DOES PERCUTANEOUS LUMBOSACRAL PEDICLE SCREW INSTRUMENTATION PREVENT LONG TERM ADJACENT SEGMENT DISEASE?

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Introduction: Percutaneous pedicle screw augmentation of lumbar interbody fusion procedures is an increasingly popular minimally-invasive technique that avoids disruption of the posterior soft tissue stabilizers. Adjacent segment disease (ASD) is a well-known complication of spinal fusion. The rate of ASD requiring revision surgery may be lower than those of traditional lumbar fusions with open pedicle screw procedures due to preservation of lumbar stabilizers. There is a paucity of addressing this hypothesis of great importance in the management of common spinal pathology. Additionally, abnormal sagittal plane configuration of the spine following lumbar fusion has been hypothesized to increase the rate of ASD as well.

Purpose: To evaluate patients who underwent lumbar fusion with minimally-invasive percutaneous lumbosacral pedicle screw instrumentation and specifically assess: (1) proportion revised secondary to ASD and, (2) risk factors for revision secondary to ASD including a) demographics and, b) pelvic incidence (PI) and lumbar lordosis (LL) mismatch.

Methods: A retrospective review from 2004-2014 was performed to identify patients who underwent anterior, lateral, or minimally-invasive transforaminal lumbar interbody fusion with percutaneous pedicle screw placement with a minimum follow-up of 5 years. Patients were divided into two cohorts: those who underwent revision surgery secondary to ASD and those who did not require further surgery. Demographics, ASA grading, number of levels fused and number of revisions secondary to ASD were recorded. Pelvic measurements were performed using postoperative sagittal radiographs and patients with PI-LL mismatch >10 degrees were noted. Standard binomial and categorical comparative analyses were performed between cohorts.

Results: 419 consecutive patients were included with a mean follow-up of 6.5 years (range 5-12). Overall revision proportion for any reason was 7.4% (n=31). Of these patients, 20 were revised secondary to ASD, a proportion of 4.77%. Patients revised secondary to ASD had a mean time to revision surgery of 2.5 years. The revision rate secondary to ASD was found to be 0.73% per year. Patients who developed ASD were younger (50.5 +/- 12.5 years) than those who didn’t (56.9 +/- 11.5 years) (p=0.015). There was no difference in number of spinal levels fused between patients with ASD (1.6 +/- 1.5) and the remaining cohort (1.4 +/- 0.7). There was a higher percentage of patients with PI-LL mismatch in the ASD cohort (22.2% v 18.8%) however, this was not statistically significant (p=0.758).

Conclusion: Adjacent segment degeneration in this population appears to be lower than previously published rates of adjacent segment disease. This may be related to the greater preservation of the posterior stabilizing elements of the lumbar spine during percutaneous pedicle screw placement, although further investigation is warranted.
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PERCUTANEOUS CORRECTION USING LATERAL INTERBODY FUSION AND COMPLETELY PERCUTANEOUS PEDICLE SCREW FIXATION FOR ADULT SPINAL DEFORMITY WITH DUAL ROD ROTATION TECHNIQUE AND REVERSE CANTILEVER TECHNIQUE. TECHNICAL NOTES

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Introduction. Conventional open corrective surgery for adult spinal deformity (ASD) generally produces substantial clinical results. There is, however, concern about the development of high surgical complication rates. In recent years, minimally invasive surgery (MIS) has been applied to ASD in an effort to reduce the high complication rates associated with open correction. The aim in this study was to describe a new percutaneous correction which consisted of lateral interbody fusion (LIF) and completely percutaneous pedicle screw (PPS) fixation for ASD using both dual rod rotation technique and reverse cantilever technique, and to evaluate the clinical results of this MIS method.

Methods. This method was applied to thirty-nine consecutive patients with ASD. The patients with a multilevel bony fusion or a severe malunion were excluded from this group. The mean age was 71 years old (range, 42-83 years). The mean of 7.9 intersegmental levels were fused. Operative time, surgical blood loss, pre- and postoperative global radiographic parameters were investigated. In addition to these data, complications were also evaluated.

Surgical methods. First, LIF in lumbar spine was performed in lateral decubitus position. After that, L5/S1 TLIF should be done. All pedicle screws were inserted percutaneously, and iliac screws were inserted too. The rods, bended in ideal alignment, were threaded from the caudal to the cranial. After inserting the rod within the all extender sleeve, the end caps were inserted into all sleeves leaving a little space. By rotating and pushing the caudal end of the rod, the lower thoracic spine was levered up, gaining ideal lumbar lordosis along the alignment of the rod (dual rod rotation technique and reverse cantilever technique).

Results. The average operative time was 398 minutes (range, 265-658 minutes) and the average surgical blood loss was 497g (range, 100-1795g). Pre- and postoperative coronal Cobb angle were 45 degrees and 11 degrees and LL were corrected from 8 to 50 degrees. PI-LL mismatch decreased from 43 degrees to 1 degree, SVA decreased from 144mm to 10mm, and PT was corrected from 33 degrees to 18 degrees. There were no intraoperative complications identified during the surgical procedures. Thigh numbness and weakness were observed postoperatively in seven patients, but these symptoms resolved in all cases within six months. Four patients were revealed rod fractures, and three patients were made reoperation.

Discussions. The severe spinal deformity could be corrected percutaneously. The reasons are an indirect posterior facet release by LIF procedure and an original corrective procedure with rod rotation technique and reverse cantilever technique.

Conclusions. The novel MIS method for ASD was reported. This method is original and less invasive surgery to obtain a balanced spine.

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VERTEBRAL AXIAL ROTATION IN PATIENTS WITH LUMBAR DEGENERATIVE SCOLIOSIS:
SURGICAL IMPLICATIONS FOR OBLIQUE LUMBAR INTERBODY FUSION

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Objective
Patients with lumbar degenerative scoliosis (LDS) are major subjects who will benefit from oblique lumbar interbody fusion (OLIF). Vertebral axial rotation coupled with LDS might change the distance of oblique corridor and induce improper cage position or increase the risk of contralateral root injury during orthogonal maneuver. This study aimed to investigate changes of oblique corridor in patients with LDS and determine proper working angle with respect to the direction of vertebral axial rotation during OLIF procedure.

Methods
To minimize confounding effects of age, body weight, height, and body mass index, propensity score-matched control groups were enrolled. Distance of oblique corridor and rotational angle of the left or right apex group were measured on axial T2 MR images and then compared with those of propensity score-matched control group.

Results
Fifty-five patients of the left apex group and 57 patients of the right apex group were compared with equal number (55 or 57) of patients of the propensity score-matched control group. The distance of oblique corridor in the left apex group was shorter than that in the control group at levels of L1-2 and L2-3 (16.72 ± 6.02 vs. 18.94 ± 5.73, p = 0.050 and 17.07 ± 6.58 vs. 20.52 ± 6.33, p = 0.006, respectively). In contrast, the distance of oblique corridor in the right apex group was longer than that of the control group at level of L2-3 (24.58 ± 8.53 vs. 21.49 ± 5.96, p = 0.027). For the rotatory angle of vertebral body, patients of the left apex group showed vertebral body rotating to the left side from L1-2 to L5-S1 (p = 0.000, 0.000, 0.000, 0.011 and 0.025, respectively). In contrast, in the right apex group, the vertebral body rotated to the right side at level of L1-2, L2-3, and L3-4 (all p = 0.000).

Conclusions
In the left apex group, the oblique corridor was decreased from psoas overlap and coupled axial rotation to the left side might increase the risk of contralateral nerve root injury during orthogonally working. Thus, surgeons should pay attention to the state of coupled vertebral axial rotation of LDS for OLIF procedure.

Figure 1. (A; left rotation of vertebra) and the right apex group (B; right rotation of vertebra). On both images, the oblique corridor was defined as the distance between the lateral border of aorta or the nearest iliac vessel and the anteromedial aspect of the psoas muscle (line with an arrow on both ends). Please note the different width of the oblique corridor between the left and right apex group. The rotational angle of vertebral body was referred to the angle formed by two lines: the vertical reference line (dotted line) and the line that passed through the center of the disc and the base of the spinous process. The value of rotational angle was regarded negative when the angle was created on the left side of the reference line (A) while it was considered positive when it was formed on the right side of reference line (B).

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CEMENT DISCOPLASTY FOR THE MANAGEMENT OF LUMBAR SPINE PSEUDO-ARTHROSIS IN ELDERLY PATIENTS; A LESS INVASIVE ALTERNATIVE APPROACH

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Introduction
Symptomatic pseudo-arthritis after lumbar spine fusion in elderly patients is associated with pain and reduction of the quality of life. Surgical revision through antero-posterior or posterior approach is associated with complications especially in those multi-morbid patients. Recently, there are reports about percutaneous cement injection (discoplasty) in case of symptomatic degenerative spondylosis in elderly patients aiming to avoid fusion surgeries.

The aim of this work was to evaluate the results of cement discoplasty in lumbar and thoraco-lumbar symptomatic pseudo-arthritis after posterior lumbar inter-somatic fusion (PLIF) in patients above 65 years.

Material and methods
From January 2011 to December 2017, 45 above 65 years patients with symptomatic pseudo-arthritis after lumbar spine fusion were treated in our department through percutaneous cement injection in the affected disc space. Indications of the procedure were: persistent lumbar pain despite 6 months of conservative therapy, failure of radiological fusion in x-ray and CT scan up to 12 months postoperatively, presence of gas in the disc space in CT (vacuum phenomena), and absence of neurological deficits. The operation was done using 2 perpendicular X-ray devices using a trans-pedicular approach. A high viscosity bone cement is used in all patients. Assessment of the results included clinical evaluation (VAS and NDI) and radiological assessment using x-rays and CT scan.

Results
There were 30 females and 15 males. The mean age was 74 ±4.5 years. The most common affected level was L5/S1 in 20 cases followed with L4/5 in 10 cases. Discoplasty was performed after a mean of 14±6.3 months. The mean preoperative VAS was 7.5±4.2 and ODI was 26±8. Additional cement augmentation of the adjacent vertebrae was performed in 17 patients. Cement injection was done in one level in most of the cases, in 7 cases 2 levels injection was done, and in 3 cases 3 levels. Asymptomatic paravertebral cement leakage occurred in 7 cases (15.5%). In 14 (31%) cases additional extension of the instrumentation was necessary. The mean postoperative follow up was 32±18 months. At the end of follow up VAS improved significantly to 3.5±2.3 (p=0.02) and ODI improved to 16.3±4.8 (p=0.001). Reoperation was indicated in 2 patients after a mean of 6 months due to persistence of the symptoms and loosening of the screws, and they were surgically managed with anterior fusion and posterior revision and extension of the fixation to lower lumbar levels.

Conclusions
Cement discoplasty offers a less invasive surgical solution in elderly patients with symptomatic lumbar pseudo-arthritis. Discoplasty significantly reduces the symptoms, reduces the rate of anterior revision, and improves the quality of life of the affected patients.
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THORACOSCOPIC VERTEBRAL BODY TETHERING FOR ADOLESCENT IDIOPATHIC SCOLIOSIS: MINIMUM 2 YEARS RESULTS OF PATIENTS REACHING SKELETAL MATURITY

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BACKGROUND: Growth modulation with VBT has been reported to be safe and effective. This is the first report with ≥ 2 years’ f-up, in which all patients reached skeletal maturity.

PURPOSE: The aim of the study was to show VBT is a safe and effective growth modulation technique.

MATERIAL-METHODS: Data were collected preoperatively, before discharge, and at each follow-up. Demographic, perioperative, clinical, radiographic data and complications were recorded. Respiratory function tests were done at preop and 1 year postop. Surgical and total f-up correction percentages were calculated. Descriptive statistics are given.

RESULTS: 14 Lenke 1 patients (14F, 12.3±0.9 years) with a mean f-up of 28.9 (24-54) months were included. Preoperatively, all but 2 pts were premenarchal (median Sanders: 3 (2-5), median Risser: 0 (0-3)). The mean preop main thoracic (MT) curve was 45.4° (36-59°). Mean preop upper thoracic (UT) and lumbar (L) curves were 27.5° (14-44°) and 32.3° (22-42°), respectively. A mean of 7.3 (7-9) levels were tethered (UIV: T5/T6, LIV: T11/T12/L1). Mean surgical time was 233±71 min. Mean EBL was 55±41 ml. Mean initial correction rates were 34%, 54% and 49% for UT, MT and L curves, respectively. Following initial gain in height, patients grew 6.4 (2-16) cm on average, where 7 (-5 to 15) mm was between UIV-LIV. This growth was reflected into spontaneous f-up correction. Last f-up correction rates were 44%, 78% and 83% for UT, MT and L curves, respectively. Preop mean hump of 12° was reduced to 5.4° at final f-up. No significant changes were noted in kyphosis and lordosis measurements. Mean forced vital capacity increased from 2350 to 2858 ml at 1 year (range of change, 20-1220ml). All patients reached skeletal maturity (Sanders 7). Pulmonary complications (14%) were 1 atelectasis that resolved with physical therapy, and 1 pulmonary effusion that required readmission (7%). Mechanical complications were 2 overcorrection (14%) one of which was accompanied by LIV screw loosening. No tether breakages were observed.

CONCLUSIONS: VBT enabled spontaneous correction while allowing growth. Spontaneous corrections in the non-operated upper thoracic and lumbar levels were also noted. All overcorrections were observed in Sanders 2 patients. Sanders 3-5 patients possess a lesser risk of mechanical complications. VBT resulted in improved pulmonary functions. Overall pulmonary and mechanical complications rates were 14% each.

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SURGICAL COMPLICATIONS OF ANTERIOR VERTEBRAL BODY GROWTH MODULATION FOR SKELETALLY IMMATURE PATIENTS WITH IDIOPATHIC SCOLIOSIS

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Introduction
Anterior vertebral body Growth Modulation (AVBGM) has been shown the potential to correct scoliosis while maintaining spine flexibility.

Purpose of the study
Our hypothesis was AVBGM is an effective procedure with little perioperative and early postoperative risk. The objective of this study was to report a minimum 2-year outcomes and surgical complications of AVBGM in skeletally immature patients.

Methods
Fifty-three patients (50 female, 3 males) who underwent surgical treatment between Dec 2013-Jan 2017 were included; all enrolled in a prospective database of idiopathic scoliosis treated with AVBGM. Inclusion criteria were: idiopathic scoliosis, Lenke type 1A, 1B, 1C, 2A and 2B. Patients with Lenke 3A or syndromic scoliosis were excluded. Patient demographics, perioperative data, radiographic outcomes and post-op complications are reported.

Results
Mean follow-up was 33.4±7.9 months. Preoperatively, 42 patients were Risser stage 0, five stage 1, two stage 2 and four stage 3. Mean age at surgery was 12±1.3 years with an average of 7.2±0.8 vertebrae tethered per patient. Average Cobb angle was 49.4±11 pre-op, 25.4±11 at 2 months, 17±12.4 at 16 months and 16±12.6 at last FU. Revision surgery was performed in 6 patients: 1 tether removal due to overcorrection, 1 lumbar tether added due to distal curve progression, 1 tether replaced due to breakage, 1 patient for screw repositioning and 2 revised to a posterior spinal fusion due to progression. 16 (30%) of the patients had a suspected broken tether. Two patients had overcorrection that didn’t require revision. Two patients had pneumothorax, which developed after drain removal and resolved spontaneously. Two patients had a blood patch for small dural tear recognized post-op.

Conclusion
This prospective study found a re-operation rate of 11% with otherwise good clinical and radiological outcomes. Understanding the surgical indications of AVBGM for progressive idiopathic scoliosis is critical to have higher success rate of non-fusion treatment in the future. Although not necessarily requiring surgery, 16 patients were suspected to have a broken cable. AVBGM is an effective procedure with only 11% risk of revision at two years follow up for young growing patients with idiopathic scoliosis.

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PROSPECTIVE MULTICENTER STUDY OF A MULTISTEP SCREW INSERTION TECHNIQUE USING PATIENT-SPECIFIC SCREW GUIDE TEMPLATES FOR THE CERVICAL AND THORACIC SPINE

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Background. Pedicle screw fixation is a standard procedure for spinal instrumentation, however, screw insertion carries the risk of injury to neuronal and vascular structures. To evaluate the efficacy of a patient-specific screw guide template system (SGTS) for inserting screws, the authors conducted a prospective clinical study of a multistep screw insertion method using SGTS for the cervical and thoracic spine.

Methods. Preoperative bone images of the computed tomography (CT) scans were analyzed using 3D/multiplanar imaging software, and the screw trajectories were planned. Plastic templates with screw-guiding structures were created for each lamina using 3D design and printing technology. Three types of templates were made for precise multistep guidance, and all the templates were specially designed to fit and lock onto the lamina during the procedure. In addition, plastic vertebra models were generated and preoperative screw insertion simulation was performed. This patient-specific SGTS was used to perform the surgery and CT scanning was used to postoperatively evaluate screw placement.

Results. Enrolled to verify this procedure were 103 patients with cervical, thoracic or cervicothoracic pathologies. The SGTS were used to place 813 screws. Preoperatively, each template was found to fit exactly and to lock onto the lamina of the vertebra models. In addition, intraoperatively, the templates fit and locked onto the patient lamina, and the screws were inserted successfully. Postoperative CT scans confirmed that 801 screws (98.5%) were accurately placed without cortical violation. There were no injuries to the vessels or nerves.

Conclusions. The multistep, patient-specific SGTS is useful for intraoperative pedicle screw navigation in the cervical and thoracic spine. This method improves the accuracy of pedicle screw insertion and reduces the operating time and radiation exposure during spinal fixation surgery.

Disclosures:
THE ULTRASONIC BONE SCALPEL (UBS): HOW SAFE IS IT IN SPINAL SURGERY?
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Introduction:
The UBS is gaining popularity for applications in spinal surgery. There may be reservations about its safety. We report our experience of using UBS in spinal surgery

Material & Method
From 2016-2018, UBS (Misonix) was used by the senior author in a variety of spinal operations. Complications were prospectively collected.

Results:
UBS was used in 146 patients (47M, 99F) with age range 8-86 (average 32.6 years). UBS was used in 49 patients for degenerative conditions of which there was 7 anterior cervical discectomy (12 levels), 12 posterior decompressions (21 levels), 30 posterior decompression and instrumented fusion (66 levels) including 22 Transforaminal interbody fusions (TLIF) (39 levels). UBS was used in 10 adult spinal deformities (ASD) correction including 4 Pedicle subtraction osteotomies (PSO). UBS was used in 87 paediatric deformity surgeries including 69 Adolescent idiopathic scoliosis, 9 Neuromuscular, 2 congenital, 4 revision of EOS and 3 Scheuermann’s Kyphosis. In this group UBS was used to perform 884 modified in situ modified chevron osteotomies, 31 rib osteotomies, 3 PSO, 3 hemivertebra excision and division of 2 congenital bars. Overall 4 complications (2.7%) were directly related to the use of UBS. There was 1 Dural tear (0.69%), 1 haemothorax (0.69%) and 2 (1.36%) Loss of MEP monitoring with no neurological sequelae.

Conclusion:
Use of UBS in spinal surgery appears to be relatively safe with low level of acceptable complication. However, initial appropriate level of training and supervision is required to keep the complications low.

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CHARACTERISTIC SIGNS OF CAUDA EQUINA IN THE PATIENTS WITH SPINAL ARTERIOVENOUS FISTULA: CAUDA EQUINA OCCUPATION RATIO AS A NEW MARKER FOR THE CLINICAL EVALUATION

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Background:
Spinal dural arteriovenous fistula (SDAVF) is often overlooked during its diagnosing process due to its rarity and non-specific characters. Initial MRI screening is important for ruling out the other diseases as well as adequate treatment. Intramedullary T2-weighted signal hyperintensity and perimedullary flow voids has been considered as typical MRI findings for SDAVF, however, their characteristics signs of cauda equina has rarely discussed in the literatures. The objective of this study is to access the MRI findings of the patients with SDAVF and evaluate the efficacy of morphological change of cauda equina for the diagnosis of SDAVF.

Materials and methods:
We retrospectively analyzed clinical charts and radiological findings from 20 patients with SDAVF treated at our institutions. We set the occupation ratio of the cauda equina compared to the sagittal canal diameter of the lumbar spine as cauda equina occupation ratio (CEOR) in this study. The CEOR were measured from the patients with SDAVF and compared with 21 age- and sex-matched asymptomatic individuals.

Results:
There were 18 male- and 2 female patients with their age between 48 and 86 years old (average 65 years). Location of the fistula was 10 in thoracic, and 10 in lumbar spine. The mean CEOR was 56.0 ± 7.8% in the preoperative MRI study. There was no significant difference between the preoperative CEOR and the level of fistulas or preoperative neurological signs. The mean postoperative CEOR was 37.1 ± 7.4% and was significantly smaller than preoperative data (p = 0.000). Comparing the patients with SDAVF and controls revealed that the CEOR was significantly larger in preoperative SDAVF patients than in the controls (p = 0.000). Postoperative CEOR in SDAVF patients was smaller than the controls, however, their difference was not significant (p = 0.14).

Conclusions:
The CEOR in the patients with SDAVF was larger preoperatively than control and normalized after successful occlusion of the fistula. These results indicate that the CEOR is useful parameter for the preoperative examination and the postoperative evaluation for the patients with SDAVF.