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CASE REPORT

Transforaminal Thoracic Interbody Fusion (TTIF) for Treatment of a Chronic Chance Injury

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Abstract Multiple anterior and posterior approaches to the thoracic disc space have been reported. However, we are not aware of any previous reports describing a transforaminal approach for thoracic disc release and interbody cage placement. In this case report, we describe a method to perform transforaminal thoracic interbody fusion (TTIF), which is an adaptation of an established lumbar fusion technique (transforaminal lumbar interbody fusion). Key differences between the two procedures are discussed. A 24-year-old woman presented after sustaining a T11-12 Chance fracture that had been treated in a brace. She had severe, debilitating pain and a rigid segmental kyphotic deformity of 38°. The patient was treated 3 months post-injury with T10-L1 fusion with anterior release and interbody fusion with cage placement at T11-12. Anterior column release and fusion were performed via a transforaminal approach. The patient had anatomic reduction of deformity, solid arthrodesis, and relief of pain at 1-year follow-up. The TTIF approach permits access to the anterior column of the thoracic spine for the purpose of reduction of deformity and interbody fusion with reduced morbidity compared to anterior–posterior surgery.

Keywords transforaminal · thoracic · interbody · fusion · Chance fracture

Introduction

Flexion-distraction injuries or Chance fractures may occur as purely ligamentous injuries, purely bony injuries, or combined injury patterns. Associated anterior column compression fracture may occur. When promptly recognized and treated, Chance fractures without neurologic injury carry an excellent prognosis for functional recovery. Acute surgical reduction and stabilization with one-level constructs provides excellent results [1]. On the other hand, treatment of chronic Chance injuries is more difficult [2] because rigid deformity may develop and anterior column collapse may result in relative anterior column deficiency upon reduction of the deformity. In cases of rigid kyphotic deformity, access to the anterior column for the purpose of soft tissue release, reduction of deformity, anterior column support, and enhancement of fusion rate may be useful.

Commonly employed techniques for achieving access to the thoracic disc space include thoracoabdominal, open transthoracic, thoracoscopic, lateral extracavitary, costotransversectomy, and transpedicular approaches. Anterior approaches offer excellent exposure and visualization of the disc space but are associated with significant pulmonary [3] and incisional morbidity [4]. Posterior approaches not only offer more limited disc space access with less morbidity but also require significant posterior soft tissue dissection, particularly when lateral extracavitary or costotransversectomy approaches are utilized.

The purpose of this article is to report a case of treatment of a chronic Chance injury at T11-12 with rigid kyphotic deformity using a novel technique. Anterior column release and implantation of an interbody fusion cage were performed via a thoracic adaptation of transforaminal lumbar interbody fusion (TLIF)/transforaminal thoracic interbody fusion (TTIF).

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Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has approved the reporting of this case and that all investigations were conducted in conformity with ethical principles of research.

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Fig. 1. Magnetic resonance imaging (**a**) and reformatted computerized tomography in the sagittal plane (**b**, **c**) demonstrate a Chance injury with associated compression fracture of T12, interspinous process widening (**b**), and facet distraction (**c**)

Case report

The patient is an active 24-year-old female who was a restrained passenger in a high-speed motor vehicle accident. She was treated at a trauma center where she was diagnosed with a "T12 compression fracture," pulmonary contusions, a liver laceration, and multiple rib fractures. Treatment of all injuries was nonsurgical, and the "compression fracture" was treated in a thoracolumbar orthosis for 8 weeks.

Upon removal of the brace at 8 weeks, the patient was referred to physical therapy. Twelve weeks after injury, the patient continued to have severe thoracolumbar pain with activity, when lying supine or prone, and with sitting. She was unable to participate in athletic activity or yoga as she had prior to injury. The patient presented to our hospital for a second opinion 10 weeks post-injury.

Evaluation of the original injury films revealed that the patient had a T11-12 Chance injury with complete facet dislocation and an associated T12 compression fracture. Current films showed segmental kyphosis at T11-12 of 38°, decreasing to 33° on a supine hyperextension lateral radiograph over a bolster. Anterior loss of height of T12 was 27% compared to T11 and L1 (mean) (Figs. 1 and 2).

Physical exam showed a visible thoracolumbar gibbus with chronic hyperpigmented skin changes. Active or passive thoracolumbar extension caused severe pain. The patient was neurologically intact. Surgery was indicated at that time to address the patient's pain, loss of function, and deformity.

Based on the rigidity of the kyphosis on preoperative hyperextension films, it was anticipated that anterior column release would be required to correct the deformity. Furthermore, it was anticipated that reduction of the deformity would create relative anterior column deficiency due to loss of anterior vertebral body height at T12. Therefore, the planned surgery included decompression of T11-12, release of the T11-12 disc space, and instrumented fusion of T10-L1 with placement of an interbody cage at T11-12. In order to avoid the morbidity associated with an anterior approach to T11-12, the anterior column was

Fig. 2. Lateral standing radiograph (**a**, **b**) and supine hyperextension radiograph (**c**, **d**) demonstrate relatively rigid segmental kyphosis at T11-12 measuring 38° standing and 33° in hyperextension

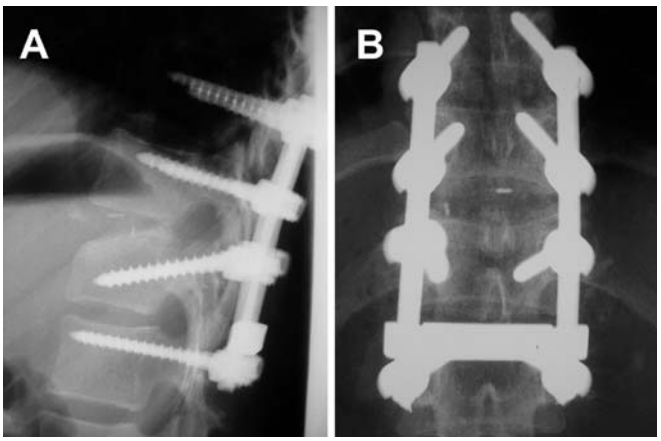

Fig. 3. Lateral (**a**) and anteroposterior (**b**) radiographs at 1-year follow-up demonstrate anatomic reduction of deformity. Radio-opaque markers show position of PEEK cage

released and an interbody cage was placed via a bilateral posterior transforaminal approach—an adaptation of the TLIF approach popularized by Harms and Rolinger [5].

Surgery was performed 3 months post-injury. Intraoperatively, the deformity was very rigid. Soft tissue and scar overlying the dura centrally and interposed between the distracted facet joints were removed in order to facilitate reduction and to prevent spinal cord compression upon reduction. Laminectomy was not performed. The lateral pars and inferior facet of T11 were partially resected in a lateral-to-medial direction until the lateral aspect of the dura was exposed. Access to the T11-12 disc space was achieved between the dura medially and the fatty tissue overlying the pleura laterally. The T11 nerve roots exited horizontally, lying cephalad to the disc space. Disc access and release was performed bilaterally. No effort was made to resect or transect the anterior longitudinal ligament.

Pedicle screws were placed bilaterally from T10-L1, but the deformity remained difficult to reduce. An 8-mm polyethyl-ether-ketone (PEEK) cage packed with iliac crest autograft was placed in the disc space and used as a fulcrum to achieve reduction via compression of the pedicle screw construct (Fig. 3). Finally, the disc space posterior to the cage was packed with iliac autograft.

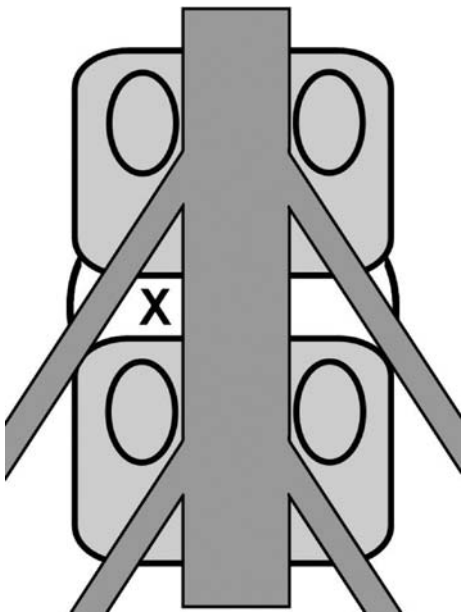

Fig. 5. TLIF working corridor (marked by "*X*"). The corridor is defined medially by the dural tube, laterally by the exiting nerve root, and by the cephalocaudal height of the disc space

Postoperatively, the patient was placed in a lumbar brace with an anterior thoracic extension for 3 months. The patient had minimal back pain upon 3-month follow-up. At 12-month follow-up, she was pain-free and had returned to full-time employment and activity without limitations. Twelve-month radiographs and CT showed that reduction was maintained, and interbody fusion was complete (Fig. 4).

Discussion

The TLIF approach, popularized by Jürgen Harms, has been shown to be a safe and practical method for accessing the lumbar disc space [5]. To our knowledge, this is the first report of the TTIF technique, which represents an adaptation of TLIF with several caveats. The working corridor in TLIF is defined by the dura medially, the exiting nerve root

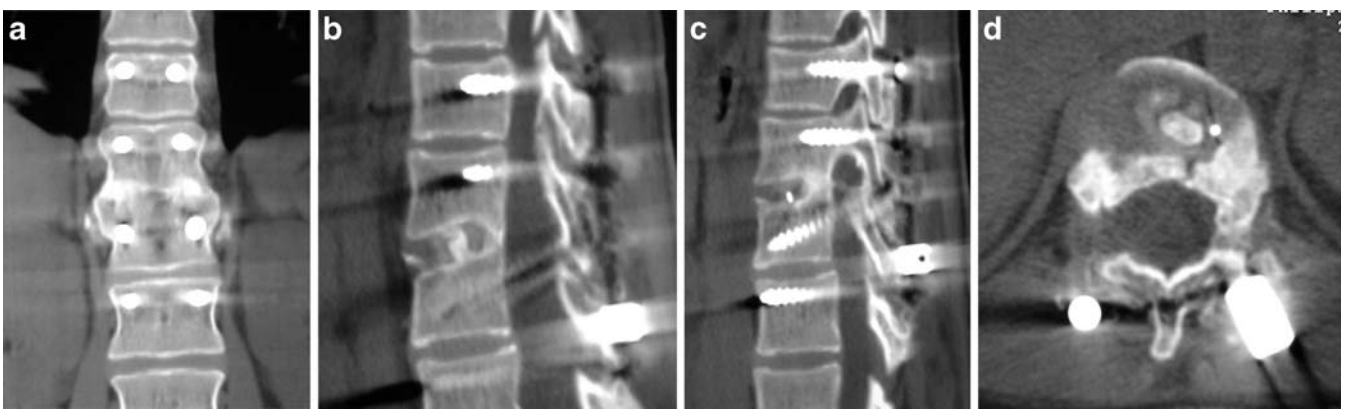

Fig. 4. Postoperative computerized tomography scan shows successful interbody fusion at 1 year on coronal (**a**), sagittal (**b**, **c**), and axial (**d**) views. Fusion has occurred through the cage and in the posterior portion of the disc space

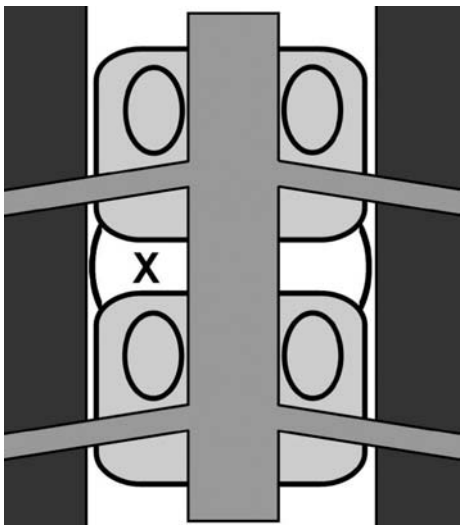

Fig. 6. TTIF working corridor (marked by "*X*"). The corridor is defined medially by the dural tube and spinal cord, laterally by the pleura (*black shading*), and by the cephalocaudal height of the disc space

laterally and the cephalocaudal margins of the disc space (Fig. 5). The working corridor for the TTIF approach is defined by the dura medially and the pleura laterally (Fig. 6). Preoperative planning includes measurement of the mediolateral "dura to pleura" interval (Fig. 7) on axial imaging to ensure that the working window is wide enough to allow disc space access and cage insertion without injury to the dura, spinal cord, or lung. Patients undergoing TTIF should be informed of the risk of pneumothorax and should have immediate postoperative chest radiographs. In the thoracic spine, the nerve root exits in a horizontal direction [6, 7] and is easily retracted cephalad to the disc space. Furthermore, a single thoracic nerve root may be ligated if necessary without significant motor deficit. The height and depth of the disc space is considerably smaller in the thoracic spine compared to the lumbar spine. As in the lumbar spine, the aorta is in close proximity to the anterior annulus and may be injured if the anterior annulus is penetrated. In the upper thoracic spine, the esophagus lies anterior to the anterior annulus. Finally, although retraction of the dura during the TLIF procedure can be safely performed at most lumbar levels, dural retraction in the thoracic spine is unsafe, and the possibility of iatrogenic spinal cord injury exists if any incidental contact with the dura occurs.

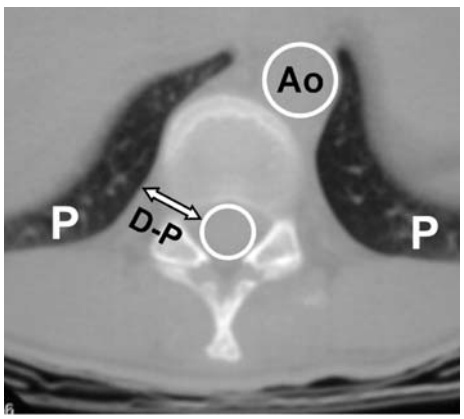

Fig. 7. Axial imaging (normal T10-11 level) is used to determine location of the pleura (*P*), "dura to pleura" interval (*D–P*), disc space depth, and location of the aorta (*Ao*)

There are many limitations to the TTIF technique. Because accessing the disc space via the TTIF approach is time consuming, the technique is ideally suited for cases in which the deformity or pathology to be addressed is limited to a small number of levels. The use of an interbody cage as a fulcrum to facilitate reduction of kyphosis would be ineffective in patients with osteoporosis. The anatomy of the rib heads would render TTIF more difficult at levels above the thoracolumbar junction. Partial rib head resection may be necessary to access the disc at higher levels. Finally, the approach affords limited access to the floor of the spinal canal for decompression of midline compressive lesions.

Use of the TTIF technique in this patient offered several advantages compared to other previously described techniques for accessing the thoracic disc space. The TTIF approach offers decreased pulmonary morbidity compared to open or laparoscopic transthoracic approaches. Open transthoracic and thoracoabdominal approaches are associated with significant approach-related morbidity. Posterior soft-tissue dissection is reduced compared to lateral extracavitary or costotransversectomy approaches. The pedicle is not removed, as in some transpedicular approaches; therefore, pedicle screw instrumentation can be utilized. Use of TTIF, in this case, allowed anterior column release for anatomic correction of a rigid deformity with a short construct, placement of anterior column support, and optimization of fusion rate via interbody arthrodesis.

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