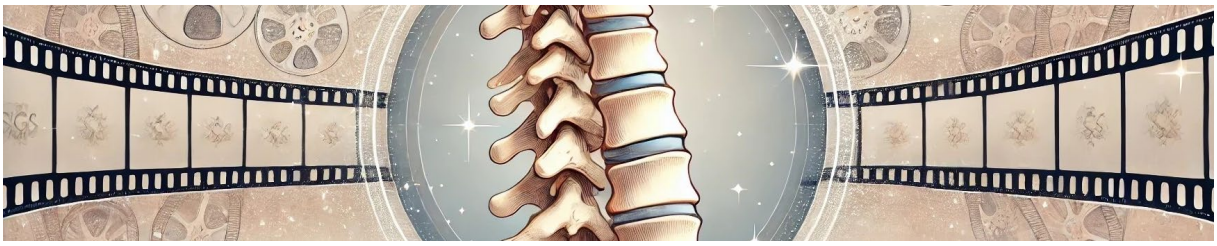

TUG	KPS	ODI	SOSGOQ2	EQ 5D	VAS
1					
-.53*	1				
.52*	-.49*	1			
-.25	.50*	-.74*	1		
-.51*	-.43*	-.72*	.69*	1	
.40*	-.46*	.78*	-.65*	-.56*	1

Table 1: Patient Demographics (N = 40)

Age (years)	60 (17.9)
Sex	Male: 45%, Female: 55%
BMI (kg/m²)	25.4 (4.2)
ASA Risk Scale	ASA 2: 20%, ASA 3: 72.5%, ASA 4: 7.5%
Charlson Comorbidity Index	6.6 (3.6)
Tumor Type	Primary: 27.5%, Metastatic: 72.5%
Hospital Stay (days)	10.2 (6.6)

Table 2: Clinical Characteristics

Affected Level	Cervical: 30%, Thoracic: 47.5%, Lumbar: 12.5%, Sacral: 10%
ASIA Score	D: 55%, E: 45%
KPS (%)	73 (16.5)
TUG (seconds)	15.5 (12.1)
VAS (Pain)	4.8 (2.9)
ODI	41.1 (24.3)
EQ-5D	0.7 (0.15)

Surgical Treatment of Recurrent Lumbar Disc Herniation: To Fuse or not to Fuse? A Single-Center Analysis of clinical and radiological Characteristics and Surgical Outcomes of 450 patients

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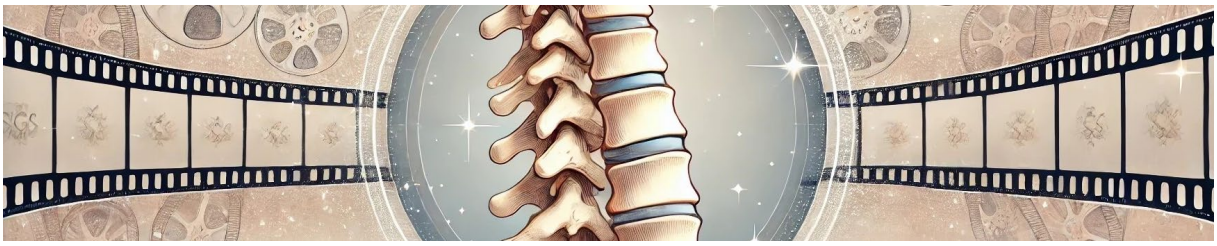
Objective: This study aims to guide surgical decision-making for recurrent lumbar disc herniation (ReLDH) by analyzing functional outcomes, re-operation rates, and clinical-radiological risk factors following microdiscectomy (MD) vs. instrumented fusion (IF).
Methods: This was a retrospective analysis of prospectively collected data from 450 patients in our local spine outcomes database who underwent surgery for ReLDH from 2004-2024. Clinical assessment included predominant symptoms (back pain, leg pain, or both), neurological deficits, and ASA grade. Comprehensive radiological assessment included disc height, Pfirrmann grade, facet angle,



and Modic changes of the affected segment on MRI, and spinopelvic parameters on standing radiographs. Patient-reported outcome was assessed using the Core Outcome Measures Index (COMI) and achievement of minimal clinical important change (MCIC ≥2.2 points) up to 5 years postoperative. Propensity score matching (PSM) was performed to control confounding factors. Re-operation rates and types of subsequent surgeries were analyzed for both groups, with at least 5 years of follow-up.
Results: Of 450 patients with ReLDH, 316 (70.2%) underwent MD and 134 (29.8%) received IF. After PSM (n=192), IF showed significantly higher odds of achieving MCIC (OR=2.08, p<0.05), although raw COMI scores were similar between groups. The IF group demonstrated significantly lower re-operation risk compared to MD (OR=0.28, p<0.001). In the MD group, subsequent operations (n=116/316, 36.7%) predominately included repeat MD (23.3%), subsequent fusion (63.8%), while IF group (n=21/134, 15.7%) mainly required adjacent segment surgery (57.1%) or hardware revision (33.3%). High BMI was associated with worse COMI scores in the unmatched cohort (p=0.003) but lost significance after PSM (p=0.08).
Conclusion: While both procedures achieve clinical improvement, IF demonstrates superior and sustainable outcomes in terms of MCIC achievement and significantly lower re-operation rates. Primary IF may be the preferred treatment option for patients with high BMI with ReLDH in the presence of radiographic disc and segmental degeneration. These findings provide an evidence-based framework for surgical decision-making based on individual risk profiles, emphasizing the importance of considering both clinical and radiological factors in treatment selection.

Outcome of Lumbar Fusion with Template Guided Cortical Bone Trajectory Versus Traditional Pedicle Screw Trajectory – a Randomized Prospective Trial

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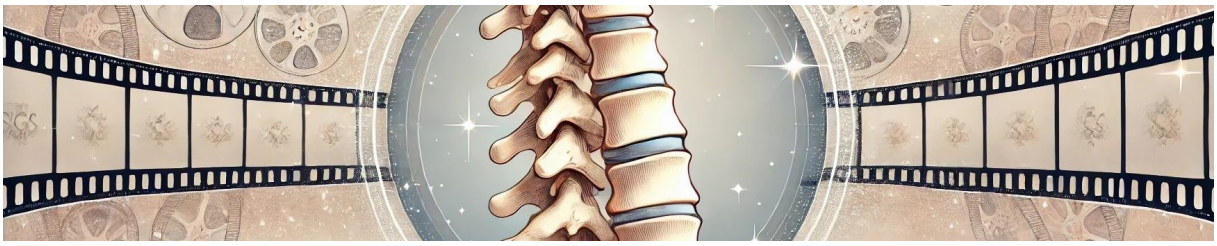
Objective: The traditional trajectory (TT) for pedicle screws in lumbar fusion is the gold standard but presents challenges. The cortical bone trajectory (CBT) offers benefits like reduced tissue damage and radiation exposure but is technically demanding. Patient-specific, CT-based 3D guides have been developed to improve CBT accuracy. This randomized clinical trial compares safety and efficacy of freehand TT versus template-guided CBT in lumbar fusion, focusing on screw placement accuracy, functional outcomes, soft tissue damage, and fusion rates over 24 months.
Methods: Sixty-seven patients (mean age 62.5 years) undergoing elective lumbar fusion for degenerative disorders were randomized (TT: n=34; CBT: n=33). TT was performed using fluoroscopy-guided freehand placement; CBT used patient-specific 3D guides. Outcomes included Oswestry Disability Index (ODI), back and leg pain (VAS 0–100), screw positioning (Gertzbein-Robbins), muscle atrophy (Goutallier grade at 6 months), and CT at 12 months for adjacent segment disease (ASD) or pseudarthrosis. Surgical complications such as pedicle fractures or infections were documented.
Results: Instrumentation time was shorter in the TT group (18 vs. 25 min, p=0.030), while exposure and total surgery times were similar. Radiation dose was significantly higher in the TT group (734.5 vs. 416.0 mGy·cm², p=0.013). Skin incision was smaller in the CBT group (9.5 vs. 12.0 cm, p=0.002). Blood loss and hospital stay were similar. ODI, back and leg pain improved in both groups at 1 and 2 years with no significant differences. Maximum fatty muscle infiltration grade at 6 months was higher in the TT group (grade 4 vs. 3, p=0.037). CBT had more upper endplate perforations, but no difference in pedicle or ventral breaches. No screw-related neurological deficits occurred. Complication rates were similar.
Conclusion: Template-guided CBT achieved comparable screw placement quality to TT. Although upper endplate breaches were more frequent with CBT, they had no clinical consequences. Functional outcomes and complication rates were similar. CBT was associated with reduced radiation exposure, smaller skin incisions, and a trend toward less paravertebral muscle degeneration.



Osteolysis After Cervical Disc Arthroplasty: Prevalence, Risk Factors, and Validation of a Novel CT-Based Grading Scale

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Objective: To investigate the prevalence and clinical relevance of periprosthetic osteolysis following cervical total disc replacement (CTDR) with the M6-C™ implant and to validate a novel Osteolysis Grading Scale (OGS) for standardized radiographic assessment.
Methods: We retrospectively analyzed 43 patients (50 implants) who underwent M6-C™ CTDR between 2011 and 2015 with a mean follow-up of 8.1 years. Clinical outcomes were assessed using EQ-5D-5L, VAS, and NDI scores. Osteolysis and heterotopic ossification (HO) were graded using the OGS. In a separate validation study, the OGS (Grades 0–4 based on cyst size relative to endplate width) was applied to 40 additional patients divided into CT (n=20) and X-ray (n=20) imaging groups. Four blinded raters graded osteolysis, and inter-rater reliability was assessed using ICC and kappa statistics.
Results: Osteolysis was detected in 44% of implants, with 10% classified as failed due to high-grade osteolysis (Grades 3–4), all in male patients with C5/6 implants (p=0.016). High-grade osteolysis was associated with increased arm pain (p=0.047) and lower EQ-5D-VAS (p=0.034). The OGS demonstrated good reliability for osteolytic cyst measurements on CT (ICC = 0.78–0.79), moderate reliability on X-ray (ICC = 0.55–0.64), and moderate agreement with reference grades (Cohen's κ = 0.46–0.60 for CT).
Conclusion: Periprosthetic osteolysis is a frequent and under-recognized complication following CTDR with M6-C™, associated with implant failure and worse patient outcomes. The OGS provides a reliable and reproducible CT-based tool for grading osteolysis severity. Routine clinical and CT radiographic surveillance, particularly for male patients with C5/6 implants, is essential to enable timely intervention and improve long-term outcomes.

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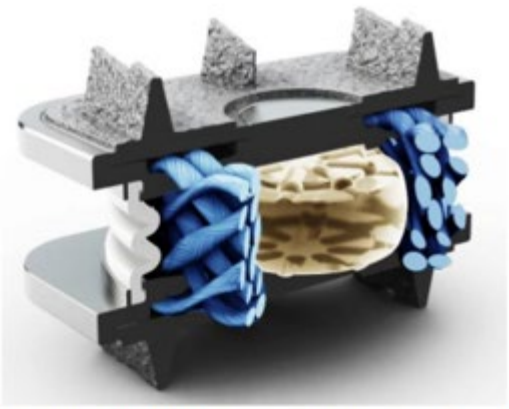
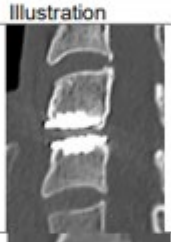
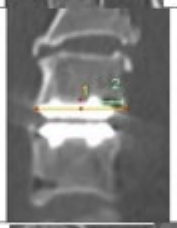
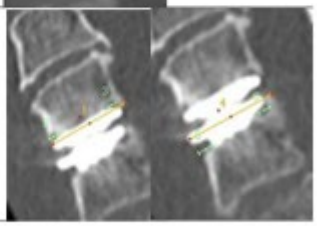
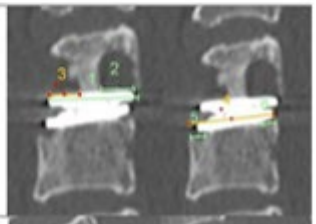
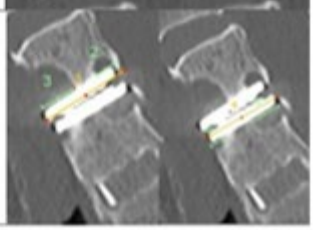
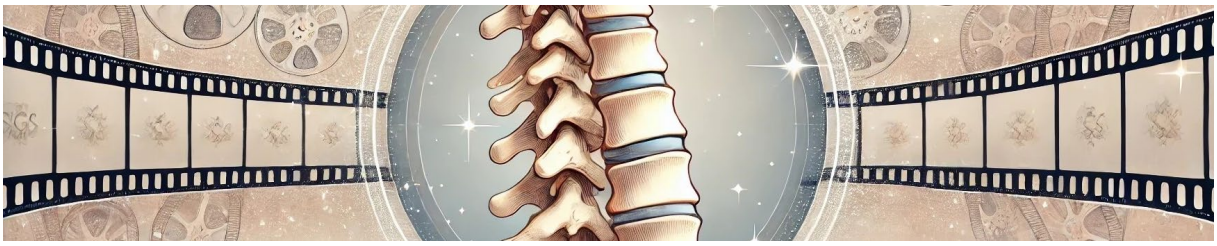


Figure 1 The M6-C™ artificial cervical disc implant comprises alloy (Ti6Al4V) outer and inner plates. Stability is ensured by two keels on each endplate. The implant features a sheath (polycarbonate urethane polymer—PCU) to prevent tissue ingrowth and debris migration. The fibre matrix represents the artificial annulus (ultra-high-molecularweight polyethylene—UHMWPE), and the core is composed of the Artificial Nucleus (PCU)

Table 1. Osteolysis Grading Scale (OGS). This grading scale is used to quantify the degree of osteolysis. Measurements for the total length of the superior and inferior endplate as well as the osteolytic cysts have been included on radiographic images A-E.

Grade	Definition	Criteria	Illustration
0	No Osteolysis	No cystic defect visible on either endplate	
1	Mild Osteolysis (single endplate)	<50% cyst width on either superior **or** inferior endplate	
2	Mild Osteolysis (both endplates)	<50% cyst width on both superior **and** inferior endplates	
3	Severe Osteolysis (single endplate)	≥50% cyst width on either superior **or** inferior endplate	
4	Severe Osteolysis (both endplates)	≥50% cyst width on both superior **and** inferior endplates	



ALIF's impact on sexual function, a retrospective comparative cohort study

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Objective: This study compares the impact of Anterior Lumbar Interbody Fusion (ALIF) and Transforaminal Lumbar Interbody Fusion (TLIF) on sexual dysfunction. While both approaches are well-studied for risks and benefits, sexual dysfunction, particularly from damage to the hypogastric plexus in ALIF, remains controversial. The study assesses whether ALIF carries a risk of sexual dysfunction and if it is higher compared to TLIF.
Methods: This retrospective multi-center comparative cohort study analyzed matched cohorts (80 ALIF vs. 80 TLIF) based on age, sex, surgical segment (L5/S1) and completed one-year follow-up. To ensure surgical consistency, all ALIF procedures were performed by the same surgeon and all TLIF by another surgeon. Data from medical records, including demographics, surgery details, postoperative outcomes (e.g. pain score) and a one-time questionnaire on sexual function were collected.
Results: There was no statistically significant difference between both groups in postoperative sexual dysfunction. Erectile dysfunction was reported postoperatively in 3.75%, decreased ejaculation ability in 2.5% and disturbed genital sensation in 2.5% with a total sexual dysfunction rate of 8.75% across all categories. No statistically significant differences could be seen between both groups for pain reduction ($p = 0.59$). Mean preoperative pain scores were 7.24 (SD ±1.26) for ALIF and at 6.79 (SD ± 1.51) for TLIF, improving postoperatively at one year to 2.71 (SD ± 2.59) and 3.32 (SD ±2.75), respectively. Improved sexual function was reported in 54.5% of the patients for ALIF, 40.9% experienced no changement and 4.5% reported a worsened function.
Conclusion: Despite the potential risk of plexus hypogastricus damage, ALIF did not lead to a higher incidence of sexual dysfunction compared to the dorsal approach (TLIF). Although surgery had an impact on sexual dysfunction, the majority of cases appear to be primarily associated with advancing age and menopausal status. Overall, postoperative sex life improved, mainly due to pain relief. Both approaches also achieved similar outcomes regarding pain relief.