Spine Deformity
www.spine-deformity.org

Spine Deformity 3 (2015) 502–511

Transforaminal Anterior Release for the Treatment of Fixed Sagittal Imbalance and Segmental Kyphosis, Minimum 2-Year Follow-Up Study

Fred A. Sweet, MD[a,*], Andrea Sweet, BS[b]

[a]*Rockford Spine Center, 2902 McFarland Rd, Suite 300, Rockford, IL 61107, USA*
[b]*University of Missouri, Columbia, MO 65211, USA*

Received 16 March 2014; revised 7 January 2015; accepted 23 February 2015

Abstract

Study Design: Retrospective review of prospectively accrued patient cohort.
Objective: To report minimum 2 years' follow-up after a single-surgeon series of 47 consecutive patients in whom fixed sagittal imbalance or segmental kyphosis was treated with a novel unilateral transforaminal annular release.
Summary of Background Data: Fixed sagittal imbalance has been treated most recently with pedicle subtraction osteotomy with great success but is associated with significant blood loss and neurologic risk.
Method: Forty-seven consecutive patients with fixed sagittal imbalance (n = 29) or segmental kyphosis (n = 18) were treated by a single surgeon with a single-level transforaminal anterior release (TFAR) to effect an opening wedge correction. Sagittal and coronal correction was performed with in situ rod contouring. An interbody cage was captured in the disc space with rod compression. Radiographic and clinical outcome analysis was performed with a minimum 2-year follow-up (range 2–7.8 years).
Results: The average increase in lordosis was 36° (range 24°–56°) in the fixed sagittal deformity group. Coronal corrections averaged 34° (range 18°–48°). The average improvement in plumb line was 13.6 cm. There were four pseudarthroses, one at the TFAR. Average blood loss was 578 mL (range 200–1,200). One patient had a transient grade 4/5 anterior tibialis weakness. There were no vascular injuries or permanent neurologic deficits. There were significant improvements in the Oswestry Disability Index ($p < .001$) and Scoliosis Research Society Questionnaire scores ($p = .003$). Eighty-four percent of patients reported improvement in pain, self-image, and satisfaction with the procedure.
Conclusion: TFAR is a useful procedure for correcting segmental kyphosis and fixed sagittal imbalance with relatively low blood loss and was found to be neurologically safe in this single-surgeon series.
Level of Evidence: Therapeutic study, Level IV (case series, no control group).

Keywords: Transforaminal anterior release; Fixed sagittal imbalance; Pedicle substraction osteotomy; Vertebral column resection; Kyphosis

Introduction

Adult spinal deformity, in particular fixed sagittal imbalance, is problematic for patients in regards to endurance fatigue, pain, and disability. Segmental kyphosis produces similar, albeit not as severe, functional impairment as fixed sagittal imbalance. Further, the surgical treatment of these deformities is quite challenging. Fixed sagittal imbalance has been treated most recently by pedicle subtraction osteotomy (PSO) and posterior vertebral column resection (VCR) with great success [1-8]. However, PSO and VCR have been associated with significant blood loss and neurologic complications [1-3,8-14]. It has been recommended that elderly patients and those with significant comorbidities may not be the best candidates for these technically demanding and high-risk procedures [9,15-18]. For PSOs, despite meticulous preoperative planning, it is technically difficult to achieve intraoperatively the planned correction [1,4,7,19,20].

Informed consent: Signed informed consent was obtained from all patients in the study.

IRB approval: Our institutional review board reviewed and approved of our study.

Funding sources: none.

Author disclosures: FAS (none); AS (none).

*Corresponding author. Rockford Spine Center, 2902 McFarland Rd, Suite 300, Rockford, IL 61107, USA. Tel.: 815-316-2100; fax: 815-316-2099.

E-mail address: fredspine@gmail.com (F.A. Sweet).

2212-134X/$ - see front matter © 2015 Scoliosis Research Society.
http://dx.doi.org/10.1016/j.jspd.2015.02.006

The purpose of this study is to describe a single-surgeon series of treating fixed sagittal imbalance and segment kyphosis with a novel transforaminal annular release technique that allows a continuum of sagittal and coronal correction, low blood loss, and neurologic safety. We evaluate the correction rates, perioperative and postoperative complications, and clinical outcomes.

Material and Methods

Between 2006 and 2012, a total of 63 consecutive patients who underwent spinal deformity reconstructive procedure, with either fixed sagittal imbalance or segmental kyphosis performed by a single surgeon, were identified who underwent a transforaminal anterior release (TFAR) through a posterior only approach for sagittal and coronal deformity correction. Forty-seven patients had a minimum of a 2-year follow-up and are included in the investigation. There were 38 women and 9 men with an average age of 66. Average follow-up was 2.7 years (range 2–5). No patients were lost to follow-up in the study group. Patients were divided into two general diagnostic categories: Fixed sagittal imbalance (n = 29) and segmental kyphosis (n = 18). Fixed sagittal imbalance was defined as C7 plumb line falling more than 8 cm anterior to the lumbosacral disc on a standing 14 × 36 inch lateral radiograph with the hips and knees extended. This decision was based on clinical correlation with symptomatic fixed sagittal imbalance as described by Kim et al. [10]. Segmental kyphosis was defined as any clinically significant and symptomatic kyphosis that produced less than 8 cm of positive sagittal alignment as measured by the C7 plumb line. Radiographic analysis was performed preoperatively, including flexibility films. Radiographic analysis was also performed immediately postoperation and at the final follow-up. Radiographic measurements were obtained in accordance with published techniques on standing radiographs [21].

Medical records were reviewed and preoperative data included age, gender, diagnosis, and comorbidities. Postoperative data included deformity correction, number of levels fused, operative time, blood loss, transfusions, and any complications. Oswestry Disability Index (ODI) and Scoliosis Research Society (SRS) Questionnaire were completed by patients before surgery, immediately postoperation, and at the last follow-up. SRS scores were converted to percentages to allow direct comparison across different versions for the SRS questionnaire.

Surgical decision making

The decision to perform a TFAR was made after identifying rigid deformities on flexibility radiographs not amenable to adequate correction with conventional in situ techniques. These included side bending radiographs and hyperextension over a bolster radiographs. The location of the TFAR is outlined in Table 1. The location of the TFAR was based on consideration of the apex of kyphosis, apex of scoliosis, or the lowest nonfused disc space that would allow adequate fixation points above and below. If significant coronal correction was required, the TFAR would typically be in the apex of the deformity and the approach to the disc space on the concavity. In addition to releasing the concavity under direct vision, this also allows the temporary stabilizing rod to be placed on the convexity for in situ contouring to correct both the coronal and sagittal deformities. Patients with previous retroperitoneal exposure were considered at increased risk of vascular injury and considered a relative contraindication. We have performed TFAR at levels with previous posterior fusions but preserved anterior disc spaces. Even if the disc space is severely collapsed, dysplastic, or has significant subluxations, we have been able to reduce these segments to near anatomic alignment, which has the additional benefit of relieving severe foraminal stenosis or neural compression related to the focal deformity. TFAR is not applicable to levels with anterior fusions.

Table 1
Location of TFAR by procedure.

Procedure	L5–S1	L4–L5	L3–L4	L2–L3	L1–L2	T12–L1	T10–T11
FSI		5	12	7	1	2	2
SK	6	4	6	1	1		

TFAR, transforaminal anterior release; FSI, fixed sagittal imbalance; SK, segmental kyphosis.
Note: Values are n.

Surgical technique

Surgically, TFAR is challenging yet a natural extension of a transforaminal lumbar interbody fusion (TLIF). All patients were placed on the OSI (Jackson, Orthopedic Systems, Inc., Union City, California) open operative frame with adjustable pads (The use of multimodality spinal cord monitoring is strongly recommended.)

A normal subperiosteal posterior approach to the spine was performed. Fixation points with multiaxial pedicle screws (Legacy, Medtronic, Minneapolis, MN) were placed at the preoperatively planned levels using the free hand technique described by Kim et al. [22]. The level of TFAR was most commonly performed at either the L2–L3 or L3–L4 disc space (Table 1).

A Harms spreader was used in the lumbar spine to distract across the interval to allow sufficient access to the transforaminal route and intradiscal space. Distraction was not used in the thoracic spine to prevent distraction injury of the spinal cord. Subsequently, a unilateral facetectomy is performed to expose the lateral recess and exiting nerve root. The contralateral facet is typically preserved to maintain a hinge point for correction as well as surface area for fusion. In some patients, a portion of the contralateral inferior facet may be resected as needed for larger corrections. The contralateral recess was decompressed with