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Original Research

Application of a narrow-surface cage in full endoscopic minimally invasive transforaminal lumbar interbody fusion

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HIGHLIGHTS

- Endoscopic lumbar interbody fusion still remains a technical challenge.
- An 8-mm-wide narrow-surface cage was selected for 42 cases underwent endoscopic lumbar interbody fusion.
- All procedures were performed safely and successfully with minimal trauma and improved visualization.
- Clinical outcome and fusion rate of narrow-surface cage were acceptable and promising.

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ABSTRACT

Background: Spinal endoscopy has been widely applied in lumbar discectomy and decompression. However, endoscopic lumbar interbody fusion still remains a technical challenge due to the limited space within the working trocar for cage implantation. The purpose of this study was to investigate the feasibility and effectiveness of using a narrow-surface fusion cage in full endoscopic minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) for the treatment of lumbar degenerative disease.

Materials and Methods: From Jun 2013 to Dec 2014, a total of 42 patients (23 males, 19 females) underwent full endoscopic MIS-TLIF at our hospital was recruited. An 8-mm-wide narrow-surface fusion cage was selected for all cases. Perioperative parameters and complications were recorded. Comparisons on visual analog scale (VAS) and oswestry disability index (ODI) scores before and after surgery were performed. At the last follow-up, Nakai grading system was applied to assess patients' satisfaction; meanwhile, interbody fusion was evaluated by computed tomography.

Results: Mean operation time was 233.1 ± 69.5 min, and mean blood loss during surgery was 221.8 ± 98.5 ml. Two patients (4.8%) developed neurological complications. Postoperative follow-up ranged from 24 to 36 months (mean 27.6 ± 3.8 months). VAS and ODI scores were significantly improved 3 months after surgery and at the final follow-up, respectively ($P < 0.05$). Outcome of surgery was graded as excellent for 32 patients, good for 8 patients, and acceptable for 2 patients, corresponding to a success rate ("good" and "excellent") of 95.2%. Thirty-nine of the 42 patients demonstrated solid interbody fusion at the last follow-up, indicating a fusion rate of 92.9%.

Conclusion: Application of a narrow-surface fusion cage in full endoscopic MIS-TLIF for the treatment of lumbar degenerative disease is feasible and effective. The clinical outcome and fusion success of this procedure were acceptable and promising.

1. Introduction

Current endoscopic techniques in spine surgery use varied minimally invasive working trocars to establish the surgical approach, which cause much less trauma to the paraspinal muscle compared with open surgery [1–3]. The endoscope can clearly

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show the fine structures in the deep surgical field and provide excellent visualization [4,5]. Spinal endoscopy has been widely applied in lumbar discectomy and decompression [6–9]. However, reports on endoscopic lumbar interbody fusion are still in paucity.

Endoscopic spine surgery differs from open surgery due to the limited space and consequently, requires specialized skills and instruments, especially for fusion cage implantation [5,10]. Meanwhile, the neural elements should be retracted and protected during the operation. Therefore, the placement of a regular infusion cage of open surgery remains a technical challenge in minimally invasive endoscopic surgery using a trocar diameter usually of 20–22 mm [11–13]. Although using larger-diameter trocars or expandable retractors could somewhat improve the operating environment, the selection of a trocar-matched narrow-surface cage of suitable size may be a solution to this problem.

The objective of this study was to investigate the feasibility and effectiveness of application of a narrow-surface (8-mm-wide) interbody fusion cage in full endoscopic minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) for the treatment of lumbar degenerative disease.

2. Materials and Methods

2.1. Patient data

From Jun 2013 to Dec 2014, a total of 42 patients underwent full endoscopic minimally invasive transforaminal lumbar interbody fusion at our hospital was recruited. The inclusion criteria were as follows: 1) lumbar disc herniation with segmental instability or intervertebral disc space narrowing; 2) lumbar canal stenosis with intermittent claudication; 3) degenerative spondylolisthesis with low back and/or leg pain; 4) symptoms not improved after non-surgical treatment for at least 3 months. Patients with severe osteoporosis, 3 or more segments affected, revision surgery, and bilateral lateral recesses stenosis requiring concurrent bilateral decompression were excluded.

The cohort consisted of 23 males and 19 females, with a mean age of 64.2 ± 12.8 years (range: 37–75 years) (Table 1). Thirty-four of these patients were diagnosed as lumbar canal stenosis, 6 patients were diagnosed as degenerative spondylolisthesis, and 2 patients were lumbar disc herniation with segmental instability. One segment was involved in 28 patients as follows: L3-4 in 4 patients, L4-5 in 11 patients, and L5-S1 in 13 patients. Two segments were involved in 14 patients as follows: L3-4 and L4-5 in 5 patients and L4-5 and L5-S1 in 9 patients. In this series, all surgeries were performed by one senior surgeon (E.X.H.), who is proficient in minimally invasive spine surgery with more than 10 years' experience. This study was approved by the Institutional Ethic Committee of our hospital, and informed consents were obtained from all participants.

Table 1
Clinical demographics of patients.

Parameters	Values
Number of patients	42
Mean age (y)	64.2 ± 12.8 (range 37–75)
Sex ratio (M/F)	23/19
Diagnosis	
Lumbar canal stenosis	34 (81.0%)
Degenerative spondylolisthesis	6 (14.3%)
Lumbar disc herniation	2 (4.8%)
Level of fusion	
L3-4	9 (16.1%)
L4-5	25 (44.6%)
L5-S1	22 (39.3%)

Note: Data are presented as n (%) or mean ± standard deviation; M = Male, F = Female.

2.2. Surgical technique

The patient was positioned prone on top of surgical pads with the abdomen free. The operative field was disinfected and draped, and the location of the targeted segmental space was marked on the skin according to preoperative fluoroscopy. First, a stab incision was made 3–4 cm away from the midline. A guide needle was then inserted into the desired location, which was determined by C-arm fluoroscopy. The incision was extended longitudinally to a length of 25 mm. A series of dilation probes ranging from small to large were inserted through the paraspinal muscle to enlarge the approach (Fig. 1A). Finally, a 22-mm working trocar was inserted and secured with the mounting system (Fig. 1B). Fluoroscopy was repeated to align the working trocar directly aiming the targeted intervertebral space on the lateral view (Fig. 1C). A electrical cautery was used to remove the remaining soft tissue on the bone surface, and a 25° rigid endoscope was then placed to identify anatomical structures under appropriate visualization (Fig. 1D).

Resection of the inferior and superior facet joints, along with laminectomy and removal of ligamentum flavum were performed to accomplish canal decompression (Fig. 2A and B). If contralateral decompression was indicated, the working trocar was tilted to the medial side and further removal of the contralateral inner layer of the lamina was achieved. After removal of intervertebral disc and preparation of endplates (Fig. 2C and D), the previously resected autologous bone were mixed with allogeneic bone and grounded into bone chips, which was then packed into the intervertebral space via a specialized cannula (Fig. 3A). Finally, an 8-mm-wide narrow-surface fusion cage made of polyetheretherketone (PEEK) (Double Medical Technology Inc, Xiamen, China) was selected with different heights corresponding to the targeted intervertebral space (Fig. 3B). The cage was firmly packed with bone chips and then gently hammered toward anteromedial direction into the intervertebral space while protection of the nerves and cord was carefully noted under endoscopic monitoring (Fig. 3C). Lateral radiograph was obtained to secure the satisfactory position of the implanted fusion cage (Fig. 3D). Long-arm pedicle screws and connecting rods (Double Medical Technology Inc, Xiamen, China) were inserted percutaneously under C-arm fluoroscopic guidance. Bilateral compression was performed before final tightening of the pedicle screw-rod construct.

2.3. Clinical assessment and statistical analysis

One independent observer, who was blinded to all included cases, evaluated the following parameters: operation time, intraoperative blood loss, incision length, perioperative complications, hospital stay and postoperative ambulatory time. Visual analog scale (VAS) and Oswestry disability index (ODI) scores were also recorded before surgery, 3 months after surgery, and at the last follow-up. Comparisons on clinical outcomes before and after surgery were tested by paired sample *t*-test. At the last follow-up, Nakai grading system [14] was applied to assess patients' satisfaction; meanwhile, interbody fusion was evaluated using computed tomography (CT) [15]. In this study, statistical analysis was performed using SPSS version 16.0 (SPSS, Chicago, IL, USA) and significance was defined as $P < 0.05$.

3. Results

A total of 42 patients were included in this study. The mean operation time was 233.1 ± 69.5 min (range: 120–340 min). The