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Clinical Study

Long-term outcomes after non-instrumented lumbar arthrodesis

David Santiago-Dieppa [a,b], Mohamad Bydon [a,b], Risheng Xu [a,b,c], Rafael De la Garza-Ramos [a,b], Roger Henry [b], Daniel M. Sciubba [a,b], Jean-Paul Wolinsky [a,b], Ali Bydon [a,b], Ziya L. Gokaslan [a,b], Timothy F. Witham [a,b,*]

[a] Department of Neurosurgery, Johns Hopkins University School of Medicine, 600 North Wolfe Street, Meyer 7-113, Baltimore, MD 21287, USA
[b] Spinal Column Biomechanics and Surgical Outcomes Laboratory, Johns Hopkins University School of Medicine, Baltimore, MD, USA
[c] Medical Scientist Training Program, Johns Hopkins School of Medicine, Baltimore, MD, USA

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ABSTRACT

Non-instrumented lumbar fusion is an accepted technique for the treatment of various spinal degenerative pathologies. The purpose of this study is to report long-term outcomes of patients undergoing *in situ* fusion. A retrospective review was performed at a single institution over a 20 year period. The main outcome variables were symptom resolution at last follow-up, development of adjacent segment disease (ASD) and overall need for re-operation. A total of 376 patients were identified, with a mean age of 61.1 ± standard deviation of 13.54 years. The most common presenting symptom was back pain in 344 (91.5%) patients, followed by radiculopathy in 304 (80.9%) patients. The most common pre-operative diagnosis was multi-level spinal stenosis with claudication in 211 (56.1%) patients. At last follow-up, the prevalence of back pain (60.64%; $p < 0.001$) and radiculopathy (57.71%; $p < 0.001$) were significantly lower. The cumulative rate of ASD was 18.35% (69 patients). In total, the rate of re-operation due to non-improvement or worsening of symptoms was 30.59% (115 patients). In this manuscript, we present one of the largest cohorts of patients undergoing *in situ* fusion for degenerative lumbar spine disease with a median follow-up time of 92 (range 24–154) months. Although the prevalence of both back pain and radiculopathy was significantly reduced at last follow-up, a significant portion of patients still experienced continued symptoms. Notably, while 18.35% of patients developed ASD, 30.6% of patients required re-operation due to recurrent or worsening symptoms during the follow-up period, highlighting the need for additional stabilization techniques.

1. Introduction

It has been more than a century since Hibbs and Albee earned permanent recognition in medical history for independently describing non-instrumented techniques for posterior arthrodesis of the mobile spine [1,2]. With the development of screw fixation by King in 1944 [3], and the use of metallic rod instrumentation by Harrington in 1947 [4], arthrodesis of the lumbar spine rapidly evolved in operative technique and expanded in indication to include the treatment of spinal oncology, trauma, infection, congenital deformity, and degenerative disease [5–9]. Despite the ever-increasing introduction of new medical devices and/or biologics to enhance fusion rates, significant controversies still exist with regard to the relative benefit experienced by the patient in terms of neurologic outcome and post-operative functional status. Thus, a significant number of contemporary studies have demonstrated acceptable fusion rates in both the cervical and lumbar spine after non-instrumented *in situ* fusion compared to their instrumented counterparts [6,9–21]. Moreover, a number of studies have revealed similar functional outcomes in patients treated with non-instrumented fusion compared to instrumented lumbar fusion, with some demonstrating higher peri-operative complication rates in patients undergoing instrumented arthrodesis [2,12,14,22–26].

In order to further our understanding of the pathophysiology of lumbar degeneration in the context of *in situ* procedures, we report the long-term outcomes of 376 patients treated with *in situ* lumbar fusion without instrumentation. These patients were followed up for a median time of 92 (range 24–154) months, and assessed for symptomatic improvement as well as outcomes such as rates of pseudoarthrosis, adjacent segment disease (ASD), as well as the need for re-operation due to continued or worsened neurological symptoms.

* Corresponding author. Tel.: +1 410 502 2383; fax: +1 410 502 3399.
E-mail address: twitham2@jhmi.edu (T.F. Witham).

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2. Methods

Data were obtained for all patients undergoing postero-lateral onlay (non-instrumented) lumbar arthrodesis for the treatment of degenerative lumbar disease at our institution over a 20 year period. Arthrodesis procedures performed for oncologic, infectious, traumatic, and rheumatologic pathologies were excluded. Patients with metabolic bone diseases, and those undergoing interbody fusion or circumferential fusion were excluded as well. In conducting the study, we retrospectively reviewed clinical notes, operative narratives, and radiology reports. Given that this is a retrospective study, we invariably lost some patients who moved away from the region or sought the services of other surgeons. When possible, we attempted to mitigate this factor through telephone calls to the patients to inquire about their functional status and surgical history since our last follow-up.

Demographic information, such as age and sex, as well as comorbidities such as obesity, smoking, hypertension, diabetes, coronary artery disease, and osteoporosis, as well as the initial diagnosis and presenting symptoms manifested by the patients, such as low back pain, radiculopathy, weakness, sensory deficits, and bowel and bladder dysfunction, were collected and documented for all patients. Intra-operative and peri-operative data such as the number of levels in the arthrodesis construct, intra-operative blood loss, hospitalization length, iatrogenic durotomies, cerebrospinal fluid (CSF) leakage, deep venous thrombosis, pulmonary embolism, infection, hematoma, wound dehiscence, discharge to rehabilitation facilities, re-operations, and instrumentation failure were also obtained from the medical record.

Post-operative follow-up times as well as functional outcomes were ascertained from follow-up clinical notes and phone calls. Patients who had follow-up times of less than 6 months were excluded. Fusion status and development of ASD was evaluated independently by a radiologist during follow-up visits.

Pseudoarthrosis was defined as either (1) absence of bridging bone across the posterior fusion sites, or (2) movement between vertebral bodies or spinous processes on dynamic (flexion-extension) radiographs. ASD was defined as radiographic evidence of degeneration at the adjacent level with clinical symptoms necessitating revision surgery. The presence of ASD was independently verified and reconciled by both the radiologist and attending neurosurgeon.

2.1. Statistical analysis

Descriptive statistics were performed and results are presented as means ± standard deviation when applicable. Pre-operative and post-operative symptoms and variables were compared via χ^2 tests. p values under 0.05 were considered significant. Statistical analysis was performed using STATA 12 (StataCorp LP, College Station, TX, USA).

3. Results

3.1. Patient population

Between 1990 and 2010, a total of 376 patients underwent non-instrumented lumbar arthrodesis for the treatment of degenerative lumbar disease. The average age for the *in situ* cohort was 61.1 ± 13.54 years, and 185 (49.2%) patients were male (Table 1). Twenty-three (6.12%) patients had diabetes, six (1.60%) were osteoporotic, 11 (2.93%) were morbidly obese, and 16 (4.26%) were active smokers at the time of surgery. A total of 344 (91.5%) patients presented with back pain, 304 (80.9%) patients presented with radiculopathy, 20 (5.32%) patients presented with motor weakness, 23 (6.12%) patients had sensory deficits, and seven (1.86%) patients had pre-operative bowel/bladder dysfunction. The most common indication for surgery was multi-level spinal stenosis with claudication in 211 (56.1%) patients, followed by degenerative disc disease in 111 (29.5%) and spondylolisthesis in 54 (14.4%) patients.

Table 1
Pre-operative characteristics of all patients undergoing *in situ* lumbar fusion for degenerative spinal disease

	n (%)
Number of patients	376
Age, years (mean ± SD)	61.1 ± 13.54
Male sex	185 (49.20)
Comorbidities	
Diabetes	23 (6.12)
Hyperlipidemia	30 (7.98)
COPD	6 (1.60)
Coronary artery disease	35 (9.31)
Osteoporosis	6 (1.60)
Morbid obesity	11 (2.93)
Smoking history	16 (4.26)
Hypertension	70 (18.62)
Depression	20 (5.32)
Presenting symptoms	
Back pain	344 (91.49)
Radiculopathy	304 (80.85)
Motor weakness	20 (5.32)
Sensory deficits	23 (6.12)
Bowel/bladder dysfunction	7 (1.86)
Diagnosis	
Spondylolisthesis	54 (14.4)
Degenerative disc disease	111 (29.5)
Spinal stenosis with claudication	211 (56.1)

COPD = chronic obstructive pulmonary disease, SD = standard deviation.

3.2. Intra-operative characteristics

An average of 1.76 ± 0.82 spinal levels were fused for all patients (Table 2). Bone morphogenic protein was used in 43 (11.44%) patients. Autograft was used in 345 (91.75%) patients, while autograft with supplemental allograft was utilized in 31 (8.24%) patients. Average blood loss was 625 ± 487 milliliters. The vast majority of patients – 348 (92.55%) – underwent laminectomy as part of their procedure, but only 45 (11.97%) patients had a concomitant discectomy. Fifteen (3.99%) patients had an intra-operative durotomy during the surgery.

3.3. Peri-operative characteristics

Peri-operatively, the average length of stay was 5.98 ± 5.78 days (Table 3). No patients experienced peri-operative myocardial

Table 2
Intra-operative characteristics of patients undergoing *in situ* arthrodesis due to degenerative spinal disease

	n (%)
Number of patients	376
Levels fused (mean ± SD)	1.76 ± 0.82
BMP	43 (11.44)
Autograft	345 (91.75)
Autograft + allograft	31 (8.24)
Blood loss, mL (mean ± SD)	625 ± 487
Incidental durotomy	15 (3.99)
Laminectomy	348 (92.55)
Discectomy	45 (11.97)

BMP = bone morphogenetic protein, SD = standard deviation.