

ANNUAL SPINE EXPERTS GROUP MEETING 2023



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Slovenian Spine Society and Spine Experts Group

President of the Organizing and Programme Committee

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ABSTRACTS

SESSION 1: DEGENERATIVE SPINE

Treatment Algorithm for Cervical Degenerative Myelopathy

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Introduction:

Cervical degenerative myelopathy is the most common cause of the spinal cord dysfunction. The natural history of the disease is generally progressive and fails to respond to nonoperative treatment.

Patients/methods/core:

The indication for surgery is based on the results of clinical, radiological, and neurophysiological examinations. JOA score is the most commonly used grading scale clinically. The gold standard for imaging in myelopathy is the MRI because it provides direct visualization of the spinal cord, including the location and degree of compression, as well as cord signal changes.

Discussion:

Anterior and posterior spine surgical procedures can effectively halt or slow the neurologic decline associated with myelopathy. Surgical approach is based on the patient's sagittal alignment, source of compression, number of levels involved, presence of axial neck pain. Prognostic factors for the outcome of surgery are: duration of symptoms, cord compression ratio, age and smoking.

Conclusion:

Asymptomatic spinal cord compression should be closely followed, and patients should be instructed for possible development of myelopathy.

In case of mild myelopathy, if the initial nonoperative treatment failed, surgery is recommended. Surgical intervention is recommended for patients with moderate or severe myelopathy.

Optimizing the cervical range of motion in the cervical spine hybrid surgery

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Background:

There are no clear indications at which level the cervical disc arthroplasty (CDA) should be performed in the Hybrid surgery (HS), involving the combination of ACDF and CDA. Retrospective analysis comparing the clinical and radiographic results in the treatment of the cervical degenerative disease was performed comparing the patients who underwent the HS and had the artificial disc implanted at different levels.

Materials and Methods:

After applying the inclusion criteria, 34 patients with two-level cervical degenerative disc disease where conservative treatment failed were included in the study. All the patients had been operated with the hybrid procedure. The CDAs in 18 patients were implanted above and in 16 patients below the ACDF level.

Clinical outcomes were assessed before and at regular intervals until one year after the procedure using neurological examination, the Neck Disability Index (NDI) and Visual Analogue Scale (VAS) for neck and arm pain, with 15% improvement in NDI and 20% in VAS defined as a clinically significant.

The cervical range of motion was evaluated using flexion-extension parameters.

Results:

The groups were similar at baseline both clinically and statistically. Both groups had a statistically significant improvement in NDI and VAS for neck and arm pain ($P > .05$) and there was no statistically significant difference between groups at any point of investigation.

There was no statistically significant difference in the C2-C7 ROM between the two groups at 12 and 24 months postoperatively ($P > .05$). The location of the arthroplasty at the level C5/6 or C4/5 provided better ROM compared to the level C6/7.

Conclusions:

Both groups resulted in significant pain reduction and functional outcome for the patients in short and long term period. The combination of fusion and arthroplasty can be adjusted to each level allowing segmental motion preservation at the affected levels and minimizing hypermobility at adjacent levels. The ROM was more affected by the level of the artificial disc implantation than relationship of the CDA towards ACDF.

Dilemmas in operative treatment of degenerative spinal stenosis

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Introduction:

Degenerative cervical spinal stenosis poses a complex dilemma for surgeons due to the multifaceted nature of this condition. This paper explores the challenges and dilemmas faced in the surgical treatment of cervical spinal stenosis, focusing on the critical decision-making processes involved. We discuss the indications for surgery, the choice of surgical approach, and the management of associated comorbidities. Additionally, the paper delves into the risk-benefit analysis of surgical interventions, considering potential complications and long-term outcomes.

Materials and methods:

Through a comprehensive review of the current literature and clinical experiences, we aim to provide insights into the intricate decisions that surgeons encounter when treating cervical spinal stenosis, facilitating informed choices that optimize patient outcomes while minimizing risks.

Results:

Through clinical cases, this paper will provide an overview and insights of some common dilemmas that surgeons may encounter in the surgical treatment of cervical spinal stenosis such as;

- 1. Timing of Surgery:** Determining the right timing for surgery can be challenging. Deciding when a patient has exhausted conservative treatments and whether the symptoms warrant surgical intervention is often a complex decision.
- 2. Choice of Surgical Procedure:** There are various surgical procedures available for spinal stenosis, such as decompressive laminectomy, laminotomy, and spinal fusion. Choosing the most appropriate procedure for a patient requires careful consideration of the specific anatomical and clinical factors involved.
- 3. Multilevel Stenosis:** Treating multilevel stenosis presents a dilemma. Addressing multiple levels during surgery can increase the complexity and potential risks of the procedure. Surgeons need to balance the need for decompression while avoiding excessive spinal instability.
- 4. Associated Instability:** Surgery can sometimes inadvertently lead to spinal instability, especially in cases where extensive decompression is performed. Balancing the decompressive needs with preserving spinal stability is a key dilemma for surgeons.

5. Patient Expectations and Risks: Managing patient expectations and ensuring they understand both the potential benefits and risks of surgery is crucial. Some patients may expect complete resolution of symptoms, which might not always be achievable.

6. Postoperative Rehabilitation: Postoperative rehabilitation and recovery vary for different surgical techniques. Determining the appropriate rehabilitation protocol and ensuring patient compliance can significantly impact outcomes.

7. Age and Comorbidities.

8. Adjacent Segment Disease: Addressing spinal stenosis at one level may alter the biomechanics of the spine, potentially leading to issues in adjacent spinal segments. Surgeons must consider the risk of future complications in adjacent areas.

9. Recurrent Stenosis: There is a risk of the stenosis recurring after surgery. Determining the factors contributing to this risk and taking measures to mitigate it pose significant challenges. **10. Minimally Invasive vs. Open Surgery:** The choice between minimally invasive techniques and traditional open surgery involves weighing factors such as patient recovery time, complication rates, and long-term efficacy.

Navigating these dilemmas in the operative treatment of degenerative spinal stenosis requires a comprehensive understanding of the patient's condition, collaboration among multidisciplinary teams, and a patient-centered approach to decision-making. Surgeons need to balance the potential benefits of surgery against the associated risks and patient-specific factors to achieve the best possible outcomes.

The role of lumbar endoscopic spine surgery

Oguz Karaeminođlu

Uniportal versus biportal spinal surgery

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Over the last ten years there has been an unprecedented development in the endoscopic surgical technique for lumbar decompression caused by intervertebral disc extrusion. This has resulted in the expansion of the surgical technique to include decompression of the spinal canal at all levels, encompassing even fusion surgeries. Endoscopic surgery of the spine is linked to increased overall patient satisfaction. The technique is divided into two types: uniportal and biportal. In literature there are few comparative reviews regarding the two methods. In this study we discuss our experiences with uniportal endoscopic lumbar spine surgery, and through literature we search for the benefits and pitfalls of the uniportal and biportal techniques.

Our Initial Experience with XLIF

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Introduction: The eXtreme Lateral Interbody Fusion (XLIF) is a minimally invasive surgical approach for addressing spinal pathologies. XLIF allows for direct access to the intervertebral disc space through a lateral approach, avoiding the need for posterior muscle dissection and neural retraction. This technique offers reduced blood loss, shorter hospital stays, and quicker recovery times compared to traditional open approaches.

Patient Selection and Preoperative Planning: Careful patient selection and comprehensive preoperative planning are crucial for the success of XLIF surgery. Ideal candidates include those with degenerative disc disease, first grade spondylolisthesis, or adjacent segment pathology. Our patient selection criteria encompassed individuals with L2 or L3 spondylolisthesis and moderate stenosis. Preoperative planning involved meticulous assessment of patient-specific anatomical factors, including spinal alignment and disc height.

Operative Technique and Outcomes: XLIF surgery was performed exclusively through a lateral minimally invasive approach. During the procedure, intraoperative neuromonitoring was employed to safeguard against sacral plexus injury. Our results demonstrated minimal blood loss, reduced surgical time, and excellent radiographic outcomes. All patients experienced significant relief from preoperative symptoms and were mobilized within a day post-surgery. Patients were discharged, on average, two days after the procedure, showcasing the rapid recovery associated with XLIF.

Discussion: Our initial experience with XLIF surgery shows promising results in terms of patient outcomes, safety, and efficiency. This minimally invasive approach has the potential to become a preferred choice for patients with lumbar spondylolisthesis occurring at upper lumbar levels, degenerative disc disease or adjacent segment pathology.

Conclusion: Our early experience with XLIF surgery demonstrates its potential as a valuable tool in the treatment of various spinal conditions. The benefits of XLIF, such as reduced postoperative pain and shorter hospital stays, make it a valuable addition to our surgical armamentarium.

SESSION 2: SPINAL DEFORMITY

How to reduce complications in pediatric deformity corrections?

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Surgical correction of paediatric spinal deformity is a complex surgical procedure, which highly associated with risks, adverse events, and complications that must be preoperatively discussed with patients and their parents. The incidence of complications varies in relation to the underlying aetiology of spinal deformity and surgical procedure. Intraoperative complications include bleeding, neurological damage, dural tear, implant malposition, and those related to positioning. Postoperative complications include persistent pain, surgical site infection, venous thromboembolism, pulmonary complications, and also pseudarthrosis and implant failure, proximal junctional kyphosis, distal junctional failure, adding-on deformity, which often require revision surgery. Interventions included in enhanced recovery after surgery protocols may reduce the incidence of complications. Complications must be diagnosed, investigated and managed expeditiously to prevent further deterioration and to ensure optimal outcomes. The aim of this presentation is to summarize complications associated with paediatric spinal deformity surgery and their management.

The use of 3D-printed personalized spinal guides for pedicle screw insertion in thoracolumbar deformities

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Introduction: In recent years, computer-assisted orthopaedic surgery concepts have been successfully implemented in the clinical setting. One of their rapidly-evolving fields is the advancement of 3D-printed patient-specific spinal surgical guides (PSGs), where significant benefits have been recognized in improving several pedicle screw placement criteria.

Patients/methods/core: A single-surgeon case series of spinal deformity patients were retrospectively evaluated to assess the accuracy, learning curve, and timing of pedicle screw placement using PSGs.

Discussion: This innovative approach enhances the overall precision of spinal surgeries regarding pedicle screw placement accuracy resulting in risk management reduction of complications (e.g., damage to neural or vascular structures and biomechanically inferior implant malposition). PSGs are especially useful when dealing with complex anatomy (i.e., spinal deformities or instrumented revision cases). The constant evolution of PSG technology contributes to its continuous improvement with cost-benefit economics and reduction of electromagnetic radiation exposure to the patient and the surgical team, warranting further research efforts.

Conclusion: PSG is a valuable surgical aid in complex spine surgery, reducing operative time, improving pedicle screw position, and shortening the learning curve of pedicle screw placement. The use of PSGs marks a significant stride toward safer and more effective spinal procedures (i.e., instrumented revisions and deformities), ushering in a new era of individualized patient care.

Lateral approach in the treatment of spinal deformities

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The anterior approach for the lumbar spine is more preferable due its minimally invasive nature, the ability to correct of sagittal balance and overall better fusion rates. Literature describes lesser complications, a shorter hospital stay and higher patient satisfaction. The benefits of the lateral approach for fusion of the lumbar spine is the avoidance of major blood vessels, a better chance of fusion and the indirect decompression. In this study we discuss our experience with the lateral lumbar cages in surgical treatment of lumbar spine deformities.

Benefits of Robotic Assisted Surgery for Spine Deformities Correction

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Introduction: In the field of spine deformity correction, achieving specific goals is paramount. These objectives encompass obtaining and maintaining correction, restoring coronal and sagittal balance, ensuring a solid fusion to halt progression, addressing cosmetic concerns, and prioritizing safety during major surgeries.

Patients/Methods/Core: Over the span of 23 years, the author's journey in scoliosis surgery evolved from earlier techniques, such as hooks and rods, to the more recent adoption of robotic guided pedicle screws. In the last two years, the author exclusively engaged in robotic-assisted surgeries, performing 159 surgeries for pediatric spinal deformities and overseeing the insertion of over 3000 screws. The transition from traditional free-hand methods to optical navigation and robotic guidance approaches is outlined.

Discussion: The challenges of applying these techniques in scoliosis surgery are highlighted, including the complexity of drilling trajectories in curved spines, the need to protect vital structures, and the associated learning curve. The author delves into the differences between free-hand screw insertion, navigation and robotic guidance, emphasizing the unique benefits and limitations of each.

Conclusion: The adoption of robotic guidance, particularly the Mazor system, is presented as a transformative and advantageous approach to achieving the goals of pedicle screw fixation in spine surgery. The ease of preoperative planning, increased accuracy, and efficient execution of the surgical plan are highlighted. The author shares insights from their experience, demonstrating the potential for this technology to enhance surgical outcomes and reduce the physical and mental stress on surgeons, ultimately improving patient care.

Navigation and robotic spine surgery; Pros and cons

Yunus Uysal

SESSION 3: SPINAL TUMORS

Current and emerging approaches to spine malignancies and their limitations

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Primary and especially metastatic spine tumors represent significant medical problems and quality of life issue for many patients. Spine tumors require multidisciplinary approach such as chemotherapy, radiotherapy and surgical interventions. With the current advances and new approaches in chemotherapy and radiotherapy we have two different effects for surgical planning. First, because of chemo-radiotherapy advancements primary organ tumor patients are living longer and metastatic spine tumor numbers are increasing. Second, chemo-radiotherapy advancements may allow us to plan less surgery and may reduce the extensivity of the planned surgery.

As stated before, spine tumor management needs multidisciplinary approach but carries the risk of treatment delays due to long discussions. Starting the treatment and to find an empty spot for the patient is also a big problem for hospitals.

Surgical aims for spine tumor surgery;

1. To remove tumor mass and secure the spinal cord
2. To establish stability

To achieve these aims is not always easy, because of anatomic location of the tumor. Sometimes, the surgeon has to sacrifice vital organs and this usually requires extra help from other surgical specialists. Not every hospital has the full service when need it. Extensive approaches also increase the complication rates and severity of complications which again require good follow-up in an intensive care unit.

Clinical Pathway in Primary Malignant Spinal Tumour Care in Slovenia

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Introduction: Slovenia's response to spinal osseous malignancies is facilitated by Slovenian Cancer Registry, collecting data from diverse sources. The annual incidence of primary bone and articular cartilage cancer, ranging from 15 to 25 cases between 2011 and 2020, aligns with global incidence.

Core: Patients with localized back pain are preliminarily assessed by their General Practitioners, who may refer the patient for further evaluation. In instances of radiological changes suggestive of benign etiology, non-urgent referrals are typically directed towards orthopedic surgeons. Conversely, where there exists a substantial suspicion of malignant pathology, urgent referral to orthopedic surgeons is crucial. In the presence of a prior oncological record, referral to the Institute of Oncology is usually made with later consultation of orthopedic surgeons, traumatologists or neurosurgeons. After radiological confirmation of spinal oncological pathology, a biopsy is indicated. Positive histological outcome necessitates a multidisciplinary approach at the Institute of Oncology, where the Tumor Board makes individualized treatment plans. Primary spinal osseous malignancies are surgically managed exclusively through the Department of Orthopedic Surgery at Ljubljana University Medical Center. In contrast, secondary malignant spinal tumors are treated either at the Department of Orthopedic Surgery or Trauma at Ljubljana UMC or the Department of Neurosurgery or Trauma at Maribor UMC. Intradural neoplasms fall within the scope of neurosurgeons.

Discussion: Slovenia's approach ensures a systematic and specialized process for diagnosis and treatment of primary malignant spinal tumours. The collaboration between medical specialties and the Tumour Board contributes to tailored and effective treatment plans.

Conclusions: In summary, Slovenia's well-coordinated multidisciplinary system shows commitment to effective treatment of spinal malignancies, ensuring timely and personalized care for all patients.

The single posterior approach for L3 chordoma resection

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Introduction: Primary spinal tumors are uncommon and make up fewer than 5% of bone neoplasms. The annual incidence of primary spine tumors is in the range of 2,5-8,5 per 100,000 population. Chordomas are rare primary spine malignant tumors, accounting for 2-4% of all primary malignant bone tumors with a prevalence of 0,51 per million.

Core: In this case report the authors present a case of 51 old male referred to orthopedic spine surgeon due to back pain and numbness in lower extremities. Other to this complaints patient found himself healthy. Standard x ray looked normal and he was prescribed analgesic therapy which failed. Later MRI revealed L3 bone tumor. CT scan of lung and abdomen with contrast, was negative to other possible sources of tumor metastasis. Transpedicular biopsy performed and patohistologic analysis revealed chordoma. We performed the single posterior removal of tumor with later confirmed free marginal resection on additional patohistological analysis. 10 ml of Cisplatina was administred at the end of procedure in order to reduce risk of local recurrence. Fibular 2 pieces of strut autograft used to replace removed body of L3 vertebra. 3 years later control MRI did not show any signs of tumor recurrence and patient got back to normal life without any complaints.

Discussion: Chordoma is a rare primar malignant tumor very hard to treat depending of its extension and localisation.

Conclusion: Wide resection with free surgical margin removal of chordoma in lumbar spine is possible to perform with single posterior approach and is most important prognostic factor. Extent of surgical resection and adequacy of surgical margins are the most important prognostic factors and thus patients with chordoma should be cared for by a highly experienced, multi-disciplinary surgical team in a quaternary center.

Enneking appropriate treatment of primary sacral tumors

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Introduction: The Enneking system for the surgical classification of primary bone tumors is more than 40 years old, but still one of the main decision making tool in the management of primary spinal tumors. Especially at the sacral region, Enneking appropriate (EA) surgical treatment can be challenging, resulting in major neurological loss and high complication rate. Success of EA treatment of sacral tumors have crucial elements, supporting by growing body of evidence which is reviewed and summarized in this presentation.

Methods: Literature review and analysis of institutional case-series focusing on the complication rate, surgical and oncological outcome and technological details of primary sacral tumor surgeries.

Discussion: Detailed preoperative planning is the key element of the EA treatment of primary sacral tumors but postoperative care and patient management can also influence the outcome.

Conclusion: In primary sacral tumors, the principle of the treatment is the Enneking classification and growing body of evidence that EA management provides the best oncological outcome. On the other hand, significant comorbidity and complication rate can be related to the EA surgery and latest therapeutical developments can give the opportunity for the choice of Enneking Inappropriate (EI) but still successful treatment modality. Patient specific evaluation and detailed planning of the multi-dimensional management should be performed in all cases.

Carbon fiber transpedicular screws in treatment of spinal metastatic disease and stereotactic radiotherapy- project of the prospective, randomized trial

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Background: Spinal metastatic disease constitute a serious clinical problem in oncology. Bones are the third most common organ where metastases are located, and the spine is the place where they are most often located. Due to the complexity of the clinical problem, metastatic spine disease remains of interest to many medical specialties: neurosurgery, orthopedics, clinical oncology, radiotherapy and rehabilitation. With the development of modern diagnostic methods and wider access to them, the demand for neurosurgical treatment in this group of patients is growing. Surgical treatment is undertaken in cases of spinal cord compression, instability, spinal deformation or pain that is resistant to radiotherapy. The standard treatment in most cases is posterior instrumentation of the spine using titanium pedicle screws. Unfortunately, these systems cause numerous artifacts in diagnostic imaging, both in CT and MRI. These distortions make it difficult to plan radiotherapy and determine the optimal dose that would avoid healthy tissues. Moreover, artifacts could make difficult postoperative follow-ups aimed at assessing local recurrence. The solution to these problems is the use of radiolucent implants. There are systems based on carbon fibers embedded in PEEK which do not cause typical artifacts for titanium implants.

Study plan: The open, three-arm, prospective randomized study is planned to involve 226 patients with metastatic disease of the spine, with a known or undiagnosed primary site. Patients will be qualified for 2 types of interventions. The first one includes treatment with stereotactic radiotherapy (SBRT) in the first stage of treatment and early instrumentation of the spine with titanium implants. The second type of intervention includes patients qualified for surgical treatment using spine stabilization and postoperative SBRT. Patients within this arm will be randomized into two groups differing in the type of material the instrumentation is made of: carbon-PEEK or titanium. The study group will be patients stabilized with carbon implants, and the control group will be those who will have titanium implants.

Study population: The study includes adult patients with metastatic spine disease, with a known or unknown primary tumor, qualified for SBRT and surgical treatment.

Assumed effects: It is assumed that the treatment proposed in the project would extend progression free survival by several months or achieve local control in an additional 5% of

patients. Moreover, by improving the quality of imaging, earlier diagnosis of local recurrences and implementation of appropriate locoregional treatment would be possible.

Current Concepts in the Treatment of Intradural Extramedullary Spinal Tumors

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Introduction: Intradural extramedullary spinal tumors (IEST) are rare, comprising about 40-45% of all spinal tumors. The mean age of patients is around 45 years and they are more common in males. Median time to diagnosis is around 12 months. Patients present with signs and symptoms of spinal cord or nerve root compression. Common presentations include weakness, localized back pain, radicular pain, sensory deficits, paraparesis and sphincter dysfunction combined with erectile dysfunction.

Patients: Fifty-four patients who were treated due to IEST at our institution since January 2018 were retrospectively analyzed.

Discussion: The most common IEST are meningiomas, nerve sheath tumors and filum terminale ependymomas. Preoperative MRI with and without contrast is the diagnostic modality of choice, sometimes aided by dynamic X-ray and CT. IEST can significantly compress and displace the spinal cord, the nerve roots or even the surrounding structures (such as the vertebral artery). This can impact preoperative neurologic presentation and operative morbidity. Gross total tumor resection while preserving and improving neurologic function is the usual goal of surgery, which can be achieved in great majority of cases. Intraoperative monitoring-somatosensory evoked potentials (SSEP) and motor evoked potentials (MEP) may be utilized as can spinal navigation system. After a detailed clinical, neurologic and neuroradiologic evaluation, the operative approach is planned. Approaches are based upon location of the tumor, its extension, its size and other parameters. The goal is to provide maximal intra-operative exposure of the tumor, while minimizing damage to the surrounding anatomical structures. For most IEST resections, the posterior approach with midline incision is sufficient. The results of surgery of IEST are usually excellent. Even long lasting preoperative neurologic deficit may be improved and reversed postoperatively. Most common complications include cerebrospinal fluid leak, pseudomeningocele formation and wound infections. Less common is postoperative spinal instability and neurologic deficit

Conclusion: IEST can be radically resected with no mortality and minimal perioperative morbidity. Thorough perioperative planning, meticulous microsurgical techniques and early mobilization and rehabilitation are essential for good clinical outcomes.

SESSION 4: MEET THE EXPERT

Degeneration and revisions. When things do not go as planned

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This is a case report of a 75-year-old patient, with a history of mild dementia, diabetes mellitus, and arterial hypertension, who presented in the office with aggravating back pain. He had prior fusion back surgery at another institution 5 years ago. For the last 3 years, he reported worsening pain in the lumbosacral junction radiating mainly towards the right side. CT scan showed signs screw loosening, and the MRI showed suspected early adjacent level disease at the L2 – L3 junction. He was planned for revision surgery, but due to a long waiting time at his primary institution, decided to seek help at our hospital. His clinical status worsened, and he reported a claudication distance of only 20 m. He was offered and scheduled for a revision surgery.

During the revision loosening of the pedicle screws in L3 and L5 was observed. The original screws were exchanged for 7.5 mm screws and the fusion was elongated one level up and one level down, to L2 – S1. The rest of the hospital stay was unremarkable.

12 days after the surgery he presented to our emergency offices again with a reported 4 days of worsening back pain, urine incontinence, and paraparesis in his legs. Laboratory findings reported inflammation and the emergency MRI uncovered a spondylodiscitis with a psoas abscess on the right side.

Complication after vertebroplasty / case report /

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Introduction: Vertebroplasty is a minimally invasive procedure used to treat vertebral fractures. Vertebral fractures are a common problem, particularly in the elderly population, and understanding vertebroplasty is crucial for improving patient care.

Epidemiology of Vertebral Fractures: Vertebral fractures are a significant health concern, with an increasing prevalence due to factors such as an aging population and osteoporosis. Data on the demographics of affected patients reveal that women and the elderly are at a higher risk. The economic and public health impact of these fractures is substantial.

Vertebroplasty Procedure: Vertebroplasty involves the injection of bone cement into fractured vertebrae to stabilize and alleviate pain. The procedure has evolved over the years, with advancements in materials and techniques. Various types of bone cement can be used, and the procedure is guided by imaging technology. It has proven to be a valuable option in pain management and fracture stabilization.

Indications for Vertebroplasty: Indications for vertebroplasty include acute or chronic painful vertebral fractures, often caused by osteoporosis or trauma. Careful patient selection is crucial, and criteria based on clinical symptoms, imaging, and other factors help identify suitable candidates.

Complication Rates and Risks: Complications associated with vertebroplasty are relatively low, but they do exist. Possible risks include cement leakage, neurological impairment, infection, allergic reaction, and excessive bleeding and adjacent vertebral fractures. There have been case reports of severe morbidity (i.e. respiratory distress or death) associated with embolization. The understanding of risk factors is essential in minimizing these complications. Complication rates have been reported in various studies, providing insights into the safety and efficacy of the procedure. This case report example illustrates one of the severe occurred complication after vertebroplasty and our solution.

Conclusion: In conclusion, vertebroplasty is a valuable tool in the management of vertebral fractures. Recognizing the indications for vertebroplasty ensures that it is used judiciously in clinical practice. While complications are possible, their rates are relatively low, and careful patient selection and procedural techniques can minimize risks.

Post-resection kyphosis and trauma

Ozren Kubat

Management of severe post-laminectomy cervical kyphosis

Ufuk Aydinli

Adolescent idiopathic scoliosis

Nikša Hero, Peter Brumat

Surgical treatment of cervical spine chordoma

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Chordoma is a rare tumour (1 % of central nerve system tumours) that develops from remnants of embryonic notochord down the neural axis. It is primary low malignant tumour. Most often it presents cranially at clivus and in sacral part of spine. It rarely metastasizes, but it has high level of recurrence after surgical removal (in 85 %). On images it is in majority cases lytic bone tumour, with frequent calcifications and enhancement with contrast. Treatment is complete excision and postoperative radiotherapy with proton beams.

We present case of a 13-years old girl with headache, neck pain, paresthesias in right arm. MRI presented tumour in C5 vertebral body and cystic part of a tumour in anterior part of spinal canal that was spread from upper part of C4 to C6. First we performed anterior approach, removed the tumour in vertebrae C5 with corpectomy and we removed cystic, well demarcated part of a tumour from spinal canal. We performed anterior stabilization with autologous bone graft.

Pathohistological report confirmed chordoma. Because of a small remnant of tumour on the right anterior part of cervical canal at the level C6 (that was seen on control MRI), we operated her again. From posterior approach with laminectomy C6 we removed the remnant of tumour. Control MRI was free of tumour. She was treated with radiotherapy with proton beams. She is recovering well in now one-year follow up.

Recurrent osteoblastoma of the lumbo-sacral junction

Armand Dominik Škapin, Miha Vodičar

SESSION 5: SPINAL TRAUMA

Damage Control on Thoracolumbar spine fractures in polytraumatized patients

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The combination of Polytrauma and spine injury is important due to the high incidence of spine trauma in polytraumatized patients, due to the high association with primary neurologic impairment, the high incidence of missed spine injuries in polytrauma patients and the high incidence of missed other injuries in patients with spine injury. If this pathology is not addressed seriously, they are subject to complications and/or secondary neurologic deterioration. There is a complex and still not standardized treatment approach of these patients, and they are caused by very high-energy trauma with a variety of other injuries, that make it difficult and complex to decide. The topic is often not specifically seriously addressed in resident curricula. Spine injury on it's one disturbs homeostasis due to serious impact on the whole body, and combined with other injuries, has a high level of mortality/morbidity. Early operation seems to have more profound benefits in multiply injured patients versus those with isolated spine injuries. It is beneficial in neurologic recovery of the patient with neurologic impairment, prevents neurological deterioration, and reduces ICU and hospital stay. However, timing should be individual according to a repetitive assessment of the overall physiology of the patient, to stability of the fracture, neurologic impairment, according to the complexity and lasting of the surgery, and according to the hospital facilities, including the specialized personnel.

Strategy in the surgical treatment of unstable upper cervical spine fractures

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Introduction: Unstable upper cervical spine fractures (UCSF) are remaining challenge for spine and trauma surgeons. Those patients who skip devastating neurological complications or even death, are at risk of delayed diagnosis or treatment. The trauma and spine community still has not reached clear consensus regarding treatment of these injuries. There is wide variety in the treatment, although there are recommendations in the literature.

Patients/methods/core: We have analyzed patients with UCSF surgically treated in our hospital in the last 3 years according level/type of injury. We analyzed the diagnostic protocol that was used. There was one missed injury of C1, because of low quality CT from another institution and focus on high paraplegia Th4-Th5 confirmed on MR (C1 injury not detected on MR). We found cases treated according literature recommendations (WFNS Spine Committee recommendations), but also cases that were not treated according those recommendations, although the final results were satisfying. Selected cases will be presented and discussed regarding diagnostic protocol, type of chosen treatment (approach and fixation) and results.

Discussion: UCSF treatment no matter conservative or surgical requires immobilization/fixation for healing, yet aiming mobility for function. We should look at the fracture morphology, but also at the patient as a whole when choosing adequate treatment.

Conclusion: The routine use of CT with reconstructions should lower the percent of missed diagnosis. In polytrauma setting, unless there is neurological deficit, these injuries require detailed operative plan for achieving good radiological and functional results. Lack of experience and lack of equipment or implants can lead to serious intraoperative and postoperative complications, not excluding even death.

Closing the extension fractures in ankylosing spondylitis

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Introduction: Ankylosing spondylitis (AS, Mb. Bechterew) is a long-lasting inflammation of the spine leading to generalized ossification of the spinal column. The spine biomechanics is altered due to loss of flexibility, osteoporosis, kyphotic deformation, and loss of segmentation, leading to increased incidence of fractures with an elevated risk of subsequent displacement and neurologic injury. Several types of fracture patterns are seen, the most common is an extension fracture through the ossified disk and vertebral body, which causes opening of the anterior column with gap between vertebral bodies.

Methods: 23 patients with open anterior column were treated with MISS posterior percutaneous stabilization with titanium rods. There was 1 type B neurologic deficit. Preoperative anterior column angulation ranged between 5 and 27° (average 17.1°), immediate postoperative between 4 and 26.4 degrees (average 15.1 degrees). 5 patients were lost to follow up, 3 died during hospitalization. All but one fracture gap gradually closed after the operation, the angulation was 3,8° (0 - 12°) after 3 months and 1,0° (0-7°) after 6 months. 1 patient needed a reoperation due to unresolved facet joint luxation, 1 had painful pseudarthrosis.

Discussion: Closing the open extension fractures of the thoracolumbar spine is usually unsuccessful during the surgery. Patient positioning, poor bone quality that prevents excessive forces during reduction maneuvers and soft titanium rods are the main reasons. After the surgery, the spine realigns on the rod, while the posterior fixation prevents dislocation.

Conclusion: Percutaneous fixation with titanium rods of the extension fractures allows gradual realignment of the anterior column without the risk of additional dislocation and neurologic compromise.

Operative versus nonoperative management of type II odontoid process fracture in octogenarians

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Introduction: Odontoid fractures are the most common spine fractures in patients older than 80 years. Despite their frequency, a consensus for optimal treatment has historically remained lacking in the literature. Both nonoperative and operative management are associated with high mortality rates and decreased functional status.

Material and Methods: A retrospective review of C2 fractures in patients 80 years of age or older who were admitted at University Medical Centre Ljubljana from 2011 to 2021 was performed.

Results: We identified 62 patients with C2 fractures classified as Anderson–D’Alonzo Type-II odontoid fracture. Patients were treated either nonsurgically (n = 49) or surgically (3x odontoid screw fixation, 6x anterior transarticular screws fixation, 1xMagerl, 3x Goel-Harms) (n = 13). The mean age was 84,8 versus 85,0 years ($p > 0,8547.$); mean CCI (Charlson Comorbidity Index) was 5,3 versus 6,4 ($p > 0,1803$); mean fracture displacement was 2,6mm versus 6,2mm ($p > 0,0097$); mean non-union rates was 23,7% versus 22,2% ($p > 0,9299$); mortality (days after injury) was 950 versus 1201 ($p > 0,5160$).

Discussion: Although the surgically treated patients had similar age, higher CCI and significant higher fracture dislocation and by that were more prone to complications and worse outcomes compared to the nonoperative group our data demonstrates no significant difference in union rates and mortality between the two groups. Our results suggest that patients with grater dislocations may benefit from surgery, however in nondislocated cases nonoperative treatment is recommended.

Conclusion: Although some appropriately selected octogenarians with odontoid Type II fracture may benefit from operative treatment, surgery should be approached with pronounced trepidation in this population in the face of increased surgical risk.

Undertreatment vs overtreatment of osteoporotic thoracolumbar spine fractures- do we need standardized treatment protocol?

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Introduction: Osteoporotic spine fractures (OSF) are major worldwide growing health problem, leading cause of pain, disability, impaired quality of life and morbidity in the elderly. The best treatment is prevention, treating causes, correcting calcium and vitamin D, exercise program...

Medical treatment includes hormonal replacement, bisphosphonates, calcitonin, raloxifene, teriparatide... Nonsurgical treatment includes bedrest, cast/brace, analgesia...

If conservative treatment fails, surgery - minimally invasive (vertebroplasty or kyphoplasty) or invasive, open approach to the spine is indicated. Since it is mainly geriatric population, the choice of treatment is a challenge, while trying to do no harm.

The fracture acuity is evaluated with MRI. Appropriate time for surgery is 3 weeks to 3 months after injury, unless dealing with pseudoarthrosis or late neurological deficits.

Patients/methods/core: We have evaluated retrospectively patients with OSF treated in our hospital from June 2020 to June 2023. The diagnostic protocol, the OF classification and score, the chosen treatment, the results, the need of surgery after fail of previous treatment were analysed.

We have found the OF classification and OF score reliable tool for choosing adequate treatment. The score incorporates level of pain, bone density, acuity of the fracture, neurological deficits and general health status, besides the classification.

Discussion: Because of number of comorbidities that geriatric patients have, it is crucial to apply treatment protocol in clinical setting for treating OSF.

Conclusion: When dealing with OSF it is imperative to use OF classification and OF score for choosing appropriate treatment in order to lower the incidence of complications and additional surgical procedures in elderly.

Surgical treatment of posttraumatic deformities

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Posttraumatic deformity is a stable late deformity which is more likely subsequent to burst fracture with significant anterior bone stock loss, flexion distraction type fractures and thoracic sequential compression fractures of 2 or more levels with or without rib fracture. Fracture related risk factors are sagittal index more than fifteen degrees, vertebral body height loss more than thirty per cent, local kyphosis angle more than thirty degrees and posterior ligamentous complex and posterior osseous injuries.

Back pain is at the apex of deformity, can be above or below the deformity due to spinal stenosis and increase with daily activities. There may be neurological deficit, pyramidal findings or cauda equina syndrome due to spinal stenosis. Treatment can be done either by posterior or combined approaches.

In the presence of round flexible kyphosis with mobile disc, Smith Petersen osteotomy with posterior instrumentation can be done. In round rigid kyphosis with no mobile disc, we can do PVCR and if there is angular kyphosis with immobile disc, PSO or PVCR can be performed.

The main goal in the treatment is to prevent the formation of posttraumatic deformity. It is essential to consider fracture type, posterior ligamentous complex condition, anterior bone stock, local kyphosis angle, sagittal index, load sharing classification and patient related factors. The posttraumatic deformities due to malunion or nonunion can be treated successfully with posterior only approach with osteotomies like SPO, PSO, PVCR and posterior instrumentation.

Noncontiguous unstable cervical and thoracic spine fracture

Tomi Kunej

Dislocated extension fracture in ankylosing spondylitis

Cene Kopač

SESSION 6: BASIC SCIENCE

3D printing in spine surgery: application, feasibility, utility

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Introduction: The National Center for Spinal Disorders (NCSO) has implemented a four-step strategy for the clinical application of medical 3D printing.

Patients/methods/core: First, the acceptance of 3D technologies was assessed through a brief survey. Second, FDM and DLP 3D printing technologies were compared. Third, a patient-specific surgical navigation guide was developed to demonstrate a clinical application. Fourth, 3D-printed anatomical models were evaluated against traditional imaging.

Discussion: The survey from the first step indicated a general interest in 3D technologies, with only 2.1% of respondents expressing skepticism about its future and 1.4% stating they were "not interested." In the second step, the comparative analysis showed that the more cost-efficient FDM 3D printing process achieved sufficient geometric accuracy, with 99% of the 3D-printed vertebrae falling within 1 mm of the original virtual geometry. The surgical guide development method in the third step incorporated the patient's biomechanical parameters, proving more cost-effective than conventional methods and reducing the need for intraoperative X-rays. The survey in the fourth step concluded that there is no statistically significant difference in perception between neurosurgeons and orthopedic surgeons, and years of experience do not influence the perceived usefulness of 3D models. The greatest added value was observed in patient education compared to traditional imaging.

Conclusion: The strategy presented by the NCSO has the potential to seamlessly integrate 3D printing and various technologies into everyday clinical practice, enhancing understanding of morphology, facilitating preoperative surgical planning, and improving patient education.

Cervical spine movement control in patients undergoing anterior cervical discectomy and fusion

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Research suggests that asymmetric tonic activity provoking firing of dense muscle fibers as well as pathological ingrowth of specialized mechanoreceptors into the intervertebral discs may lead to falls sense of cervical spine position and movement control. Theoretical principles suggest that discectomy could eliminate these pathological mechanisms and restore movement control functions. The aim of the study was to investigate cervical spine movement control in disc herniation patients before and after anterior cervical discectomy and fusion (ACDF).

Movement control of fourteen patients before and one week after ACDF was evaluated using the Butterfly Test (NeckCare System, NeckCare, Iceland). Patients wore a head-mounted IMU sensor and attempted to follow a moving target on a computer screen as accurately as possible with a cursor controlled by the sensor. The target moved at an unpredictable velocity along three predetermined trajectories (easy, medium, difficult) invisible to the subject. Changes in undershoot, time-on-target, overshoot and amplitude accuracy parameters pre and post ACDF were analysed using the sign test.

Statistically significant improvements were observed for amplitude accuracy and overshoot for the difficult trajectory following ACDF. Similar trend was observed for all other parameters for the easy and medium trajectory but was not statistically significant.

This is the first study to support the hypothesis that the removal of diseased intervertebral disc may lead to improvements in movement control in patients with cervical spine herniation. A larger sample of patients is needed to confirm these findings and determine their clinical applicability.

Key words: cervical disc herniation, movement control, cervical sensorimotor control, ACDF

The use of AI in orthopedic image analysis

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Introduction: The use of artificial intelligence (AI) has, especially through deep learning (DL), spread into every aspect of medicine, including orthopedics. The Laboratory of Imaging Technologies at University of Ljubljana, Faculty of Electrical Engineering, Slovenia, has a long track in state-of-the-art research, and in the design and development of commercial applications for automated orthopedic image analysis.

Core: Examples of research include vertebra segmentation, pedicle screw placement planning, pelvic abnormality detection, and sagittal balance and Cobb angle evaluation from radiographic (X-ray), computed tomography (CT) and magnetic resonance (MR) images. Demonstrations of commercial applications display the integration of these examples into sophisticated software frameworks.

Discussion: The methods based on AI can be applied to various fields of orthopedic image analysis, including the presented examples. Vertebra segmentation from CT images has achieved a satisfactory level of accuracy, pedicle screw placement planning can target CT trajectories with the highest underlying bone mineral density, pelvic abnormalities can be detected by accurate automated MR hip morphometry, and sagittal balance and Cobb angle evaluation rely on accurate identification of X-ray keypoints used to construct geometrical measurements. Successful commercial applications are possible by integrating such research with graphical user interfaces that combine image manipulation, analysis tools and results correction into sophisticated software frameworks.

Conclusion: With the introduction of AI, especially DL, medical image analysis has become more accurate and reliable, and the resulting performance more robust. The Laboratory of Imaging Technologies has adopted this trend, and proven to successfully integrate AI into different aspects of orthopedic image analysis.

Skier position MRI for ASD assessment after spinal fusion surgery

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Introduction: Segments above fused spine have higher mobility and they are especially prone to an accelerated disc degeneration. Adjacent segment degeneration (ASD) has become a great concern as a late complication in patients following fusion spine surgery with a potential need for revision surgery. Also, axial rotation and its impact on the unilateral fused segmental kinematics remains unclear. Purpose of our study is to investigate early disc degenerative changes two levels above surgically fused lumbar spine segment. Furthermore, to investigate MRI neuroforaminal diameter changes during trunk axial rotations (skier position).

Methods: In disc evaluation study a total of 117 patients were included in this cross-sectional retrospective single center study. MRI was performed 2.5 years after surgery. The modified 8-level Pfirrmann grading system was used for the assessment of disc degeneration severity. The Mann-Whitney test and the Wilcoxon signed-rank test results were used to display differences. Also, MRI measurements were performed in standard supine patient's position and in skier position (axial rotation) in 2 spine levels on ten patients. Intervertebral foraminal cross-sectional area were calculated from maximal foraminal high and width and correlated in regard to: side of rotation and between two spine levels. Data were compared using analyses of variance and descriptive statistics t-test and mixed model ANOVA.

Results: The assessment of the intervertebral disk structure in BIL TLIF is higher two levels above fused lumbar spine segment. Early disc degeneration progression is subtle; however, detectable (UNI TLIF 9.28% vs. BIL TLIF 16.74%). In the axial rotation study, the biggest foraminal opening was in the first group of ipsilateral axial rotations (right AR, right UNI TLIF) on the contralateral side left upper foramina (for 73%) in comparison to right upper foramina (for 32%). A comparison of the average foramen surfaces between the two positions shows that the foramen surface is larger in axial rotation, regardless of the level (lower or upper) and side (left or right).

Conclusion: Patients who had undergone unilateral TLIF fusion surgery have a lower rate of early disc degenerative changes. Considering a significantly higher rate of progressive disc degenerative changes in elderly with bilateral fusion surgery, extra caution is required in the selection of appropriate surgical technique. Neuroforamina of the fused segments show lower degree of alternations during axial rotation in comparisons of higher mobility of the

unfused upper segment above. Axial rotation MRI might give additional information about degree of dynamic foraminal diameter changes and mobility of adjacent segment.

The scientific background of cell therapy treatment of the spine

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Introduction: The promise of cell and especially stem cell therapy for the treatment of various diseases is a hot topic in scientific community. We all know that not all that glitters is gold, cell therapy as well in not an answer to every disease. Thus, careful evaluation of where and when to implement cell therapies is needed to ensure benefit to the patients.

Core: Spine surgery despite its tremendous advances, still has some indications, where cell therapy could be of benefit. Given the cell therapy capabilities, such as differentiation into certain cell types and immunomodulatory function, there are some clinical indications where cell therapies appear to be most promising, such as improving lumbar fusion, treatment of degenerative disc disease and low back pain. We will try to evaluate clinical data on these indications and try to conclude which clinical indications in spine surgery can indeed benefit from cell therapies.

Discussion: There are some good examples of the use of cell therapies in spine surgery and cells seem to be beneficial also as an injection. On the other hand, there are some clinical indications, where cells do not seem to be best option as they do not improve status of patients.

Conclusion: Cell therapy can be a valuable tool for answering some of the challenges in spine surgery. However, it is not a solution for every clinical indication, so knowing when and which type of cell therapy to use is just as important as appropriate cell preparation in laboratory or in operating theater.

The influence of cervico-thoracic correction on the tension of the brachial plexus

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Introduction: Neurological complications are among the most significant concerns of complex cervical deformity surgery. The reported incidence of neurologic complications ranges from 13-29% in literature. With our anatomical study, we simulated the tension exerted on the brachial plexus nerve roots during different patterns of deformity correction.

Methods: On 6 cadaveric specimens, C2-Th6 instrumentation was performed and cervical nerve roots C5-C8 were bilaterally dissected. Changes of nerve length were measured at 0°, 40° and 80° of coronal alignment, when the correction was performed at C4-C5 and repeated at Th2-Th3. To analyze differences between nerve lengths, a one-way repeated measure ANOVA test was used.

Discussion: With increasing degree of coronal correction, nerve length and tension increased significantly on the convex side of the construct. The increase was greater when the correction was performed at Th2-Th3, compared to C4-C5. This underlines the importance of the lever arm effect. A corrective maneuver with a longer lever arm can cause greater tension and damage to the nerve roots of the brachial plexus.

Conclusion: This anatomical study demonstrated the spatial changes of brachial plexus during different cervical spine alignment patterns. With increasing degree and leverage of coronal correction, tension on the underlying nerve roots increases, as well as the risk of neurological complications.