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Radiographic outcomes of transosseous intradiscal screw fixation in lumbar reconstruction—Imaging results of an experience with an alternative in fixation of the unexpectedly osteopenic spine☆

Drew A. Bednar[a,*], E. Demetra Bednar[b]

[a] Clinical Professor of Surgery, McMaster University, Hamilton, Ontario, Canada
[b] Biomedical Sciences Program, University of Guelph, Guelph, Ontario, Canada

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ABSTRACT

Objective: To present the results of a new alternative in the technique lumbar pedicle screw reconstruction in osteopenic bone. Pedicle screw fixation is compromised in osteopenic bone and adjunct fixation commonly requires incremental technology that can increase cost and risk, and which may not commonly be available. Readily available low cost techniques are desirable.

Patients and Methods: This is a retrospective review of a prospectively accumulated case series of all patients presenting to the senior author's (DAB) practice for elective lumbar reconstruction at a tertiary spine referral center. All consecutive patients treated by the senior author 2002–2012 who were unexpectedly found to be severely osteopenic at surgery are reported.

Results: In seventy-four cases with imaging and clinical information available at an average of five years after surgery there was no screw lucency or accelerated disc degeneration observed despite these screws purposefully projecting into the suprajacent disc space within the limits of the construct. No patient had presented for instrumentation-related revision surgery of any sort.

Conclusion: Transosseous intradiscal screw fixation is a potentially viable alternative in surgical stabilization of the unexpectedly osteopenic lumbar spine.

1. Introduction

Population demographics [1,2] and documented benefit from optimized reconstruction [3] present increasing numbers of osteopenic spine care candidates. Osteopenia is a risk factor for construct failure [4–6].

Screw fixation is improved by optimized screw sizing, polymethylmethacrylate augmentation [7], expansile screws [8], hydroxyapatite coatings [9], cortical bone trajectory [10,11] and multicortical fixation at the sacrum [12]. Research here is largely biomechanical and preclinical. Clinical literature is sparse. Cement leakage is frequent [13].

Multicortical fixation is commonplace only at the sacrum [12]. Biomechanical studies show benefit equal to the alternatives [14].

The senior author (DAB) began an occasional use of transosseous multicortical fixation in 2002 with study approval from the Hamilton Health Sciences Research and Ethics Board (project #7-333) and recorded them in an Excel database. Independent biomechanical testing published in 2005 encouraged our practice [15]. We presented favorable results at mean 24 months' follow-up internally in 2007 (Fig. 1). We undertook this review to accumulate late follow-up information on the 2002–2012 experience requiring a minimum of 24 months follow-up.

2. Materials and methods

Our practice log, office records and available online medical and imaging records from our regional health system were reviewed. Where data were lacking we contacted the patients, their families and/or the referring physicians. Imaging results were compiled by direct review of all the relevant images by the senior author (DAB) and confirmed with correlation to the corresponding radiologist reports.

Clinical outcomes of concern were late pain complaints presented to any physician treating the patient for any reason, referral for

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* Corresponding author at: c/o 414 Victoria Avenue North suite M9, Hamilton, Ontario, L8L 5G8, Canada.
E-mail address: drdrewbednar@cogeco.net (D.A. Bednar).

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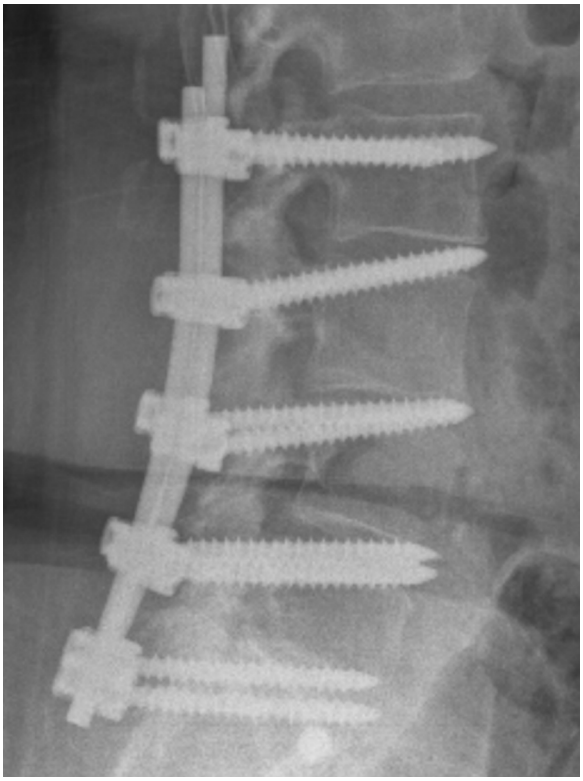

Fig. 1. Mature L2-S1 construct, transosseous screws at all levels except the apical L2 at 48 months after surgery. No radiolucency seen.

incremental spine care, or any required revision of the construct. Radiographic outcomes were screw loosening (radiolucency), implant breakage or any rapid progression of disc degeneration within the instrumented motion segments.

Statistical analysis of the loosening rates found here with against comparable peer literature was performed with the Z-test of independent proportions [16]

2.1. The procedure - inclusion criteria

These were all elective lumbar reconstructive procedures done for neuroclaudicant spinal stenosis with spondylolisthesis (36 cases), postdecompressive instability as anticipated to be caused by required extensive facet resection (38 cases), or flexible lumbopelvic mismatch (lumbar lordosis – pelvic incidence, LL-PI > 20 degrees as seen in preoperative standing lumbar X-rays but not seen in supine images (11 cases). Cases were identified only at surgery when blunt probing of the pedicle with a manually-held 4 mm probe unexpectedly met little resistance on insertion. Variability in this subjective assessment was potentially minimized by the long experience of the one involved surgeon (DAB) with the same instrumentation system (Medtronic CD Horizon MD8; Medtronic Canada, Brampton, Ontario) that had been used at our hospital for two years prior to the first case and continues to this day. Baseline bone densitometry information was only rarely available in this widespread referral population.

Being a fixation-in-situ this technique was applicable only to those patients having a reasonable lumbar lordosis (lumbopelvic mismatch or LL-PI < 20 degrees) [17] and coronal plane alignment (scoliosis < 10 degrees) under prone general anesthetic on the Jackson spine operating table.

Recognizing that screw violation of a freely mobile disc would be problematic, this technique was never used at the upper instrumented vertebra (UIV) of these constructs.

2.2. The procedure - exclusion criteria

A primary requirement is a pedicle of sufficient vertical diameter that a 6.5 mm screw could be angled sufficiently across the mean 15 mm length of a lumbar pedicle to transfix the superior end plate of the instrumented vertebra. Two patients with bilateral very small pedicles were disqualified.

Patients with vertically collapsed lateral foramena requiring elevation of the motion segment with interbody support implants for complete neuroforamenal decompression were necessarily excluded, as were patients with fixed kyphosis.

2.3. The procedure - technique of screw insertion

All pedicle screw insertions are done under fluoroscopic control with standard polyaxial screws and instrumentation in titanium alloy.

1. Under AP fluoroscopy the dorsal cortex overlying the pedicle was decorticated with a 4 mm round-headed burr which is then coaxially driven in a “straight ahead” or vertical trajectory as originally described by both Roy Camille et al [18] and the AO group [19] down the pedicle to its maximum length of approximately 15 mm, reaching the isthmus;
2. A flat-tipped straight 4 mm diameter calibrated pedicle probe is advanced through the pedicle to 40 mm, penetrating the vertebral body (Fig. 2). When there was little resistance to the probe here the indication for transosseous screw fixation was realized and the fluoroscope rotated into the lateral position;
3. The handle of the probe is then precessed in a distal and slightly lateral direction until the tip of the instrument is aimed with slight convergence at the anteroinferior corner of the suprajacent vertebral body as seen on the fluoroscope (Fig. 3). The blunt probe is gently hammered forward and through the upper end-plate of the instrumented vertebra (Fig. 4) until it is adjacent to the lower end plate of the next proximal vertebra (Fig. 5). Increased resistance to insertion is appreciated as the probe crosses that cortex. Lateral fluoroscopy confirms that the tool remains confined by the cortex of the pedicle;
4. AP fluoroscopy is used to verify that the probe has advanced in a convergent direction and that the tip of the screw is not lateral to the target vertebra above;
5. The screw is inserted manually under lateral fluoroscopy. A palpable increase in insertion torque is again consistently noted as the screw crosses the upper end-plate;
6. Rods are articulated to the screws routinely without cross-links

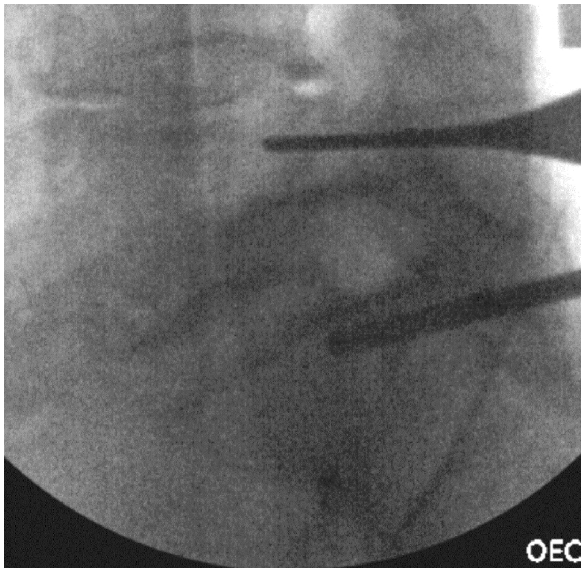

Fig. 2. Index level S1. Pedicle probe advanced just past the foramen above and into the centrum.