Anterior Column Release/ Realignment

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KEYWORDS

• Osteotomy • Spine deformity • MIS • Spine surgery • Scoliosis • XLIF

KEY POINTS

- Anterior column release/realignment (ACR) is a powerful tool to increase lumbar lordosis by lengthening the anterior column.
- Minimally invasive lateral ACR can achieve large corrections at a single segment.
- Posterior column facet osteotomies combined with lateral ACR increase segmental lordosis and can match the corrections achieved with a conventional 3-column osteotomy.
- Lumbar lordosis and other radiographic outcomes after lateral ACR are durable up to 20 months after surgery based on the authors' experience.

INTRODUCTION

Restoration of sagittal balance and spinopelvic harmony is vital in the management of adult spinal deformity. As patients lose lumbar lordosis (LL) through disk degeneration and vertebral body insufficiency, they are forced to maintain their center of balance by compensatory mechanisms, such as thoracic hypokyphosis and pelvic retroversion.[1–4] Failure of these mechanisms results in progressive mismatch between a patient's LL and pelvic incidence (PI), ultimately leading to increasing positive sagittal vertical axis (SVA). This inability to maintain posture with the head over the pelvis results in debilitating pain, impaired mobility, loss of a level forward gaze, and overall reduced function and quality of life. When addressed surgically, spinal alignment for most adults should be corrected to have an SVA of less than or equal to 5 cm, pelvic tilt (PT) less than 25°, and an LL within 10° of the PI.[2,5,6]

Traditionally, multiple posterior osteotomy techniques have been used to restore segmental lordosis to the spine by destabilizing and shortening the posterior spinal column.[7] Within the past decade, however, greater attention has turned toward surgical strategies aimed at lengthening the anterior column through release of the anterior longitudinal ligament (ALL) and placement of a large, hyperlordotic interbody. The prototypical technique is an extension of the minimally invasive surgery (MIS) lateral lumbar interbody fusion (LLIF), where the ALL can be safely dissected and released from a lateral approach, but other anterior and posterior approaches have also emerged. As a collective, these surgical strategies are referred to as anterior column release/realignment (ACR).

Beginning with adoption of the lateral ACR technique through the transpsoas LLIF approach, access to the anterior lumbar spine with overall reduced operative time and morbidity has become

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more feasible with powerful correction of global spinal alignment on par with traditional posterior osteotomies.[8–13] Early outcomes of MIS lateral ACR demonstrated a 10° to 27° increase in segmental lordosis and 16° to 31° increase in mean global lordosis, with complication rates varying from 18% to 48%, with a 5.3% risk of proximal junctional kyphosis (PJK).[14] Long-term results regarding surgical outcome of MIS ACR remain lacking. Within this review, the authors present an overview of the current lateral ACR technique from surgical planning to execution and evaluate long-term radiographic outcomes from their personal case series.

PATIENT SELECTION

A summary of indications and contraindications for ACR is included in **Table 1**. A lateral ACR provides indirect decompression of the thecal sac, neuroforamen, and restores significant segmental lordosis greater than what is typically achievable through a standard LLIF. Consequently, the predominant indication for performing an ACR rather than a traditional LLIF is to provide segmental lordosis exceeding 10° for correction of spinal deformities. Specifically, previous work reported by Mummaneni and colleagues[15] delineated a framework for determining the deformity patient population that is most amenable for an MIS treatment strategy. Patients ideally should have an SVA less than 6 cm unless their curve is flexible, PT less than 25°, PI-LL mismatch between 10° and 30°, maximum coronal Cobb angle less than 20°, and thoracic kyphosis less than 60°.[15] Treatment of patients outside of these parameters is possible but should be reviewed by multiple surgeons and attempted only by experienced providers.

In principle, the T12-L5 segments can be accessed laterally for an ACR, but in practice a majority of ACRs are performed at L2-5 to reapproximate the distribution of segmental lordosis in the lumbar spine. Contraindications for a lateral ACR include extensive previous surgeries involving retroperitoneal structures, such as the kidneys and ascending/descending colon. Because interbody subsidence is a prominent source of treatment failure, a lateral ACR should be avoided in patients with severe osteopenia or osteoporosis. The authors prefer patients to be evaluated with dual-energy x-ray absorptiometry (DEXA) and have femoral neck T-scores greater than −2.0. Lastly, caution and close evaluation of preoperative imaging must be performed when planning to intervene at L4-5 in patients with transitional anatomy due to anterior displacement of the lumbar plexus.

TECHNIQUE

A lateral ACR uses much of the same workflow as a transpsoas LLIF but with greater risk to the great vessels and peritoneal structures. Therefore, surgeons attempting an ACR should first be adept and comfortable with the classic retroperitoneal, transpsoas LLIF approach. First described by Pimenta and colleagues,[16] the LLIF initially entailed a transpsoas dissection through endoscope assisted direct visualization but has since evolved into multiple minimally invasive platforms, such as the Extreme Lateral Interbody Fusion (XLIF) (NuVasive, San Diego, California) and Direct Lateral Interbody Fusion (DLIF) (Medtronic, Memphis, Tennessee). These contemporary systems rely on fluoroscopically assisted passage of a blunt dissector through the psoas muscle that is sequentially dilated to expose the lateral aspect of the disk space. Directional electromyographic (EMG) neuromonitoring further allows active neuromonitoring to ensure that the dilators and retractor are anterior to the lumbar plexus, aiding in prevention of retraction related injury.

Preoperative Evaluation

Prior to surgery, close scrutiny of MRI and CT imaging should be performed to determine the optimal side of approach and relationship of

Table 1
Indications and contraindications of lateral anterior column release

Indications	Contraindications

• Location: T12-L5 disk spaces
• Need for segmental lordosis >10°
• Radiographic parameters:
  ○ SVA <6 cm unless the curve is flexible
  ○ PT <25°
  ○ PI-LL mismatch 10°30°
  ○ Cobb angle <20°
  ○ Thoracic kyphosis <60°
	• Fused or previously instrumented disk space
	• Transitional anatomy at L4-5
	• T-score >2.0 measured at the femoral neck
	• Previous retroperitoneal surgery
	• No tissue plane between vertebral body and ventral vessels assessed on preoperative imaging