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The Fate of the Adult Revision Spinal Deformity Patient: A Single Institution Experience

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Abstract

Study Design—Retrospective case series.

Objective—The aim of this study was to determine the repeat revision rates for all revision SD surgeries performed at a single center and to investigate the changes in measures of HRQL in these patients.

Summary of Background Data—Reported revision rates for primary adult spinal fusion surgeries have ranged from 9% to 45%, but to our knowledge, the repeat revision rate following

The rate of unplanned, repeat revision for adult spinal deformity surgery at a single institution was 21%. Nearly one third, 27%, of these patients underwent multiple repeat revision surgeries. Despite this, improvement in SRS-22 scores were observed at a minimum of 2 years of followup.

Level of Evidence: 4

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revision spinal deformity (SD) surgery has not been reported. The reported improvements in health-related quality of life (HRQL) measures following revision SD surgery have also been quite modest.

Methods—455 consecutive adult revision SD surgeries (1995-2008) were identified and the records were reviewed to determine the reason for and timing to any additional operation(s). SRS Outcomes scores were recorded at the first visit and at planned followup visits.

Results—94/455 patients underwent further surgeries for a repeat revision rate of 21%. 2-year followup was available for 74 (78%) of these patients (mean followup, 6.0 years, range 2.4-12.6, gender: F=61, M=13; mean age 53 years, range 21-78). The most common causes of repeat revision surgery were pseudarthrosis (N=23, 31%), implant prominence/pain (N=15, 20%), adjacent segment disease (N=14, 19%), and infection (N=10, 14%). Twenty five (27%) patients underwent more than one revision procedure. SRS Outcomes scores were available for 50 (68%) patients, at an average followup of 4.9 years (range 2-11.4). The mean improvements in the SRS outcomes measures were Pain: 0.74 ($p<0.001$), Self-Image: 0.8 ($p<0.001$), Function: 0.5 ($p<0.001$), Satisfaction: 1.2 ($p<0.001$) and Mental Health: 0.3 ($p=0.012$).

Conclusion—The rate of repeat revision following revision spinal deformity surgery was 21%, most commonly due to pseudarthrosis, adjacent segment disease, infection and implant prominence/pain. However, significant improvements in SRS outcome scores were still observed in those patients requiring additional revision procedures.

Keywords

adult revision spinal deformity; outcomes; HRQL

Introduction

Rates of spinal surgery, including spinal deformity surgeries, are rising with the aging population.¹ Revision rates for primary spine fusion procedures range from 9% to 45%, where length of followup is associated with greater revision rates.²⁻⁴ Despite modern instrumentation and advances in osteobiologics, the rates of revision spine fusion procedures are not improving.⁵ With the aging population, it is inevitable that the revision burden grow in coming years. To our knowledge, the rate of repeat revision spinal surgery has not been reported from a consecutive patient cohort.

Estimating the rates of repeat revision spinal deformity surgery is difficult, as the patient population is heterogeneous.⁶ Individual reports often focus on the various diagnoses that require repeat revision surgery, such as pseudarthrosis and adjacent segment disease.⁷⁻¹¹ Thus, the prevalence of these diagnoses amongst those patients requiring repeat revision surgery is not known. The results of revision surgery for diagnoses such as pseudarthrosis, adjacent segment disease and infection have been reported, often with favorable results, though not replicating the results of successful primary surgeries.^{10,12}

The purpose of this study was to determine the rate of repeat revision surgery in patients undergoing revision spinal deformity surgery at one institution. The reasons for revision will be reported, as well as the reasons for repeat revision surgeries. A secondary aim was to

calculate the changes in health related quality of life (HRQOL) scores for these patients undergoing repeat revision spinal deformity surgery.

Materials and Methods

After Institutional Review Board approval, a surgical database at a single institution was queried for revision spinal fusion procedures performed between 1995 and 2008. Inclusion criteria for the search were adults (18 years old or greater), diagnosis of a spinal deformity (i.e., scoliosis, kyphosis, spondylolisthesis) undergoing a revision surgery, or a revision surgery involving six levels or more performed by one of two senior, fellowship trained surgeons. Exclusion criteria included acute trauma and tumor. Infections, neuromuscular disease, and rheumatologic disease were included in the search.

From this patient database, all records were examined for patients undergoing a repeat revision spinal surgery. This cohort comprised the group of interest and the first revision surgery was considered the index procedure. Hospital records were reviewed for all hospitalization stay data, clinic chart data and any correspondence. Demographic data on the patients were recorded, including age at revision, reason for revision, number of prior surgeries (one *versus* multiple), diagnoses for primary surgery, if known, body mass index, and whether the prior surgery was complicated by an infection at any time point. Surgical data for the first revision procedure (index procedure) included the number of levels involved (fused or explored) the upper and lower instrumented vertebrae, surgical approach (anterior, posterior, combined), timing of any staged procedures (same day *versus* delayed), whether interbody fusions were performed (yes or no), whether a three-column osteotomy was performed (yes or no), estimated blood loss and total surgical time. Any unplanned surgery was counted as a repeat revision. Planned, but delayed, anterior and posterior surgeries were not counted as repeat revisions. For repeat revisions, the reason for the surgery, and the date of surgery was recorded. Scoliosis Research Society – 22 (SRS-22) and SRS-24 scores, when available, were recorded for the first visit and the final visit. Scoliosis Research Society scores were compared using Wilcoxon signed rank test for non-parametric, paired data using SPSS statistical software (version 19, SPSS, Chicago, IL). Statistical significance was defined as $p < 0.05$.

Results

Four hundred-fifty five (455) patients were identified as having undergone revision spinal deformity surgery between the years 1995 and 2008 by one of two surgeons at this institution. Ninety-four (21%) of these patients underwent repeat revision surgery during the followup period. Followup data at a minimum of two years were available for 74/94 (78%, mean, 6.0 years; range, 2.4-12.6) patients. This group consisted of 13 males and 61 females. The mean age was 53.0 years (range, 21-78). The average body mass index was 28.2 kg/m² (13.0-49.1). The original diagnoses for surgery were as follows: thirty two (43%) with idiopathic scoliosis, 24/74 (24%) patients with iatrogenic deformity after degenerative spine surgery, 9/74 (12%) with degenerative lumbar scoliosis, 7/74 (9%) with kyphosis, 4/74 (5%) patients with spondylolisthesis, 3/74 (4%) with neuromuscular scoliosis, and 1/74 (1%) with a syndromic scoliosis. Twenty-three (31%) patients had prior surgery with Harrington

instrumentation. Thirty-two patients (43%) had undergone multiple prior procedures and five (7%) had infections complicating their prior procedure.

Pseudarthrosis was the most common reason for the index revision surgery (30/74, 41%); three (10%) of these patients had a previous spinal infection. Twenty-one (28%) patients presented with degeneration below their previous construct causing a fixed sagittal malalignment. Nine (12%) patients presented with proximal junctional kyphosis, five (7%) with curve progression around a prior construct, and five (7%) with a post-laminectomy kyphosis. One patient presented with residual stenosis requiring a revision decompression. One patient presented with a fracture of the upper instrumented vertebra (UIV). One patient presented with malpositioned instrumentation requiring a revision. One patient presented with adjacent segment disease requiring decompression and extension of the fusion. The medical records did not allow us to calculate the time from prior surgeries to these index procedures.

The mean time to repeat revision was 32.4 months (range, 0-154 months). The most common reason for repeat revision surgery was pseudarthrosis, occurring in 23/74 (31%) of cases (Figure 1). The second most common reason was removal of painful implants in the setting of a solid fusion (14/74, 19%; Iliac Screws:12, Crosslink:2) and a well aligned spinal column. Twenty-one (21/74, 28%) patients underwent early (0-6 months) repeat revision surgery. The most common cause for early (0-6 months) repeat revision was infection (7/21, 33%, Figure 2). Twenty-six (26/74, 35%) patients underwent repeat revision surgery between 12 and 36 months after the index procedure. The most common cause for repeat revision surgery in this time frame was pseudarthrosis (11/26, 42%). Twenty-five (25/74, 34%) patients required repeat revision surgery beyond 36 months of followup. Pseudarthrosis was the most common cause in this time frame as well (9/25, 36%).

Twenty-five (25/91, 27%) patients underwent multiple repeat revision surgeries, for a total of 74 additional procedures. One woman underwent 22 irrigation and débridements for a deep wound infection and a single revision posterior spinal fusion surgery for pseudarthrosis. One gentleman was diagnosed with Cronkite-Canada Syndrome and underwent nine additional procedures for pseudarthroses.

SRS-22 or SRS-24 scores were available at the preoperative and postoperative visit for 50 (50/94, 53%) patients (Figure 3). Statistically significant differences were observed in all five categories. The greatest change was observed in the patient satisfaction subscale (+1.3, $p < 0.001$), followed by pain (+0.8, $p < 0.001$), self-image (+0.8, $p < 0.001$), and function (+0.5, $p < 0.001$). Patient mental health improved the least (+0.3, $p = 0.012$). Using a change of +0.8 to indicate the minimum clinically important difference (MCID), three of the five scores indicating a meaningful improvement was observed following repeat revision surgery.

Discussion

The rate of revision following primary adult revision spine surgery has been reported to be between 9% and 45%.²⁻⁴ Despite the use of modern instrumentation and bone graft

extenders, the rates of revision following primary spinal fusion procedures are not improving.^{3,5} The rates of, and reasons for, repeat revision surgery following revision spinal deformity surgery have not been clearly defined. Also not well described, are the outcomes associated with repeat revision spinal deformity surgery. The purpose of this study was to define the rate of repeat revision surgery following revision spinal deformity surgery. Secondary goals of the study were to determine the causes for repeat revision surgery and to investigate the outcomes of repeat revision surgery.

An analysis of 455 consecutive revision spine surgery patients at a single institution revealed an incidence of repeat revision surgery of 21% (94/455) at an average followup of six years. Twenty patients were lost to followup, leaving 74 (79%) patients for analysis. Our standard of care, when instrumenting to the sacrum, is to place iliac screws as support. At the time of any procedure including instrumentation of the pelvis with iliac screws, patients are counseled that they may require removal of the iliac instrumentation as a minor procedure. Excluding removal of painful implants (14/74), the incidence of repeat revision surgery was 17% (79/455). The most common reason for repeat revision surgery was pseudarthrosis (23/74, 31%). Deep infection requiring irrigation and débridements was the second most common cause of repeat revision surgery, occurring in 20% (15/74) of cases. Adjacent segment pathologies, either proximal (12/74, 16%) or distal (6/74, 8%), accounted for the next most common cause for repeat revision surgery. Twenty-five (25/74, 34%) patients required multiple repeat revision surgeries. Infection (13/25, 52%) and pseudarthrosis (10/25, 40%) were the most common reasons for subsequent repeat revision surgeries.

Repeat revision surgeries occurring within the first six postoperative months were most often due to acute infection (7/21, 33%). The majority (49/74, 66%) of repeat revision surgeries occurred within the first three postoperative years. Five pseudarthroses (5/23, 22%) presented more than five years postoperatively. Lead-time bias confounds the analysis of the revision rates over the time period studied. However, there does not appear to be a difference in repeat revision rates following revision spine surgery over the time period studied (Figure 4), as rates of revision in the near term mirror those from earlier in the study period. This is despite advances in techniques, instrumentation, and osteobiologic graft substitutes and suggests that more work must be done to improve results for these complicated reconstructions.

Preoperative and last followup outcomes scores (Scoliosis Research Society (SRS) – 24, Scoliosis Research Society-22) were available for 68% (50/94) of the patients undergoing repeat revision surgery. Each of the five SRS questionnaire domains showed statistically significant improvements when the preoperative scores were compared with the last followup scores (Figure 3). Patient satisfaction scores improved the most (+1.3, $p < 0.001$), while mental health showed the least improvement (+0.4, $p = 0.012$). While statistically significant increases were observed in all domains, the changes may not indicate clinically significant differences, as the minimum clinically important difference (MCID) is not well defined for the SRS-22 questionnaire.¹³ Only the satisfaction score approached the population norms for normal patients, though one should not expect multiply revised spinal deformity patients to be without some residual disability recorded in any of the questionnaire domains.¹⁴

Fritsch *et al*⁶ reported the rate of revision following revision spine surgery as 34%. While this group underwent discectomy as their initial surgery, this paper highlights the heterogeneous composition of failed back surgery patients, making comparisons between patients difficult. In addition, despite undergoing a smaller, nonfusion operation at their initial procedure, close to one third of the patients required multiple revision surgeries. Jang *et al*¹⁵ reported their results of revision spinal surgery for fixed sagittal imbalance with 19 patients. Iatrogenic flatback was the most common reason for revision surgery followed by adjacent segment degeneration. No pseudarthroses were found at the time of revision surgery, nor were any subsequent reoperations reported in their followup period, which averaged 31 months. As we have shown here, this is not an adequate followup period for these multiply revised patients. Several studies have shown a 10% repeat surgery rate following surgery to address pseudarthrosis.^{8,11} Multiple pseudarthroses have been shown to put patients at risk for subsequent pseudarthrosis, more likely at the thoracolumbar and lumbosacral junctions, and repeat revision surgery.¹¹

Good outcomes following treatment of failed spinal deformity surgeries may be expected.^{10,12,16,17} In this series, despite requiring multiple revisions, clinically significant improvements were observed in four of the five SRS outcomes scores domains. While a statistically significant improvement in mental health was observed here, the MCID has not been well defined, thus the clinical significance is unknown. That the mental health disability associated with failed spinal fusion surgeries does not respond favorably to “successful” treatment, as opposed to physical outcomes, has been shown before.⁷ In all cases, however, patients must be counseled that their outcomes are unlikely to approach those associated with primary surgery for spinal deformities.

This study is limited by the retrospective design. The reported rates of repeat revision may underestimate the true value, as patients may have pursued repeat revision surgeries at another institution. Furthermore, as time passed from the initial surgery, some patients may have required repeat surgeries, which may have been contraindicated, as their age or other medical comorbidities that made them poor surgical candidates. Finally, the data abstraction is limited by what is available in the chart. For example, in this series we could not accurately quantify the number of previous surgeries patients had undergone. For this reason, patients were categorized either as a first revision surgery or as having undergone multiple prior surgeries. Outcomes data were available for only 53% of the patients undergoing repeat revision surgery. The results may overestimate the true effect associated with repeat revision surgery, as those patients with poor outcomes may have refused followup care or refused to complete the postoperative questionnaires.

In this study, we found a repeat revision surgery rate of 21% for spinal deformity patients undergoing revision surgery at a single institution. Excluding minor procedures, such as removal of iliac instrumentation, the repeat revision surgery rate was 17%. Nearly one third of patients undergoing repeat revision spinal surgery required multiple unplanned surgeries. Despite advances in techniques, instrumentation, and osteobiologics, the rates of repeat revision surgery did not change across the study period. However, despite requiring repeat revision surgeries, clinically significant improvements in HRQOL scores were observed. Future study may include prospective analysis of these patients to minimize loss to followup

and to obtain more complete outcomes data. Patients that are subject to multiple revision surgeries comprise a heterogeneous cohort and detailed data collection is necessary to provide information regarding risk factors for failed revision surgery.

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IRB Approval Received

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1. Repeat revision rate for adults undergoing revision spinal deformity surgery was 21%.
2. Pseudarthrosis was the most common for repeat revision surgery.
3. Despite multiple, unplanned surgeries, good HRQOL scores were observed at a minimum of two years of followup.
4. 27% of patients underwent multiple unplanned surgeries.

Reasons for Repeat Revision Surgery **Figure 1. Reasons for Repeat Revision Surgery**

Figure 2. Timing and Reasons for Repeat Revision Surgery

Figure 3. Scoliosis Research Society Domain Scores (Preoperative vs. Postoperative)

Figure 4. Rates of Repeat Revision Surgeries By Time Period of Index Revision