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Case Report

Stand-Alone Rod Augmentation for Instrumentation Failure after Pedicle Subtraction Osteotomy: A Case Report with a 2-Year Follow-up

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Abstract

Background: Revision surgery of spine can be a complex procedure and has known complications. It involves hardware revision, removal of scar/callus tissue, realignment of sagittal balance, and anterior augmentation. However, through this report, we aim to demonstrate that a stand-alone rod augmentation at the failure site without removal of scar/callus tissue and/or anterior fixation can achieve excellent results in select cases.
Case Report: A 66-year-old woman underwent L2 pedicle subtraction osteotomy (PSO) + T9-iliac fixation for fixed sagittal imbalance and osteoporotic collapse of L3. One year later, she developed progressive axial lumbar pain and difficulty in mobilization. The patient was diagnosed with pseudoarthrosis and instrumentation failure and underwent revision spine surgery with stand-alone rod augmentation. She had an uneventful rehabilitation and showed complete radiographic union and excellent clinical outcome in the 2-year follow-up.
Conclusion: Stand-alone rod augmentation can provide stable posterior construct to prevent future pseudoarthrosis and/or instrumentation failure after revision spine surgery in selected cases. Anterior augmentation or resection dural scar tissue or dissection through callus tissue is not always necessary.

Keywords: Spine; Revision Surgery; Treatment Failure; Subtraction Technique; Osteotomy

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Background

Pedicle subtraction osteotomy (PSO) is inherently associated with a high rate of mechanical complications and implant failures (1). Incidence of hardware failure after PSO is surprisingly high (15-20%) (2, 3). Pseudoarthrosis and/or instrumentation failure are among the most challenging complications of PSO. Conventional treatment involves hardware revision, removal of scar/callus tissue, realignment of sagittal balance, and anterior augmentation. However, through this report, we try to demonstrate that a stand-alone rod augmentation at the failure site without removal of scar/callus tissue and/or anterior fixation can achieve excellent results in select cases.

Anterior approach to the spine is coherently associated with higher rates of morbidity and mortality (4). A staged second surgery for anterior augmentation amplifies the risks of anesthesia and additional blood loss. If the goals of revision spine surgery can be achieved without the risks of second anterior approach, then we believe it balances the optimal desired results. Currently, there is no gold standard revision strategy for achieving solid fusion and to prevent future instrumentation failure or pseudoarthrosis (5).

Rod augmentation is often used in revision surgery mostly in conjugation with hardware revision and anterior fixation (6). However, several biomechanical studies have proven that rod augmentation provides a stable construct that prevents future occurrence of pseudoarthrosis and/or failure (5). Based on a similar strategy, we performed stand-alone rod augmentation and the patient showed good clinical and radiological outcome after a 2-year follow-up.

Case Report

A 66-year-old woman underwent L2 PSO + T9-iliac fixation for fixed sagittal imbalance and osteoporotic collapse of the L3 vertebra (Figures 1 and 2).

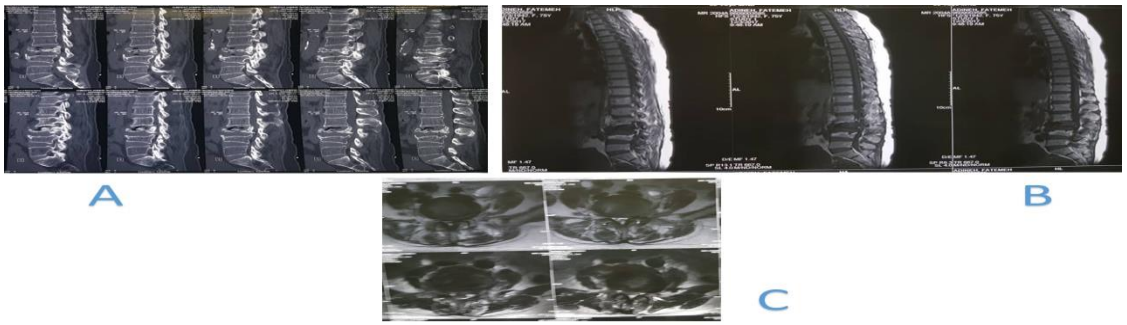

Figure 1. Preoperative images: computed tomography (CT) scan showing collapse of the L3 vertebra (A), magnetic resonance imaging (MRI) T1 sagittal sequences showing osteoporotic collapse and loss of lordosis (B), MRI T2 axial images showing severe canal stenosis at the level of L3-4 (C)

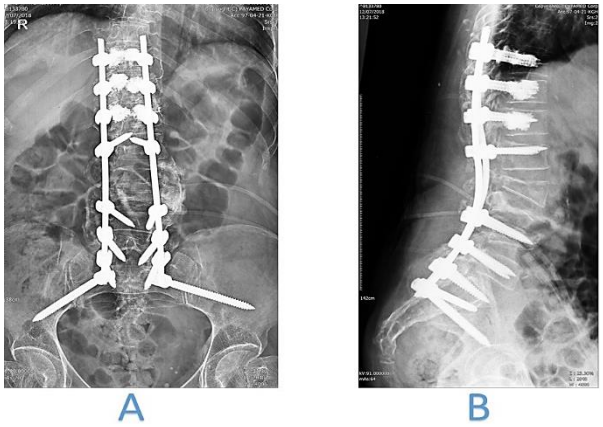

Figure 2. X-rays immediately after the primary surgery: antero-posterior (A) and lateral (B) view

The patient was symptom free for 1 year until she developed progressive axial lumbar pain and difficulty in mobilization. Serial radiograph showed evident pseudoarthrosis and instrumentation failure at the site of the previous PSO (Figure 3).

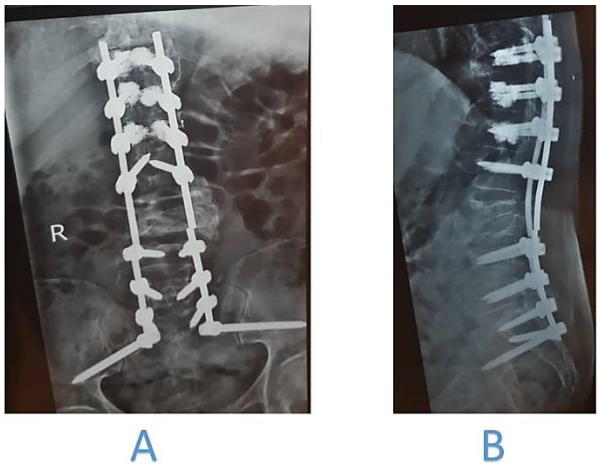

Figure 3. X-ray prior to revision showing anterio-posterior (A) and lateral (B) instrumentation failure

The spino-pelvic alignments had been restored to near normal limits after index surgery (Table 1).

Table 1. Radiographic parameters and clinical outcome score comparison

Parameters	Pre-operative	Post-operative	Pre-revision	Post-revision
LL	22	42	30	37
SVA (cm)	12	2.4	5.2	2.7
SS	25	35	32	37
PI	58.5	55.8	55.8	57.5
ODI	48.5	35	45	30
SRS-22r	47.3	62.2	52	68.5
VAS	7	4	8	3

LL: Lumbar lordosis; SVA: Sagittal vertical axis; SS: Sacral slope; PI: Pelvic incidence; ODI: Oswestry disability index; SRS: Scoliosis research society; VAS: Visual analogue scale

The patient was scheduled for revision surgery. At first, we removed the broken rods, then we attained a short augmentation using one level above and one level below the failure site. A separate long fixation was then placed from T9 to ilium (Figure 3).

All the fixation points were checked before finalizing the construct and no pedicle screw needed revision. No attempt was made to dissect scar/callus tissue. The patient was mobilized the next day and discharged on day three. Consecutive follow-up showed good radiographic union and excellent clinical outcome (Figure 4). Oswestry Disability Index (ODI), Scoliosis Research Society-22r (SRS), and visual analogue scale (VAS) improved dramatically at ultimate post-revision follow-up (Table 1).

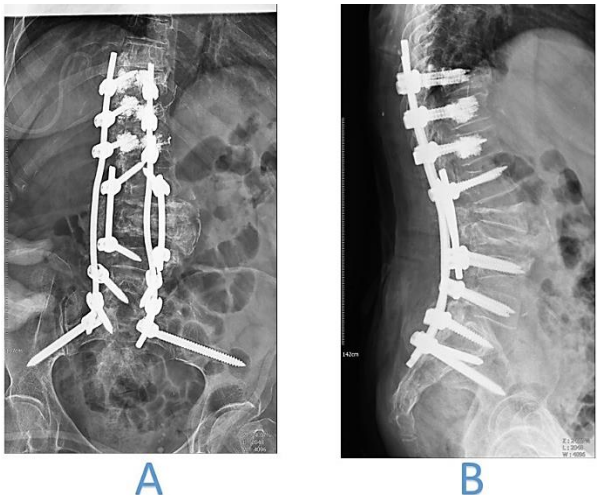

Figure 4. Post revision surgery x-rays showing rod augmentation with good anterio-posterior (A) and lateral (B) union

Discussion

Global sagittal imbalance can be associated with pain and physical disability in patients with adult spinal deformity (ASD) (7). Rigid imbalanced spine requires one or a combination of osteotomy procedures. PSO is a technique in which the posterior elements, including the pedicles, and also a V-shaped wedge of the vertebral body is resected. Despite the advantages, it is associated with significant rate of complications, ranging between 30-50 percent (8). A frequent delayed complication is the instrumentation failure (9).

Revision surgery of spine can be a complex procedure and has known complications. Indications for revision include pseudoarthrosis, instrumentation failure, infection, progressive deformity, and adjacent segment disease (10). Revision spine surgery often presents unique problems such as epidural fibrosis, scar/callus tissue, compromised vascular supply, and infections. When undertaking a revision, certain factors must be considered that are not present during index surgery (11). Intraoperative factors such as operative time and blood loss are imperative to success. Therefore, we tend to keep both operative time and blood loss to minimum, 2-3 hours and 150-200 ml, respectively.

Biomechanical studies show that the osteoporotic spine is prone to complications such as subsidence and implant pull-out leading to revision (12).

In this case, factors predisposing to failure of the primary surgery can be attributed to patient age and severe osteoporosis. However, authors have adopted all the precautionary measures at the index surgery; pedicle screws were augmented with bone cement, multiple stable fixation points were achieved, spino-pelvic alignment was carefully restored to normal sagittal balance (Table 1). Nevertheless, instrumentation failure is a complex event, affected by various factors such as bone healing/union and dynamics and distribution of mechanical loading (9).

Traditionally, revision spine surgery is performed with resection of the dural scar and callus tissue in order to attain union and sagittal balance (13). However, resection of the dural scar and callus tissue has major implications that may lead to dural tear, extensive blood loss, and major increase in the operation time. Therefore, we suggest that, if possible, no attempt be made for such dissection unless there is doubt of severe nerve root impingement.

Stand-alone rod augmentation is regarded as inherently unstable and mostly requires supplementary anterior fixation (14). However, given the authors' experience and in light of this report, we would like to proclaim otherwise. The patient showed acceptable timely union with excellent clinical outcome. Future studies on revision spine surgeries must identify patients with instrumentation failure after PSO and compare the outcomes of such minimal intervention.

Conclusion

Stand-alone rod augmentation can provide stable posterior construct to prevent future pseudoarthrosis and/or instrumentation failure after revision spine surgery in select cases. Anterior augmentation and/or resection of dural scar and dissection through callus tissue is not always necessary.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgments

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