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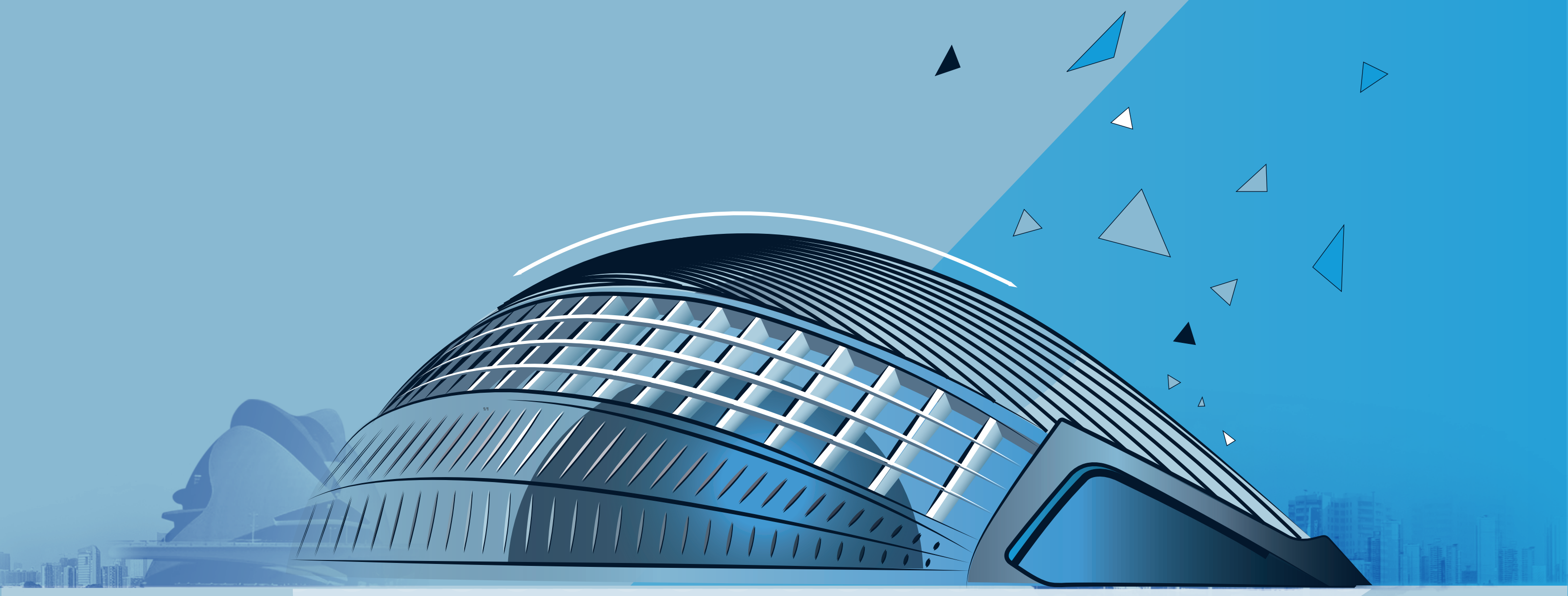
Neo BEYOND THE EXPECTED

Abstract Book



THINK BEYOND FUSION

2nd International Spine Expert Symposium

June 23-25, 2022

Valencia, Spain

Speaker List from the 2nd International SENSE Symposium

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Speaker Abstracts from the 2nd International SENSE Symposium

Contents

1. From fusion to functional fusion: The quest for an anatomical and bio-mechanical balance of the spine

Pierce D. Nunley, MD

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Questions to Consider

- Have you ever wondered how much excessive force some instruments apply into constructs and ultimately the anatomy? How might that impact results?
- Have you ever thought about why some set screws are loose compared to others when performing a revision? What is causing this?
- Have you ever considered what causes implants to make a squeaking noise during assembly? Why might this matter?

Background

According to literature, fusion is achieved in 85% to 95% of cases[1], and outcomes have remained constant for comparable procedures since the 1980s. However, solid fusion alone is not a predictor of good long-term clinical outcome. Failed Back Surgery Syndrome (FBSS) has been created to "explain" the poor outcomes, with incidences reported between 10% and 40%[2,3,4,5,6]. The more complex the surgery, the higher the FBSS rate.

The revision rates reported in the literature on degenerative and deformity spine surgery are significant and have increased from 2006 to 2014[2-7]. The most common reason for re-surgery is implant failure, whereas 67% of re-interventions may be attributable to mechanical stress.

Controllable Risk Factors During Surgery

Intraoperative reasons leading to unsatisfactory results can be explained directly or indirectly by (bio)mechanical reasons. Today, much attention is paid to controlling sagittal alignment and protecting the facet joints of adjacent segments during pedicle screw placement. Risk factors that have received little attention offer the opportunity to improving outcomes: coronal and axial alignment and mechanical forces applied during instrumentation.

Recent PSS developments aim to minimize the applied forces, potentially reducing the biomechanical complication rate after instrumented posterior lumbar fusion surgery.

Mechanical Risk Factors

- Several biomechanical studies have identified risk factors for mechanical overloading:
- Screw head/rod mismatch: using a persuasion device to reduce residual gaps of 5mm generates enough force to pull out screws [8]
- Correction of rod contouring: in-situ bending creates significantly higher loads compared to cantilever bending [9]
- Rod contouring: 60% less force applied to screws during computer-assisted bending compared to manual bending [10]
- Unintentional stress: heavy instruments with high centers of gravity, blocked screw polyaxiality preventing orthogonal implant alignment, seating force pulling the spine to the rod, flat set screw design limiting orthogonal alignment and creating friction
- Screw head/rod alignment: 90° are mandatory to avoid overload, friction and cold welding.

Forced Fixation

Unknowingly applying forces and mechanical stresses during the assembly and locking of a pedicle screw construct which may result in implant loosening and hardware failure."

Possible consequences include reduced pull-out strength, creation of axial deformity, increased facet pressure, trabecular fractures and annular tearing[11].

Force Control

Force control is a surgical technique that respects the following principles

- Unique physiological screw head position
- Maintain screw head mobility throughout
- Awareness and control of mechanical force

This is supported by lightweight instruments with a balanced COG that allow screw polyaxiality, the use of real-time data, convex set screw designs and zero-friction screw driver.

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2. The impact of surgical fixation technique on pedicle screw anchorage

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Background

Pedicle screw loosening is one of the most frequent complications of thoracolumbar posterior fixation. Incidences of up to 15% have been reported in non-osteoporotic patients and over 60% for non-cemented pedicle screws in osteoporotic bone[1, 2]. The reported prevalence is considerably depending on definition, e.g. screw pull-out or radiolucent rim >1 mm around the screw[3].

However, a recent PubMed systematic literature search confirms a patient-related loosening rate of 15.1% (CI 14.2%-16.0%, range 0%-63.4%) and a screw-related loosening rate of 3.8% (CI 3.5%-4.1%, range 0%-20.3%) on pooled data. There is evidence that 89.3% of loosened pedicle screws are pulled-out during rod connection[4]. Screw pull-out strength[5], insertion torque (IT) and extraction torque (ET)[6] correlate strongly with intrapedicular bone density. The aim of this study is to investigate the effects of reduction and tightening, and the influence of additional distraction forces on pedicle screw anchorage at different bone densities during construct assembly and final locking.

Material and Methods

Two human cadaver specimens (13 segments, T5-S1) were stabilized in direct side-by-side comparison using pedicle screw rod systems following different fixation philosophies: force control (FC: Neo Pedicle Screw System) and standard fixation (SF: CD Horizon Solera). ITs and, after assembly, final tightening and a short period of settling, ETs were measured digitally. The impact of reduction and final tightening was evaluated by comparing the losses between IT and ET. In addition, the effect of distraction forces (100N) applied across pedicle screw heads was investigated in polyurethane foam blocks of certain densities. Statistical significance at $p < 0.05$, Mann-Whitney U test for comparisons and correlation analyses according to Spearman.

Results

With FC, the median torque loss was significantly lower (0.393Nm) than with SF (0.539Nm) ($p<0.001$). Despite higher ITs with SF (0.966 vs. 0.747Nm), ETs were similar (0.344 vs. 0.301Nm) (Fig.1). IT and ET correlated statistically significant (FC: $r=0.792$ and SF: $r=0.783$; $p<0.001$). Torque losses were higher in both groups when additional distraction forces were applied directly across pedicle screw heads ($p \leq 0.041$).

Conclusions

Reduction and tightening of the rod-screw interface have a significant impact on pedicle screw anchorage. The loss between IT and ET quantifies the loss of biomechanical behavior and consequently the load transferred to the instrumentation and the surrounding tissue. It is higher if the instrument assembly is performed with a standard fixation technique. Force control alters the biomechanical behavior to a lesser extent and results in lower forces during reduction and tightening of the pedicle screw construct. Utilizing surgical techniques that avoid unnecessary load application during screw-rod assembly could potentially decrease screw loosening, construct failure and reoperation rates, and improve clinical outcomes.

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3. How forced fixation affects patients' clinical outcomes

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Background

The literature indicates that 15 years after lumbar fusion, 27.3%[1] to 37.5%[2] of patients require a new surgical treatment due to adjacent segment disease (ASD), depending on the diagnosis. 75% of patients were dissatisfied with their outcome[2]. In recent decades, the number of hardware-related reoperations has increased[3]. Approximately 70% of all revisions are due to mechanical failure, such as screw pull-out, screw loosening, disassembly, implant breakage, pseudarthrosis, ASD and proximal junctional kyphosis[3,4], and another 10% due to infection[3]. Since it is known that in 90% of all loosened screws, screw pull-out occurs during intraoperative tightening of the pedicle screw-rod assembly[5], special consideration must be given to the forces applied to the spine during this process. In many cases where implant failure and early ASD occur, mismatch of the pedicle screw head and rod (S/R) can be seen on postoperative radiographs. Mismatched pedicle screws and rods are clear signs of overload. This overload is transferred to the surrounding tissues and has significant impact on the biomechanics and alignment of the spine. The objective of this study is to analyze the impact of mismatches on clinical and radiological outcome.

Material and Methods

Retrospective review of patients who underwent fusion surgery with pedicle screw/rod systems for predominantly degenerative pathologies between 2013 and 2018 and for whom clinically and radiologically complete preoperative, postoperative, and 1-year follow-up data were available. 1,183 patient records were reviewed accordingly. Comparisons were made between patients with and without mismatch in terms of fast appearing ASD, VAS pain and revision surgery. S/R alignment is measured as the angle between each pedicle screw head and the associated rod. Angles other than 90° +/- 0.3° are considered mismatched.

Results

406 patients met the inclusion criteria for the study. A total of 3,016 pedicle screws were implanted in them between T2 and S2. Mean follow-up time was 5 years (1 to 7 years). In 42.1% of the patients (171/406) a S/R mismatch was found in at least one of the pedicle screws, affecting 20.3% of all pedicle screws (613/3016). Of the patients who developed a new radiographic ASD sign at the upper adjacent level at final follow-up, 83.9% were in the mismatch group (47/56). Patients with S/R mismatch experienced significantly more pain (mean (SD) VAS pain 2.8 (0.8) vs. 1.4 (0.8)). The overall revision incidence was 11.8% (48/406). Of the cases that underwent revision surgery, 95.8% belonged to the mismatch group (46/48). When comparing patients who underwent intraoperative correction and/or reduction with those who did not, there were statistically significant differences in screw mismatch (p=0.004) and revision incidence (p=0.001).

Conclusions

Orthogonal alignment between pedicle screw head and rod plays an important role in clinical and radiological outcome. In addition, the control of spinal parameters is mandatory. Mismatch of the pedicle screw/rod interface should be considered as an important factor for unexpected outcomes.

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4. Benefits of preoperative planning in degenerative indications

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Background

Primary surgical aims of spinal fusion are improvement of pain, adequate decompression of nerve roots, stability with perfect implant positioning, and correction of deformities if necessary. Secondary goals are to achieve a solid fusion and to avoid recurrent pain and subsequent surgery. However, problems associated with fusion include implant-related complications such as screw misplacement, pseudarthrosis, and screw loosening, as well as biomechanical problems including adjacent segment disease (ASD). In fact, the ASD related revision rate 15 years after circumferential lumbar fusion is 37.5%[1]. Natural progression of the degenerative disease is often cited as the reason, but in many cases a common problem can be identified, namely hypolordosis of the fused segment.

Which are major drivers for ASD?

There is evidence that age > 60 years is one risk factor for ASD . PLI F also increases the risk for ASD by a factor of 3.4 compared to TLIF[2] and an uncorrected mismatch between lumbar lordosis (LL) and pelvic incidence (PI) by a factor of 10[3]. A recent study shows that fusion in non-physiological kyphosis or hyperlordosis causes high stress on the adjacent intervertebral discs[4]. In a healthy spine, the lumbar vertebral segments are always in lordosis, and the lordotic angle increases from cranial to caudal. If a segment is placed in hypolordotic alignment, this will result in an anterior shift of the plum line or compensatory erection of the adjacent segments with hyperlordotic disc angles. This is a typical mechanism for ASD.

How to prevent ASD?

The use of TLIF instead of PLIF is a possible option to reduce ASD rates. LL and PI should be matched and adjacent segments be protected from unnecessary stress by fusion in anatomical lordosis. Literature indicates that in the lower lumbar spine, fusion segments with a lordosis angle greater than 15° have significantly less ASD[5].

What do we need to plan a short lumbar fusion?

Upright lumbar spine radiographs showing the femoral heads are required to measure PI (sacral slope + pelvic tilt), LL, L4-S1 angulation and segmental angulation. From these data, one can calculate the angles to be obtained intraoperatively for a PI-matched LL (0.54 x PI + 27.6; acc. to Le Huec), optimal L4-S1 angulation (2/3 of LL) and segmental angulation (L5/S1: 40% of LL; L4/5: 27% of LL; L3/4: 18% of LL). For a rebalancing short TLIF, adequate release, anterior cage position, perfect cage height, and intraoperative measurement of lordosis are mandatory.

Conclusions

Non-anatomic fusion is a possible trigger for ASD. The potential key to long-term success is restoration and anatomic distribution of LL. To achieve this, detailed preoperative planning is required for each fusion case.

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5. Force Control techniques and technologies applied in complex deformity corrections

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Background

The concept of controlled fixation can be used for complex deformity correction. Four controlled reduction maneuvers are to be considered for different types of deformity: 1. Canitilever technique for flexible kyphosis, 2. Translation technique for flexible idiopathic scoliosis, 3. Bloc reduction for neuromuscular flexible scoliosis and 4. Pedicle Substraction Osteotomy (PSO) with Domino compression for rigid kyphosis.

Cantilever Controlled Reduction

The first case shows a L4-S1 lordosis reduction. Here, the initial key aspect is precise rod bending and stress-free placement between iliac fixation and the S1 screw. Further checks should follow up to the most cranial level to control the reduction performed, using the towers as a reference. Another case shows a 70 years old male with Parkinson disease. The patient had prior surgery for lumbar stenosis with progressive spinal deformity, proximal and distal junctional kyphosis and pseudarthrosis. He had standing and walking difficulties, but no leg pain and no deficit. The patient was treated in staged surgery. Step 1: T2 to Ilium posterior fusion without osteotomy by Wiltse approach, posterior instrumentation and Domino correction procedure. Step 2, 3 weeks later: L4-L5 and L5-S1 anterior graft by ALIF procedure. Three months postoperatively, radiographs show good correction of global alignment.

Translation Controlled Reduction

The next case shows how the Neo system can be used for the correction of idiopathic scoliosis in controlled translation technique. This technique has demonstrated superiority, especially in restoring thoracic kyphosis[1]. After standard screw insertion, the towers of the monoaxial screws exactly follow the curved spine. Inserting the rod should be easy. Then all set screws can be screwed in until they touch the rod and then tightened. This generates major correction forces. These forces cannot be avoided, but Neo supports to share these loads well in a controlled way.

Bloc Controlled Reduction

In neuromuscular flexible scoliosis, bloc reduction is the treatment of choice with the Baker technique. It aims to fix the spine from the bottom up. Due to the strong fixation in the lower part, it is possible to achieve distraction by passing long rods under the skin and under the fascia to the upper part of the instrumentation. This allows good correction with a relatively simple and less aggressive operation. In 7 years of experience with about 60 cases, no rod breakage has occurred so far.

PSO Controlled Reduction with Domino Compression

PSO is the most difficult procedure in deformity correction surgery, and performing it with proper tower management is challenging. To achieve a force-controlled reduction, the caudal and cranial parts of the fixation are performed separately in stress-free cantilever technique, which can be controlled by the Neo towers. The upper and the lower blocs are then reduced in Domino technique and fixed to each other without avoidable pull-out stress. With this technique, the forces required for correction are applied in a controlled manner, i.e. only the load that is absolutely necessary is exerted where it is needed.

Conclusions

All types of deformities can be treated with the Neo system in a controlled fixation technique with only a few instruments. The main issues are the optimal placement of the screws, the precise bending of the rods and the flexibility of the spine.

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6. Controlling forces in trauma indications: How to get the best of the technique

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Background

The principle of fracture treatment is simple: reposition, stabilization and maintenance of stabilization. The challenge of spine surgery in 2022 is the management of poor bone quality in osteoporosis. In Germany, 80% of all vertebral fractures are due to poor bone quality.

Challenges of Reduction and Stabilization

In general, fracture reduction should always be attempted by hyperlordotic positioning of the patient using ligamentotaxis. For this purpose, the patient's legs are pulled until adequate spinal distraction is achieved. In spine surgery, there are a variety of strong and powerful instruments designed for reduction, such as persuaders, rockers or pushers. The use of these devices reduces pedicle screw anchorage in bone by nearly 50%, with little difference between normal and osteoporotic bone. A 5mm reduction is enough to cause screw loosening[1]. Especially in elderly patients with traumatic indications, the use of these instruments should be avoided.

Loosening or pulling out of the pedicle screw is a relevant complication that occurs in about 15% of cases in good bone quality. 82% of the loosened screws were pulled out during the final rod connection[2]. The risk of screw loosening can be reduced by 48% by achieving an optimal fit of the rod/screw interface[3].

Forced Fixation – A Problem of design?

Conventional spinal instruments are heavy (0.8 kg to 1.5 kg), have long lever arms and a center of gravity far away from the surgical site. This reduces tactile feel and increases the load on the implants by a factor of 40. These instruments block the polyaxiality of the screw head and thus prevent a perpendicular alignment of rod and screw. Forceful reduction maneuvers pull the spine toward the rod, creating high loads, and flat set screws prevent orthogonal alignment of the rod and screw during the last half turn, promoting cold welding and stabilization failure.

Controlled Fixation in Trauma Indications

The three main principles of controlled fixation are:

1. To place the screw head in a reproducible anatomical position,
2. To keep the screw head polyaxial, and
3. Control the mechanical forces.

This is supported by the use of balanced, lightweight instruments with short lever arms that provide tactile feedback and visual control of screw position, reduction and fit of the rod to the screw. Rod reduction through polyaxiality of the screw heads allows stress-free and controlled positioning of the rod. The convex screw design and the "frictionless" locking mechanism support controlled final tightening, reducing cold welding and implant failure. Locking the construct should always be parallel, symmetric, and alternating to control coronal deformity, sagittal compression or distraction, and mal-rotation.
Another key to stable screw fixation in the osteoporotic spine is cement augmentation in conjunction with a maximum screw diameter[4]. Using 1ml bone cement per screw increases the fatigue load by 41%[5]. In addition, intermediate screws at the fracture level have been shown to significantly improve maintenance of correction[6].

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7. ADVISE™ Augmented technology platforms: A clinical perspective

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Background

While pre- and postoperative imaging for measurement and planning is standard in spinal fusion care, numerous efforts have been made in recent years to optimize pedicle screw placement through intraoperative navigation techniques. However, technologies to assist in rod bending and placement have stagnated. Currently available rod system technologies, such as the Bendini® Spinal Rod Bending System, are primarily aimed at reducing OR time. However, biomechanical studies were able to show further benefits: computer-bent rods provide 60% lower residual forces than manually bent rods, which significantly reduces the risk of screw failure[1]. A decrease in screw loosening[2] and a significant decline in rod breakage[3] 1 year after surgery provide clinical evidence that the precision of rod bending is of significant importance. To avoid new problems caused by deformities unintentionally created intraoperatively, tools are needed to assist the surgeon in monitoring, managing, and achieving the proper level of correction for each patient.

ADVISE™ - Your Intraoperative Advantage

ADVISE™ is a radiation free Augmented Reality (AR) software that runs on an Apple iPad. ADVISE™ stands for Advanced Dynamic Visualization of Intraoperative Spinal Equilibrium. The software assists the surgeon in objectively measuring the patient's specific conditions intraoperatively compared with preoperative planning to achieve a patient-tailored construct for optimal correction, fixation and outcome. Thanks to the familiar, easily accessible hardware and a simple learning curve, ADVISE™ is easy to use. It can be applied for all indications of in-situ posterior fixation or correction.

For intraoperative use, the iPad is covered with a sterile sleeve. By scanning the surgical field in three dimensions or using additional markers placed on the towers, the integrated iPad camera identifies the positions of each pedicle screw head based on the screw towers. During this process, the respective tower is displayed in yellow. Once the registration of a screw is complete, the color changes to blue. After having done this for all screws, ADVISE™ calculates the size and shape of the rods to be used. The user can select any available rod to test the placement and adjust the position of the rod with gestures. Templates of ideally bent rods for a given screw orientation are mapped in the coronal and sagittal planes. The bending of the rod can be done over the iPad along these templates to initially obtain appropriate correction and avoid re-bending. For spondylolisthesis and trauma cases where predefined correction values are to be achieved, specially developed modules offer the possibility of taking these correction values into account in the rod bending.

Conclusions

ADVISE™ is an easy-to-use, iPad-based AR-enabled platform. The surgeon will be assisted in obtaining precisely fitted curved rods that will benefit all patients, but especially those with weakened bones (e.g., cancer, osteoporosis). It can be used for all types of cases, saving time, shortening the time of surgery that could possibly leading to fewer infections in more complex cases, and helps reduce radiation exposure for patients, surgeons and OR staff. In addition to controlled fixation, predictive correction helps maximize outcomes. Clinical data are needed for further insight.

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8. MIS deformity correction using disruptive, AI-driven, augmented reality technology: Early clinical experiences

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Background

In daily practice, the philosophy of wanting to transfer as little stress as possible to the screw-bone interface contrasts with the goal of wanting to achieve a perfect sagittal alignment, for instance in semirigid deformities. But even in cases where heavy metal is required, augmented reality technology like ADVISE™ can significantly improve the outcome.

Case 1

Anamnesis: 59 year old male, severe back pain, walking distance < 500m, slight hyperlordosis thoracolumbar junction, Global Alignment and Proportion (GAP) score = 3
Surgical goal: restoration of disc T12-L1
Treatment: XALIF & OLIF with posterior instrumentation T10 to ilium, rod bending using ADVISE™: precise shape of a long rod
Outcome: proper correction achieved (GAP score = 0)

Case 2

Anamnesis: 59 year old female, severe hypolordosis, coronal dysbalance, GAP score = 7, stenosis, 3 prior surgeries: 2x compression, 1x fusion without graft L4-L5
Surgical goal: re-balancing
Treatment: ALIF & OLIF with posterior instrumentation L2-S1, rod bending using ADVISE™: precise rod shape, no force needed for final tightening of set screws
Outcome: improved balance (GAP score = 2)

Case 3

Anamnesis: 76 year old male, severe hypolordosis, degenerative lumbar scoliosis, GAP score = 12
Surgical goal: re-balancing
Treatment: 3x OLIF & 1x XLIF with posterior instrumentation L1-L5, rod bending using ADVISE™: precise rod shape
Outcome: improved balance (GAP score = 2)

Case 3, Pre-op

Case 3, Post-op

Case 4

Anamnesis: 65 year old male, moderate hypolordosis, degenerative lumbar scoliosis, GAP score = 9
Surgical goal:re-balancing
Treatment: ALIF with posterior instrumentation L1-S1, rod bending using ADVISE™: precise rod shape
Outcome: improved balance, slight overdistraction causes less correction of scoliosis (GAP score = 1)

Clinical results so far...

21 patients treated with MIS deformity correction using ADVISE™ software, average follow-up 4 months (1 to 7 months), mean length of hospital stay 5.5 days, no proximal junctional kyphosis or failure. Experience to date suggests that the use of AR software in long posterior percutaneous instrumentation results in intraoperative time savings, reduces radiation exposure, decreases postoperative pain, and allows earlier mobilization.

Next steps

ADVISE™ is, at the moment, a screw-based measurement. However, when merged with intraoperative imaging, this self-learning platform can generate large amounts of data. This could allow real-time intraoperative tracking of spinal correction and enable the surgeon to "bring preoperative planning to the table" by monitoring the achieved correction step by step.

9. Making data-driven decisions in spinal surgery

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Background

Spinal deformity surgery is the most expensive and complicated procedure in orthopedic surgery. In addition to clinical outcomes, economic decisions are important in this costly area of healthcare. The criteria for choosing a medical device manufacturer are diverse and include personal relationships, economic factors, ease of use, unique factors, environmental impact, and data. But how do we use data like angles, screw pull-out, and failure rates in our decision making?

Total Technology Ecosystems

From an economic perspective, it makes sense to choose value-based care, such as that offered by Neo. Concrete cost improvements have been demonstrated: reduced operational costs by saving over $1600/€1415 per case, improved intraoperative efficiency by reducing operating time by almost 30% and decluttering the OR by reducing instrument and implant requirements by 90%[1]. With its single-use sterile platforms, force control capabilities and accessible AI/AR technology for all indications, including degeneration, trauma, tumor and deformity, it acts as a unique total technology ecosystem. Outcomes have been shown to be better, with fewer implant loosening and failures[2,3], and less deep implant infections[2]. Environmental impact is decreased through material efficiency, reducing the carbon footprint per case by 75%[4].

What Are We Talking About in Spinal Deformity Surgery?

When experts talk about deformity surgery today, they are primarily talking about complications. About 70% of all publications on adult spinal deformity correction report on reoperation rates and the incidence of complications, including potentially life-threatening complications and complications associated with disability. There is a clear need to improve patient outcomes. In addition, surgeons want technology to improve intraoperative control of spinal alignment[5]. Artificial Intelligence offers a significant advantage in guiding complex procedures that require high precision and accuracy, and has tremendous potential to revolutionize spine care[6].

Adjusting Our Technology Adoption Criteria

Future technology for spine surgery should be value-based providing clinical and economic benefits. In the total technology ecosystem of Neo, streamlined and perioperatively integrated instruments for all indications support cost improvement. Integrated functionality helps to control correction and fixation forces to improves patient outcome. And intraoperative navigation using accessible AI/AR technology supports both cost and outcome improvement.

Conclusions

Multilevel spinal fusion procedures are expensive, invasive, and complicated, and yet our patients willingly allow us to perform this. We have an ethical, moral, and global obligation to provide the best care possible, while reducing costs and complications, and improving outcome. Honest and objective analysis of our collective experience should inform our decision making. Technology, when used appropriately, will allow us to provide the best possible care and outcomes for our patients.

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10. Open Forum: Techniques vs. technologies Building systems to optimize patient outcomes

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Background

New technologies in spine fusion surgery have for many years being focused on the placement of pedicle screws (e.g. navigation, robotics), with less attention to instrumentation and surgical techniques that offer the appropriate biomechanical and anatomical control of the forces applied on patients' spines.

Did we spent too much effort in developing new technologies, instead of trying to improve the surgical techniques used?

Introduction Technologies by Dr. Ignacio Dominguez

Pedicle screw placement is one of the most critical steps in spinal instrumentation because of the potential complications associated with screw-malposition, which may result in neurovascular damage, facet joint violation, and poor primary fixation. Complication rates >25% have been reported in the literature.

Navigation and robotics have been introduced into the spine surgery field in recent years. Given the advantages of precise orientation and reproducibility, robot-assisted pedicle screw placement is believed to improve clinical outcomes. Does the current available literature support this believe?

A recently published expert review[1], including 24 comparative studies, concluded that the robot-assisted spine surgery appeared to be more accurate in pedicle screw placement than the free-hand technique, are associated with shorter radiation exposure time, but show longer operative time than free-hand technique. However, multiple studies included in the review showed results in contrast to the above conclusions.

Cost-benefit studies and long-term follow-up studies are needed in the future to confirm better patient outcomes.

Dr. Dominguez shared his experience from using the technology in Hospital Clínico San Carlos in Madrid.

Introduction Surgical Techniques by Dr. Scott Blumenthal

Arthroplasty: Total Disc Replacement (TDR) – A treatment for everyone? Where are we now?

Center for Disc Replacement, Texas Back Institute - 20 Years of experience

The modern era of TDR began in the mid 1980s, and since then an extensive number of papers have been published on the lumbar TDR technique. In PubMed more than 1,000 articles published on lumbar and cervical TDR are found. Results from multiple studies in Europe with more than 10 years FU are available. Meta-analysis 5-year follow-up of RCTs (Ziegler, 2018)[2] (PubMed and Cochrane databases searched; 4 studies included). Results showed that compared with fusion, TDR had a significantly greater likelihood of:

- ODI success, patient satisfaction, and avoiding re-operation
- No difference in improvement in back pain scores

Many studies discuss results in appropriately selected patients. Literature is robust, strongly supports lumbar and cervical TDR in appropriately selected patients, with outcomes noninferior to fusion, and superior on some measures, including rate of re-operations.

What do we know about indications for lumbar TDR?

The main contraindications: Deformity, Instability, Combined degeneration, and Osteopenia. Operative factors related to better outcomes (Gornet, 2014)[3].

- Larger percent of endplate covered with the implant
- Larger implant heights
- Greater increases in disc space heights
- Greater increase in index level lumbar lordosis

In Which Cases Do Surgeons Specializing in Total Disc Replacement Perform Fusion in Patients with Symptomatic Lumbar Disc Degeneration? (Zigler et al, Eur Spine J, in press):

34.6% of patients coming to the clinics for a TDR had a contraindication, and were treated instead with fusion surgery, and contraindications were more common in older patients.

Wisdom from Experienced Arthroplasty Surgeons...

- TDR is not for every patient
- TDR is not for every surgeon
- A good TDR is better than a good fusion
- A good fusion is better than a bad TDR
- A bad TDR is worse than a bad fusion

Open forum questions

With the overall goal of our surgeries to achieve better patient´s outcomes

- Do we focus more on technologies vs. focusing on surgical techniques?
- Are we adopting to new technologies at the cost of patient outcomes?
- Is fusion a 'bad' technique?
- How can we manage to combine techniques and technologies to optimize treatment results?

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Faculty contributors from the 2nd International SENSE Symposium

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