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Clinical Study

Unilateral *versus* bilateral pedicle screw instrumentation for single-level minimally invasive transforaminal lumbar interbody fusion

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ABSTRACT

Minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) has become an increasingly popular method of lumbar arthrodesis. However, there are few published studies comparing the clinical outcomes between unilateral and bilateral instrumented MIS TLIF. Sixty-five patients with degenerative lumbar spine disease were enrolled in this study. Thirty-one patients were randomized to the unilateral group and 34 to the bilateral group. Recorded demographic data included sex, age, preoperative diagnosis, and degenerated segment. Operative time, blood loss, hospital stay length, complication rates, and fusion rates were also evaluated. The Oswestry Disability Index (ODI) score and Visual Analog Scale (VAS) pain score data were obtained. All patients were asked to follow-up at 3 and 6 months after surgery, and once every 6 months thereafter. The mean follow-up was 26.6 months (range 18–36 months). The two groups were similar in sex, age, preoperative diagnosis, and operated level. The unilateral group had significantly shorter operative time, lower blood loss, and shorter hospital time than the bilateral group. The average postoperative ODI and VAS scores improved significantly in each group. No significant differences were found between the two groups in relation to ODI and VAS. All patients showed evidence of fusion at 12 months postoperatively. The total fusion rate, screw failure, and general complication rate were not significantly different. Results showed that single-level MIS TLIF with unilateral pedicle screw fixation would be sufficient in the management of preoperatively stable patients with lumbar degenerative disease. It seems that MIS TLIF with unilateral pedicle screw instrumentation is a better choice for single-level degenerative lumbar spine disease.

1. Introduction

A large number of techniques have been developed for lumbar spinal fusion. Interbody fusion has become widely popular because it provides a large surface area for fusion with the graft under compression. Harms first described the transforaminal lumbar interbody fusion (TLIF) technique with cage fusion that, due to the lateral approach to the disc space, reduced the amount of thecal sac and nerve root retraction required [1]. Although TLIF is a unilateral procedure, it is usually combined with posterior bilateral pedicle screw fixation. The TLIF procedure allows a single point of access to be used for interbody fusion and posterior instrumentation. It preserves the anterior longitudinal ligament and a major portion of the posterior ligament complex with minimal compromise of spinal stability. However the need for paraspinal muscle dissection and retraction remains a drawback that can lead to muscle denervation, atrophy and consequently persistent low back pain [2]. Advances in lumbar fusion techniques have concentrated on reducing soft-tissue damage and neural retraction while maintaining the ability to achieve neural decompression and interbody fusion.

Minimally invasive (MIS) TLIF was introduced by Foley et al. in 2002 [3]. It has become an increasingly popular method of lumbar arthrodesis. Recent technological advances in spinal instrumentation have culminated in the development of MIS TLIF with unilateral pedicle screw fixation [4]. The potential shortfall is an insufficiently stable construct that may result in a higher incidence of instrumentation failure. A higher incidence of nonunion may also be a risk. Biomechanical studies have shown that unilateral fixation after TLIF provided less rotational stability and stiffness than bilateral pedicle screw fixation [5]. Slucky et al. reported that the unilateral pedicle screw construct provided only half of the improvement in stiffness compared with bilateral constructs and allowed for significant off-axis rotational motion after TLIF [6]. However, several studies have also reported that unilateral pedicle screw fixation is as effective as bilateral pedicle screw fixation in lumbar spinal fusion [7,8]. There are few published studies on clin-

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ical outcomes of MIS TLIF with unilateral pedicle screw fixation, even though perioperative and postoperative complications and surgical outcomes have been well described in the literature [9]. The purpose of this prospective study was to compare the clinical outcomes between unilateral and bilateral instrumented MIS TLIF.

2. Patients and methods

2.1. Patients

Sixty-five patients with single-level degenerative lumbar spine disease at L4–L5 or L5–S1 were recruited from July 2009 to June 2011. All patients had suffered from low back pain, severe unilateral radicular pain or neurological symptoms. All patients underwent at least 6 months of conservative management before surgery, with no response or an inadequate response. All patients were confirmed to have single-level degenerative lumbar spine disease with plain radiographs, CT scans, and MRI. They were randomly divided into two groups using a computer-generated number list. Thirty-one patients were assigned to MIS TLIF with unilateral pedicle screw fixation (Group A, Fig. 1), and 34 were assigned to MIS TLIF with bilateral pedicle screw fixation (Group B, Fig. 2). Demographics and procedure data for the two groups are listed in Table 1.

In this study, a stable level was defined as a degenerative disc without spondylolisthesis. Patients were included if they were aged between 40–70 years and only had one level of degenerative disease. Patients were excluded if they were elderly (>70 years old), had isthmic or degenerative spondylolisthesis, were significantly obese (body mass index $\geqslant 35$ kg/m^2), had undergone previous lumbar fusion or discectomy, or had multi-level disease.

2.2. Surgical approaches

After induction of general endotracheal anesthesia, patients were placed in the prone position on a radiolucent operating table, with the abdomen hanging free and slight flexion of the lower limbs. C-arm fluoroscopy was used to position the diseased segments and to determine the incision site. A 2–2.5 cm incision was made overlying the affected level and continued down through the posterior lumbar fascia. Sequential dilators were introduced until a METRx tubular retractor (Medtronic Sofamor Danek, Memphis, TN, USA) was placed. The operating microscope was moved into the field and the laminar edge was identified. The isthmus, the unilateral posterior arch of the vertebrae and the inferior joint facet of the subjacent vertebra were removed. This bone was kept for use as an autograft during the interbody fusion. The thecal sac and traversing nerve root were identified. The operating table was tilted down contralaterally and the microscope was angled toward the medial side. The deep cortical surface of the contralateral lamina was removed and drilling was extended to the contralateral lateral recess and foramen. Finally, the ligamentum flavum and its bony attachment edge were removed. Then, a thorough discectomy and endplate preparation were performed. The disc space was packed with autograft bone. A polyetheretherketone (PEEK) interbody graft (Capstone, Medtronic Sofamor Danek) was then obliquely inserted and placed in the center of the disc space. The entire procedure was carried out using the surgical microscope with variable magnification and sufficient lighting of the operative field. Once the interbody discectomy and arthrodesis were completed, the working channel was removed. With the assistance of the Sextant system (Medtronic Sofamor Danek), percutaneous lumbar pedicle screws were inserted. The screws were compressed over the interbody cage to provide a degree of segmental lordosis and compression across the cage. In Group B, contralateral percutaneous pedicle screw fixation was also performed. All procedures

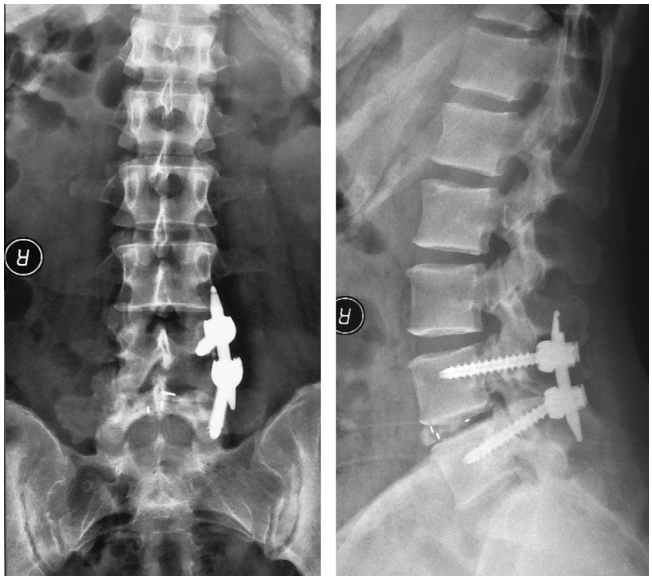

Fig. 1. (Left) Anteroposterior and (right) lateral CT scan showing unilateral pedicle screw fixation in lumbar spinal fusion.

Fig. 2. (Left) Anteroposterior and (right) lateral CT scan showing bilateral pedicle screw fixation in lumbar spinal fusion.

Table 1
Demographic data and distribution of fused levels in the two study groups with unilateral pedicle screw fixation (Group A) or bilateral pedicle screw fixation (Group B)

	Group A	Group B	*p* value
Patients	31	34	
Sex (female/male)	14/17	18/16	0.462
Age, years	57.3 ± 11.7	58.9 ± 10.1	0.153
Mean height, cm	169.5 ± 9.4	171.2 ± 10.6	0.317
Mean weight, kg	68.8 ± 8.4	69.6 ± 9.5	0.462
Diagnosis			0.579
Unilateral lumbar disc herniation	10	12	
Foraminal stenosis	15	18	
Discogenic low back pain	6	4	
Level of fusion			0.730
L4–L5	15	15	
L5–S1	16	19	

Data are presented as mean ± standard deviation or number.