Cage-screw and anterior plating combination reduces the risk of micromotion and subsidence in multilevel anterior cervical discectomy and fusion – A finite element analysis

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Abstract

BACKGROUND: Anterior cervical discectomy and fusion (ACDF) is widely used to treat patients with spinal disorders, where the cage is a critical component in achieving arthrodesis. It is unclear whether a cage with or without screws is the best choice for long-term fusion, as micromotion and subsidence of the cage still occurs.

PURPOSE: This study aims to examine the effect of cage-screws on the biomechanical characteristics of the human spine, implanted cage, and associate hardware by comparing the micromotion and subsidence.

STUDY DESIGN: A finite element analysis study.

METHODS: A finite element (FE) model of a C3-C5 cervical spine with ACDF was developed. The spinal segment was modeled with the removal of the anterior longitudinal ligament (ALL), posterior longitudinal ligament (PLL), and discectomy, then implanted with a cage-screw system. Three models were analyzed: the first was the original spine (S1 model), the second, S2, was implanted with cages and anterior plating, and the third, S3, was implanted with a cage-screw system in addition to the anterior plate. All investigations were under 1 N·m in flexion, extension, lateral bending, and axial rotation situations.

RESULTS: Finite element analysis (FEA) demonstrated that range of motion (ROM) at C3-C4 in the S2 model was significantly reduced more than that in the S3 model, while the ROM at both C4-C5 in the S3 model was reduced more than that in the S2 model in all simulations. The ROM at C3-C5 in the S1 model was reduced by over 5º in the S2 and S3 models in all loading conditions. The micromotion and subsidence at all contacts of C3-C5 in the S3 model were lower than that in the S2 model in all flexion, extension, bending, and axial simulations. The subsidence and micromotion could be seen in the barrier area in the S3 model, while they occurred near the edge of the screw in the S3 model.

CONCLUSION: These results showed that the cage-screw and anterior plating combination has promising potential to reduce the risk of micromotion and subsidence of implanted cages in two or more level ACDFs.
Adjacent Segment Disease after Anterior Cervical Decompression and Fusion: a Single Surgeon Experience Over Ten Years and Systematic Review of Literature

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Background

The treatment of Adjacent Segment Disease (ASD) after anterior cervical discectomy and fusion (ACDF) is a contentious issue. We share our experience with standalone interbody cage (SAC) systems for ASD after ACDF and present a systematic review of literature on the management of ASD after ACDF.

Materials and Methods

We retrospectively reviewed consecutive operations (between 2010 and 2018) performed by a single surgeon whereby SAC was used for ASD after ACDF. Radiographic and clinical data were analyzed post-operatively. We then performed a systematic review of literature on the surgical treatment of ASD after ACDF.

Results

Our case series included 47 patients [mean age: 55 years (+/- 10.1); M:F = 17:30]. Most (75%) patients presented with cervical radiculopathy. The mean interval from prior ACDF to re-operation for ASD was 7.69 years. Mild post-operative symptoms were noted in 15/47 (32%) patients, with dysphagia experienced by all 15, and hoarseness and hematoma occurring less frequently. At radiographic follow-up (mean – 11.4 months), 81% patients showed bony fusion. On the systematic review of literature, 17 articles were selected for ‘surgical treatment of ASD after ACDF’.

Conclusion

The systematic review of literature highlighted the lack of consensus for the surgical treatment of ASD after ACDF. The results of our study showed that SAC can be safely performed for ASD after ACDF with low immediate peri-operative complication rates and acceptable outcomes at intermediate (1 year) follow-up.
Chordomas are a relatively uncommon tumor that make up less than 1% of intracranial tumors and 3% of primary bone tumors. The majority of these lesions occur in the clivus or in the sacrococcygeal region, with other sites being rare and sparsely documented. These tumors present a challenge for treatment because, although they are considered low grade, they are highly locally aggressive and have a high rate of recurrence. We present a case of a 34 year old male that presented with progressive neck pain and dysphagia that was found to have a large cervical chordoma. We review his work-up and management course, which ultimately included anterior and posterior approaches for mass debulking and cervical fusion. His post-operative and surveillance imaging are included to demonstrate the efficacy of his treatment to-date. We also review pearls and pitfalls for management of chordomas in general, as well as points that can be taken from this case to better inform decision-making by the neurosurgeon that finds themselves confronted with treating a patient with this challenging tumor.
Anterior Lumbar Interbody Fusion via Lateral Minimally Invasive Anterior-to-the-psoas Approach: A Case Series, Clinical Outcomes and Technical Note

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ABSTRACT

Introduction: Minimally invasive anterior-to-the-psoas (MIS-ATP) approach permits anterolateral access to the lumbar spine allowing for safe anterolateral lumbar interbody fusions. This approach can be performed without the need of an access surgeon, with minimal psoas muscle retraction, and a low complication profile due to direct and clear visualization of the retroperitoneal vasculature.

Method: This is a retrospective case series including all patients who underwent lateral MIS-ATP approach for anterolateral lumbar interbody fusion at L5-S1 treated by one surgeon at a tertiary care academic medical center. The electronic medical records were reviewed and demographic, perioperative, postoperative data, functional outcomes, and complication rates were collected.

Result: A total of 23 consecutive cases, 65% females and 35% males were included. Mean age was 59.1 years, mean body mass index was 32.2 kg/m², mean estimated blood loss was 135 mL, mean operative time was 294 minutes, and mean length of stay was 4 days. Concomitant interbody arthrodesis with anterior and posterior supplemental instrumentation was performed in all cases. Mean follow-up time was 5.2 months. Arthrodesis was observed on postoperative xray in 87.5% of cases. All patients experienced significant improvements in Numeric Pain Score (NRS) and Oswestry Disability Index (ODI). Only 3 patients had minor neurologic complications at follow up. No major neurologic complications, vascular lacerations, CSF leaks, or bowel perforations had occurred.

Conclusion: MIS-ATP is gaining acceptance as an effective and safe approach to the anterolateral lumbar spine without the need for an access surgeon, with minimal complication profile, and with good functional outcomes.
Negative Pressure Wound Therapy in Patients with Spinal Metastasis Undergoing Surgical Decompression: A single institution’s experience reducing post-operative wound complications in a high risk patient population

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ABSTRACT

BACKGROUND: Patients with metastatic spinal tumors often undergo surgical for pain alleviation and disease control. However, surgical decompressions in this population are associated with higher rates of post-operative infections. Wound dehiscence and surgical site infections in this vulnerable group lead to significant comorbidities. Therefore, interventions which enable us to decrease rates of infection would significantly improve the quality of life of these patients. Our goal with this study is to assess whether negative pressure wound therapy could decrease the rate of infection in this specific oncologic population.

METHODS: This is a retrospective study in which patients with metastatic spine tumors who underwent resection and placement of an incisional wound-vac are contrasted against historical control patients who underwent resection but with no wound-vac placement. Patients younger than age 18 were excluded. The primary outcome measured was dehiscence of surgical wound, with or without purulent drainage. Statistical significance was determined using standard chi-squared analysis, with a p value < 0.05 indicating significance.

RESULTS: In the subject group of 28 patients who received an incisional wound vac after surgical resection, there were no identified wound dehiscences. Out of 14 historical controls who received surgery without post-operative wound-vac, three patients had wound breakdowns requiring surgical revision. Use of post-operative incisional negative pressure wound therapy demonstrated a statistically significant reduction in post-operative wound dehiscence, $X^2 = 6.5, p=0.01079$ (dof=1, N=42). Subgroup analysis is ongoing.

CONCLUSION: By utilizing negative pressure wound therapy to the healing incision post-operatively, we are able to reduce the risk of wound breakdown in this particular population of patients to a statistically significant degree.
Asleep MRI-Guided Deep Brain Stimulation for Essential Tremor: A Case Series

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Introduction: Intraoperative Magnetic Resonance Imaging (iMRI) or asleep DBS is one of the techniques used in DBS to treat essential tremor (ET). This study follows surgical and clinical outcomes using this modality.

Objectives: The purpose of this study was to review retrospectively and prospectively a cohort of asleep DBS targeting the VIM to assess the modality with one of the largest cohorts in the current literature.

Methods: We reviewed all cases of ventral intermediate nucleus (VIM) of thalamus targeted awake DBS from 2016 through 2020. Data gathered for these patients includes age, sex, comorbidities, complications, pre and post ET medication dosage, programing parameters, pre and post-operative Fahn Tolosa Marin rating scales part B and C, pre and post-operative QUEST scoring, unilateral vs bilateral lead placement, lead model, battery model, and radial error of lead placement.

Results: Of the 70 patients who underwent asleep DBS during the study period, follow up has been completed on 35. Statistically significant improvement was seen on FTM part B, FTM part C, QUEST, and reduction of daily dosage of primidone. Complications rates were comparable to existing awake DBS literature were found.

Conclusions: Our asleep DBS for ET cohort has demonstrated significant clinical improvements with low surgical complication rate suggesting an effective surgical procedure.
Does Family History in Parkinson’s Disease Impact Outcomes Following Deep Brain Stimulation Surgery?

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Background. Parkinson’s disease (PD) is associated with family history of disease (FHx) in 15% of patients, though this is not associated with greater disease severity. However, the effects of FHx on outcomes following deep brain stimulation (DBS) for PD have not been assessed previously.

Objective: The goal of this study was to quantify the effects of FHx on post-DBS outcomes in PD.

Methods: PD patients that underwent DBS were grouped based on presence (FHx+, n=50) or absence (FHx-, n=90) of FHx. Outcomes were assessed within each group in terms of pre- versus postoperative mean number of medications, doses per day, equivalent levodopa daily dosage (LED), and Unified Parkinson’s Disease Rating Scale (UPDRS). Intergroup comparisons were performed for degree of postoperative improvement in LED and UPDRS. Patients were further subdivided based on tremor (FHx+, n=37; FHx-, n=59) or rigid dominant (FHx+, n=13; FHx-, n=31) disease subtype and subgroup analyses were repeated in the manner of the full cohort analysis.

Results: Significant improvements in UPDRS were achieved in all groups and subgroups postoperatively. There were no intergroup differences in degree of postoperative improvement in LED and UPDRS for the full cohort or either subgroup comparison. However, postoperative medication requirements were significantly reduced in all groups and subgroups without FHx but not in groups and subgroups with FHx.

Conclusion: While DBS achieves clinical improvement in PD patients independent of FHx, those without FHx may additionally benefit from reduced medication requirements postoperatively whereas those with FHx do not. Further studies are needed to expand upon these findings.
Endoscopically-Assisted Percutaneous Trigeminal Rhizotomy for Trigeminal Neuralgia: A Cadaveric Feasibility Study

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ABSTRACT

Background: Trigeminal neuralgia (TN) is a debilitating syndrome characterized by paroxysmal facial pain in one or more divisions of the trigeminal nerve. The etiology and treatment paradigms are still controversial. The endoscopically-assisted procedure has not yet been described in percutaneous procedures for TN.

Objective: The aim of this study was to assess the utility and feasibility of endoscopic-assisted percutaneous approaches for trigeminal rhizotomy in TN.

Methods: This study comprised eight cadaveric sides heads that underwent an endoscopically-assisted percutaneous approach using Hakanson’s anterior puncture method for targeting the foramen ovale.

Results: V3 exiting the foramen ovale was easily visualized with the endoscope on all sides. While approaching the foramen ovale, distal branches of V3 such as the lingual and inferior alveolar nerves were first identified as they traveled between the medial and lateral pterygoid muscles. These branches were then traced proximally to the V3 trunk deep to the lateral pterygoid. Large arteries and veins were easily visualized and avoided in the trajectory to the foramen ovale. No gross injury to any neurovascular structure along the course of the needle insertion was identified.

Conclusion: We found that endoscopic-assisted percutaneous approach to the foramen ovale is feasible and allows for accurate canalization and anatomical identification of the precise location for rhizotomy under direct visualization. Such a procedure, after it is confirmed in patients, could offer a new technique for reducing unsuccessful canalization and could improve outcomes.
Use of 3D fluoroscopy for intraoperative localization during stereotactic robotic neurosurgery

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Objective:
The use of 3D fluoroscopy (Ziehm Imaging, Nuremberg, Germany) has not previously been validated in robotic stereotactic neurosurgery; we provide proof of concept and describe the workflow by which this technique may be applied in cranial practice.

Methods:
Three patients between the ages of 27 and 41 underwent robot-assisted stereotactic placement of laser ablation catheters for laser interstitial thermal therapy (LITT) for indications including mesial temporal sclerosis and glioblastoma. Prior to fiducial screw removal and transport to MRI for LITT, the 3D fluoroscope was used to acquire imaging to confirm accuracy of laser catheter placement.

Results:
The proof of concept of the 3D fluoroscope for confirmation of stereotactic laser placement during neurosurgical procedures is presented. When the rigid stylet is left in place for imaging, the quality was found to be sufficient. This technique is recommended for confirmation of laser catheter placement prior to transport to the MRI for ablation.

Conclusion:
To the best of our knowledge, there has been no prior application or documentation of 3D fluoroscopy to confirm laser catheter placement in the neurosurgical literature. Future directions may include confirming depth electrode placements for stereoelectroencephalography. These applications help to ensure stereotactic accuracy prior to leaving the operating room, thus optimizing objectives.