Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/jor

Original Article

"Reverse Bohlman" technique for the treatment of high grade spondylolisthesis in an adult population

Angel E. Macagno [a], Saqib Hasan [b], Cyrus M. Jalai [b], Nancy Worley [b], Alexandre B. de Moura [b], Jeffrey Spivak [b], John A. Bendo [b], Peter G. Passias [a,*]

[a] NY Spine Institute/NYU Medical Center Hospital for Joint Diseases, New York, NY, United States
[b] Orthopaedic Surgery, NYU Hospital for Joint Diseases, New York, NY, United States

ARTICLE INFO

Article history:
Received 30 September 2015
Accepted 25 December 2015
Available online 22 January 2016

Keywords:
Reverse Bohlman
High grade spondylolisthesis
Outcomes

ABSTRACT

Background/aims: Surgical techniques for effective high-grade spondylolisthesis (HGS) remain controversial. This study aims to evaluate radiographic/clinical outcomes in HGS patients treated using modified "Reverse Bohlman" (RB) technique.
Methods: Review of consecutive HGS patients undergoing RB at a single university-center from 2006 to 2013. Clinical, surgical, radiographic parameters collected.
Results: Six patients identified: five with L5-S1 HGS with L4-L5 instability and one had an L4-5 isthmic spondylolisthesis and grade 1 L5-S1 isthmic spondylolisthesis. Two interbody graft failures and one L5-S1 pseudoarthrosis. Postoperative improvement of anterolisthesis (62.3% vs. 49.6%, $p = 0.003$), slip angle (10 vs. 5°, $p = 0.005$), and lumbar lordosis (49 vs. 57.5°, $p = 0.049$).
Conclusions: RB technique for HGS recommended when addressing adjacent level instability/slip.

1. Introduction

Isthmic spondylolisthesis, described by Kilian in 1854[1] and refined by Taillard in 1957,[2] is forward slippage of the vertebral body, its pedicles, transverse process, and upper articular process engendered by a break in continuity or elongation of the pars interarticularis. High-grade spondylolisthesis (HGS) is defined as greater than 50% slippage of a spinal vertebral body relative to an adjacent vertebral body as per the Meyerding classification (Grades III–V),[3] and most often affects alignment of the L5-S1 motion segment. Patients can present with intractable pain, neurological deficits, and significant spinopelvic malalignment and often undergo surgery. Despite evolution of spinal instrumentation, fusion techniques, and intraoperative neuromonitoring, surgery for HGS is challenging

* Corresponding author.
E-mail address: Peter.Passias@nyumc.org (P.G. Passias).
http://dx.doi.org/10.1016/j.jor.2015.12.004

and optimal surgical treatment remains controversial. Surgical goals include pain relief, neural decompression, correction of a kyphotic slip angle, and obtaining solid fusion.[4]

Surgical options include in situ posterior fusion, instrumented posterolateral fusion, circumferential interbody fusion, vertebral resection, sacral dome osteotomy, or a combination. Although circumferential fusion procedures often produce high rates of clinical and radiographic fusion, for higher-grade spondylolisthesis, slip severity may preclude direct anterior interbody fusion.[5–8] In 1938, Speed reported experiences in performing in situ fusion through an anterior approach using a tibial autograft strut to stabilize L5-S1 spondylolisthesis.[9] In 1982, Bohlman and Cook modified this protocol for spondyloptosis using a single incision posterior approach via introducing a fibular autograft across S1 into the L5 vertebral body in conjunction with a decompression and uninstrumented L4-S1 posterolateral fusion allowing for three column spinal fixation.[10]

Although early results with this technique resulted in complications including fibular graft fracture, graft resorption, slip progression, and pseudoarthrosis,[11–13] Rodriguez-Olaverri and colleagues showed that this procedure may have similar outcomes with transforaminal lumbar interbody fusion,[14] resulting in lumbosacral kyphosis improvement.[15] With advances in techniques and instrumentation, supplementary methods of achieving three-column fixation include transacral transvertebral screw fixation,[16,17] transvertebral interbody cage fixation[18,19] and use of intrasacral rods[20,21] and custom-made screws.[22,23] While many of these were performed via posterior approach for direct decompression and stabilization with pedicle screw fixation, an additional anterior approach is useful in increasing fusion rates by providing an optimal graft environment, restoring sagittal alignment via anterior column reconstruction to restore disk height and reducing the slip angle.[24] This obviates the requirement for a complete sacral laminectomy with retraction of the caudal dura, and the associated inherent risk, while simultaneously facilitating access to the L4-5 intervertebral disk from a single anterior approach.

This study evaluated radiographic and clinical outcomes in patients with HGS treated with a modified ''Reverse Bohlman'' (RB) procedure consisting of a combined anterior/posterior approach with transacral and/or pedicle screw fixation and fibular graft or titanium mesh cage augmented with bone morphogenetic protein-2 (BMP-2) to allow for interbody fusion through an angled anterior approach.

2. Material and methods

2.1. Study design

A retrospective review of consecutive patients who underwent a modified ''RB'' procedure for HGS was performed at a single university-based center between November 2006 and October 2013. Primary outcomes evaluated were occurrence of perioperative complications and the need for revision procedures.

2.2. Data collection

Clinical parameters collected included patient age and sex, primary presenting symptoms, neurological dysfunction prior to or after surgery, and previous surgical procedures for spondylolisthesis. Radiographic parameters included Wiltse classification, slip percentage (grade), and slip angle. Perisurgical parameters included fusion levels, type of interbody device (titanium mesh cage or fibular strut), posterior instrumentation pattern (transsacral or pedicle screws), use of BMP-2, estimated blood loss (EBL), and perioperative complications.

2.3. Reverse Bohlman procedure (Fig. 1)

All procedures consisted of a combined anterior/posterior approach, with anterior access performed by an experienced vascular access surgeon. Two levels (L4-5 and L5-S1) were addressed in all cases. L4-L5 was prepared as per regular anterior lumbar interbody fusion technique with radical discectomy and endplate preparation. Prior to placement of L4-5 cage, attention was turned to the L5-S1 level. Rigid cannulated reamers were utilized over a guide wire, which was placed under real-time fluoroscopy from the anterior cephalad portion of the L5 vertebral body angled across the spondylolisthetic disk space into the sacral vertebral body. The guide wire was oriented in a trajectory almost perpendicular to the L5-S1 disk space, which was typically perpendicular to the floor (Fig. 1).

With guide wire in place, a 10.5 mm reamer was passed under fluoroscopy to the desirable depth (40–50 mm). This allowed for creation of a direct channel across the disk space into the sacrum. A standard 1 cm diameter Pyramesh cage (or fibular dowel allograft) was used and cut to the pre-reamed length. BMP-2 sponge was placed inside the cage that was then impacted into position with the proximal portion recessed into L5, continuing across the L5-S1 disk space, and ending in the proximal sacrum. No BMP was used when procedure was performed with fibular graft. The L4-5 disk space was irrigated and filled with a lordotic cage or bone graft in a standard fashion.

Following closure of the anterior procedure, the patient was turned prone and an open posterior decompression and fusion from L4-S1 was performed. Iliac fixation was not used.

2.4. Radiographic evaluation

Upright spine radiographs were collected pre-operatively and at the last follow-up and were evaluated by a single independent reviewer. Pelvic incidence was measured from preoperative digital radiographs. Slip percent and slip angle were measured digitally from standing pre-operative and final follow-up evaluations. All measurements were performed digitally with SurgimapSpine (Nemaris Inc., New York, NY) digital software. Implant and fusion status were evaluated using plain film, flexion–extension, lateral radiographs, supplemented by CT scans for selected patients at discretion of the operating surgeon.

3. Results

Six patients were identified (4 female, 2 male); mean age was 43 years (range: 28–63) (Table 1). Four patients presented with