CLINICAL ARTICLE

What is the Rate of Lumbar Adjacent Segment Disease after Percutaneous versus Open Fusion?

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Objective: Adjacent segment disease (ASD) requiring treatment or re-operation is a common problem after surgery on the lumbar spine. The hypothesis of this retrospective study was that ASD occurs less often following lumbar spine fusion in patients who undergo percutaneous minimally invasive (MIS) instrumentation than in those in whom open instrumentation is used.

Methods: A case-control study was performed on consecutive patients who had undergone staged single or two level anterior lumbar interbody fusion for degenerative conditions followed by open or MIS instrumentation from 2002 to 2005 in our institution. ASD was defined as that necessitating additional procedures for new symptoms related to an adjacent lumbar dermatome.

Results: One hundred and seventeen patients met the inclusion criteria. Of these, 53 had been followed up by chart or medical record review for longer than one year. There were 23 patients in the MIS group and 30 in the open group. Of the 30 patients in the open group, 9 had developed ASD (30%). Of the 23 patients in the MIS group, 7 had developed ASD (30%). This difference is not statistically significant ($P = 1.00$).

Conclusion: Contrary to our hypothesis, there was no significant difference in incidence of ASD in patients who had underwent open versus percutaneous instrumentation following anterior lumbar interbody fusion.

Key words: Adjacent segment disease; Minimally invasive fusion; Percutaneous screws; Reoperation

Introduction

Adjacent segment disease (ASD) is defined as the interval development of symptoms at spinal levels adjacent to a previous spinal arthrodesis. There are several theories to explain ASD; these include increased motion demands from unfused discs adjacent to a fusion, altered kinematics caused by destruction of paraspinal muscles and the progressive natural course of lumbar spondylosis. After open surgery, destruction of posterior stabilizing structures and altered kinematics are thought to result in ASD in the lumbar spine.

Despite the fact that minimally invasive (MIS) fusion techniques clearly cause less paraspinal muscle damage

association than open fusion¹⁻⁹, to the authors' knowledge, there have been no studies to demonstrate whether MIS surgery reduces the incidence of ASD. We hypothesized that MIS results in a lower incidence of ASD than open surgery because the former causes less damage to paraspinal muscles.

Materials and Methods

This was a retrospective case control study of consecutive patients who had undergone anterior-posterior lumbar fusion between 2002 and 2005 at a single institution. Patients who had undergone instrumented open one or two level anterior lumbar interbody fusion along with percutaneous (MIS)

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or open (non-MIS) posterior instrumentation for degenerative lumbar conditions were selected from a prospectively collected database. Patients who had undergone surgery for infectious, traumatic or neoplastic processes were excluded from the study. There were 113 patients identified who were eligible for inclusion in the study. Of these, there were 35 with at least 1 year chart follow-up. Some patients had significantly longer follow-up, including 24 with 2-year chart follow-up, and 17 with 5-year chart follow-up. The overall average follow-up was 3.8 years. All eligible patients who did not have greater than 1-year chart follow-up were contacted via telephone and interviewed. Eighteen such additional patients were contacted via telephone. The standard anterior reconstruction constructs had included femoral ring structural allografts with or without recombinant human bone morphogenetic protein 2 (Infuse, Medtronic, Memphis, TN, USA).

Medical records were reviewed retrospectively to ascertain whether eligible patients had undergone percutaneous or open posterior instrumentation and fusion. Posterior instrumentation systems included Viper (Depuy, Johnson and Johnson, Raynham, MA, USA), Sextant (Medtronic) and Atavi (Endius, Boston, MA, USA).

The relevant medical records were reviewed by an experienced observer. ASD was diagnosed if patients had undergone a procedure, such as an injection or reoperation, for new symptoms with a different anatomic distribution than their original symptoms but in an adjacent segment. The medical records of patients who had at least one year of clinical (office visit) follow-up were directly reviewed. Eligible patients who did not have at least one year of clinical follow-up were contacted via telephone and interviewed regarding symptom history and ASD.

This study was approved by the University Institutional Review Board. MIS and non-MIS groups were compared using Student's *t*-test for continuous variables and either χ^2 or Fisher exact tests for proportions. Statistics were calculated using SPSS v18.0.

Results

In all, we identified 53 patients with greater than one year follow-up (combining the chart follow-up and telephone follow-up groups) comprising 23 MIS and 30 non-MIS patients (Table 1). The mean age was 45.8 years (standard deviation, 9 years) and there were 21 men and 33 women. Of these patients, 50 had undergone surgery for a combination of leg and back pain and 3 for back pain alone according to the operative note and clinic notes. The subjects' mean body mass index (BMI) was 29.7. There were no significant differences between MIS and non-MIS groups in age ($P = 0.991$), sex ($P = 0.337$), mean BMI ($P = 0.803$), percentage of patients aged >45 years ($P = 0.34$), multilevel fusions ($P = 0.29$), smoking habits ($P = 0.26$), obesity ($P = 0.88$), patients who had undergone discography ($P = 0.97$) or use of bone morphogenetic protein ($P = 0.15$). The index procedure had been a revision procedure in a significantly greater proportion of patients in the non-MIS group (10/30) than in the MIS group (1/23) ($P = 0.01$).

TABLE 1 Comparison of open and MIS groups (cases) *

Variable		Open Group	MIS Group	P value
Age >45 years	No	14	10	0.343
	Yes	16	13	
Use of bone morphogenic protein	No	19	10	0.150
	Yes	11	13	
Revision surgery	No	20	22	0.010
	Yes	10	1	
Discography	No	21	16	0.973
	Yes	9	7	
Obese (BMI > 30)	No	15	11	0.875
	Yes	15	12	
Smoker	No	16	8	0.263
	Yes	10	10	
Decompression	No	11	20	<0.001
	Yes	19	3	
Sex	Male	13	7	0.337
	Female	17	16	
Multilevel fusion	No	10	11	0.290
	Yes	20	12	

* χ^2 or Fisher exact test. BMI, body mass index; MIS, minimally invasive.

Nineteen patients had undergone laminoforaminotomy or laminectomy in the open group compared with three in the MIS group ($P < 0.001$).

In all, 16 patients had developed symptomatic lumbar ASD (Table 2). Six of them had undergone reoperation, including 3/23 patients in the MIS group (15%) and 3/30 in the open group (10%, $P = 1.00$). Thirteen patients had received injections to treat new conditions: 5/23 in the MIS group (21%), and 8/30 in the open group (27%); this difference was not significant ($P = 0.76$). There were no failures of fusion, fusion explorations or hardware removals for symptomatic or misplaced hardware in either group. The overall incidence of ASD was 9 patients in the open group (30%) and 7 in the MIS group (30.4%); this difference is not significant ($P = 1.00$). There were no statistically significant differences in incidence of ASD between 1 and 2 level fusions.

TABLE 2 Comparison between open and MIS groups of reoperation or injections for new ASD symptoms (cases) *

Groups	n	ASD		Reoperation		Injection	
		No	Yes	No	Yes	No	Yes
Open	30	21	9	27	3	22	8
MIS	23	16	7	20	3	18	5
P value	—	1.00		1.00		1.00	

* χ^2 test. ASD, adjacent segment disease; MIS, minimally invasive.

Discussion

We found no difference in the rate of developing ASD between patients undergoing MIS versus open posterior lumbar fusion. The overall rate of reoperation was 11% at 3.8 years. With the addition of injections and nonsurgical treatment, the overall rate of ASD was 30%.

Previous studies have demonstrated that MIS surgery may be associated with less muscle dissection and denervation than open procedures⁷. Furthermore, previous studies have established that MIS surgery is at least as effective as open surgical decompression⁴⁻⁶. However, previous studies have not compared the effects of specific instrumentation techniques on adjacent spinal segments¹⁰.

The reported average reoperation rate after lumbar fusion is highly variable. Ghiselli *et al.* reported a rate of symptomatic degeneration adjacent to a previous arthrodesis warranting decompression or arthrodesis of 16.5% at five years and 36.1% at ten years¹¹. Other studies have reported a rate of adjacent spinal degeneration between 7.7% at two years¹² and 30.3% of patients at 5 years¹³.

The rate of reoperation in the current study (11%) is similar to that previously reported. We acknowledge that, because the need for reoperation is a subjective decision by the surgeon and patient, in some ways reoperation may not be the best endpoint for quantifying symptomatic ASD. For that reason, we also included patients who had received nonsurgical symptomatic treatment for new symptoms of radiculopathy. The inclusion of patients with symptomatic ASD who have not undergone reoperation is not standard in other reported studies on ASD.

Our research design had several weaknesses. The retrospective nature of this study limited our ability to make direct inferences from the research data. Additionally, fewer than 50% of the entire cohort of otherwise eligible patients had

been adequately followed up. To address the follow-up issue, the authors specifically attempted to contact all eligible patients for a telephone interview. This poor follow-up rate demonstrates the difficulty of performing long-term follow-up studies in urban areas, even in a multi-specialty group. It is possible that a high percentage of patients may have been lost to follow-up because they had developed symptomatic ASD sought out a different physician for treatment. Conversely, the patients who were lost to follow-up may have been those with good outcomes; possibly only the symptomatic patients may have attended for long term follow-up. The authors selected a case control design to address these issues of follow-up and reoperation. We also acknowledge that ASD is somewhat poorly defined in published reports. We defined ASD prior to the study as the presence of clinical symptoms severe enough to warrant further treatment. However, we acknowledge that some patients may have had symptoms for which they did not seek treatment or progression of degenerative findings on imaging studies without development of new symptoms. Finally, we acknowledge that the current study may have been underpowered for detecting a difference between techniques in reoperation rates. However, since the incidence of ASD was quite similar (30% vs. 30.4%), we suspect that these findings are genuine. Additionally, given the similar incidence of ASD in the fusion and non-fusion groups, future studies would require a large number of patients to identify statistically significant differences in ASD, if they exist.

Our findings led us to conclude that ASD is more likely a function of the natural history of lumbar spondylosis or the act of lumbar arthrodesis, rather than of the surgical approach. In this study, there percutaneous, muscle-sparing techniques conferred no apparent benefits in terms of reducing the incidence of symptomatic ASD. Future prospective studies are necessary to fully evaluate this topic.

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