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Original research

Comparison of tissue damages caused by endoscopic lumbar discectomy and traditional lumbar discectomy: A randomised controlled trial

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ABSTRACT

Objectives: This study aimed to compare the clinical efficacies of percutaneous endoscopic lumbar discectomy (PELD) and traditional open lumbar discectomy (OD).
Methods: The pre-operative and post-operative blood loss, hospital stays and wound sizes of the patients in the two groups were recorded. Enzyme-Linked immunosorbent assay was used to measure the changes of interleukin-6 (IL-6), C-reactive protein (CRP) and creatine phosphokinase (CPK) pre-operation and 1 h, 6 h, 12 h, 24 h and 48 h after corresponding surgery. Visual Analog Scale and Modified MacNab Criteria were used to assess post-operative results.
Results: Patients in the PELD group had less blood loss ($p < 0.01$), shorter hospitalization hours ($p < 0.01$) and smaller surgical wounds ($p < 0.01$) than the patients underwent traditional OD surgery. MacNab evaluated that the levels of satisfaction were above 90% in both groups post-operative six months. There was no significant difference in pain index between the two groups ($p > 0.05$). Furthermore, the levels of CRP, CPK and IL-6 in the PELD group were all lower than those in the OD group with a significant difference ($p < 0.01$).
Conclusion: The PELD had less damage to human tissues than the traditional OD. PELD has a clear promotional value in clinical.

1. Introduction

The spinal musculoskeletal system is destroyed in the traditional open lumbar discectomy (OD), which could easily induce neural adhesion, spinal structural damages, instability and other complications [1]. Therefore, the caused trauma could lead to a series of reactions *in vivo*, including ascent of stress hormones, production of pro-inflammatory cytokines, as well as abnormal metabolic phenomenon [2–5]. And the systemic cytokines caused by tissue damages could produce a series of adverse reactions and affect the important organs in human immune system. The minimally invasive surgery aims to achieve the least amount of trauma to human body by changes of special instruments, such as endoscopes and laser, and progresses of surgical technologies. Thus the damage of human organs and immune response caused by systemic cytokines due to the tissue damage from this surgery would be reduced [6–11].

Therefore, the levels of systemic cytokines could be used to assess the postoperative tissue damages. Percutaneous endoscopic lumbar discectomy (PELD) is a new type of spinal minimally invasive surgery in recent years, which does not needs general anesthesia and has a different surgery way and method from the traditional surgery [12,13]. PELD, a safe procedure for soft disc herniation, causes few damage to muscular and ligamentous [14]. Furthermore, some researchers have applied PELD to treat single level soft lumbar disc herniation and have received favorable consequences [15]. Nevertheless, there are few objective experimental data to confirm that PELD could cause less tissue damages than OD.

This study aimed to compare the clinical results, including pre-operative and post-operative blood loss, hospital stay, wound size, Visual Analog Scale (VAS), post-operative satisfaction and times of work recovery of PELD and traditional OD. In addition, the pre-operative and post-operative changes of systemic cytokines were analyzed to confirm that PELD had the potential to cause fewer

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damages to human tissues than the traditional OD, with quicker recovery time and shorter hospital stay in patients. In a word, PELD has a very clear promotional value in clinical research and is more effective than OD.

2. Subjects and methods

2.1. General data

A two-group randomized controlled prospective study was undertaken between October 2010 and April 2011. The indication for this surgery was herniated disk compressing the spinal nerves. The patients which were invalid after three months of conservative treatment were excluded. The exclusion criteria were set as below: (1) Patients with cauda equina syndrome; (2) Patients who had mental disease; (3) Patients who showed spinal instability; (4) Patients with serious motor nerve damages; (5) Patients who had systemic diseases, such as diabetes and hepatic diseases; (6) Patients with infectious diseases; (7) Patients who had recurrent disc herniation. After the inclusion criteria were met and informed consent was obtained, patients were allocated randomly into one of two groups: OD group and PELD group, with 10 patients in each group.

2.2. Percutaneous endoscopic lumbar discectomy

The patients underwent local anesthesia in the operative prone position on the see-through operating table just before the surgical procedure. Fentanyl (2–5 μg/kg) was added to alleviate the pain and maintain the sober situation in patients according to the doctor. The joimax lumbar endoscopic system was used with an external diameter of 7 mm and a pipeline of 3.1 mm. Along the import pathways, the spinal coordinate direction was confirmed with 10–14 cm away from the middle line mostly from the rear lateral position. The guide needle was inserted at an angle of 10–25° to the horizontal plane, followed by insertion of the pipeline into the periphery of intervertebral foramen and a 5–7 mm stab wound on the skin was made. The spinal endoscope was put into the relevant position. The rear pathway was applied in the L5-S1 and some free herniated discs. All processes were under the C-arm fluoroscopy. The catheter was put in the lesion position. Ellman bipolar radiofrequency was used for hemostasis and vaporizing tissues and Ho-Yag laser was used for assisted resection of some proliferated bone and herniated disc. At the same time, the intervertebral disc clips with different sizes were used to clip out of the loose herniated nucleus pulposus. The whole surgery was about 30–60 min.

2.3. Traditional surgery

The intervertebral discs were excised from spinal laminectomy under general anesthesia and the traditional surgery was performed according to the previous approach [16].

2.4. Index detection and surgical assessment

VAS and Modified MacNab Criteria were used to evaluate the post-operative results. The pre-operative and post-operative blood loss, hospital stays and wound size of patients in the two groups were recorded. Enzyme-Linked immunosorbent assay (ELISA) was used to measure pre-operative and post-operative changes of interleukin-6 (IL-6), C-reactive protein (CRP) and creatine phosphokinase (CPK) at 1 h, 6 h, 12 h, 24 h and 48 h.

2.5. Statistical analysis

The data were expressed as the mean and standard deviation (SD). The chi-square test was used for the calculation of significance in the univariate comparison for percentage of satisfaction for clinical outcome, and Student's *t*-test was utilized for each continuous variable. A repeated measurement of ANOVA was also performed to test the difference in cytokine between the two treatment groups. All tests were two- sided, and significance was set at $p < 0.05$ for each test.

3. Statement of ethics

This study was conducted in accordance with the declaration of Helsinki. All human studies have been approved by China Ethics Committee and performed in accordance with the ethical standards.

4. Results

The blood loss pre- and post-operation was different between PELD and OD groups and the difference was significantly statistical ($p < 0.05$). In addition, the hospital stay times was remarkable shorter in PELD group than OD group ($p < 0.05$). Furthermore, the wound size in PELD was significantly smaller than that in OD group ($p < 0.05$) (Table 1).

MacNab satisfaction was used to evaluate postoperative 6-month clinical satisfaction, with a 90% satisfaction in the PELD group (8/10 very satisfied; 1/10 satisfied) and the same satisfaction (90%) in the OD group (7/10 very satisfied, 2/10 satisfied). Meanwhile, the pain index, including preoperative and postoperative VAS, was different in the two groups with no statistical difference ($p > 0.05$) (Table 2).

There was a case of nerve numbness in the PELD group who was self-improved after two weeks treatment; meanwhile, no complication happened in the OD group. Nerve numbness might be caused by the less intervertebral clearance and the bigger oppression of endoscopic tube to part of nerve roots. Neither of the two groups needed blood transfusion.

There was no statistical difference between PELD and OD groups at pre-operation and 1, 6 and 12 h after operation ($p > 0.05$). The CRP level was significantly lower in PELD group than that in OD group at 24 and 48 h after surgery ($p < 0.05$) (Table 3). After the PELD operation, the CRP level was increased firstly, and then was decreased. However, the CRP level was less than 0.5 mg/dl at any time course (Table 3).

Furthermore, before and after corresponding surgery, the CPK levels in PELD and OD groups were significantly different ($p < 0.05$). In detail, the CPK level was lower in PELD group than that in OD group (Table 4). Finally, the IL-6 levels in PELD and OD group were different. Pre-operation and 1 h after surgery, the difference was not significant. However, along with the IL-6 level increased in OD group after operation, the difference between the two groups was remarkable ($p < 0.05$) (Table 5).

Table 1
Comparison of clinical efficacies between open surgery and endoscopic surgery ($\bar{x} \pm$ SD).

	OD	PELD	*T* value	*P* value
Blood loss (ml)	99 ± 22.33	8.35 ± 2.99	12.72	0.000*
Hospital stay (days)	5.6 ± 1.26	1.9 ± 0.74	7.99	0.000*
Wound size (cm)	4.9 ± 1.29	0.51 ± 0.02	10.80	0.000*

PELD is percutaneous endoscopic lumbar discectomy and OD is the open lumbar discectomy. *$P < 0.05$.

Table 2
Comparison of VAS between open surgery and endoscopic surgery ($\bar{x} \pm$ SD).

	Pre-op	Post-op	*F* Value	*P* value
OD	7.5 ± 1.08	1.9 ± 0.74	0.00	1.000
PELD	7.5 ± 1.65	1.8 ± 0.79	0.29	0.773

PELD is percutaneous endoscopic lumbar discectomy and OD is the open lumbar discectomy. Pre-op and Post-op mean pre-operation and post-operation. *$P < 0.05$.

5. Discussion

Due to the general anesthesia, the OD might appear post-operative spinal instability and scar tissue formation and other complications [17,18]. Therefore, in this study, PELD was used to treat the disc herniation; meanwhile, the clinical efficacies and tissue damages were compared between PELD and traditional OD. In PELD group, patients had less blood loss, smaller tissue damages and shorter times staying in hospital. Furthermore, there were no differences between PELD and OD patients about the satisfactory levels and the pain index of post-operative.

Firstly, there were significant differences in blood loss, hospital stay and wound size between PELD and OD group, especially in the hospital stay, which could reduce a lot of social costs. In detail, PELD had the ability to reduce the blood loss and wound size during the operation compared with OD. These characteristics of PELD can relieve the pain. Thus, PELD is a more improved surgery which can relieve the symptoms and improve the quality of life of patients. Generally, the patients in the PELD group could be in the normal life after two weeks and return to work after about 6–8 weeks [19]. But those in the OD group needed about two times longer than those in the PELD group [20]. Additionally, the post-operative 6-month follow-up satisfaction between the two groups was both about 90%. This indicates that patients may receive similar therapeutic benefit after PELD and OD treatment. Thus, taking these factors into account, we suggest that PEDL has a better curative effect than OD surgery both in economic and medical aspects. Moreover, the patients underwent PELD had a better work recovery than those in OD group.

IL-6 plays an important role in the induction control of acute protein response, especially in the synthesis of CRP in liver cells [21]. Previous research has reported that IL-6 and CRP may cause silent brain infarction and white matter hyperintensities [22]. The relationship of IL-6 and CRP could not been shown from the little overall changes in the PELD group. The inapparent changes of IL-6 in PELD surgery suggested the indistinctive pro-inflammatory response. Compared with OD, PELD surgery caused less IL-6 pre- and post-operation. It was indicated that the patients underwent PELD would have less inflammatory response than those with OD operation. In addition, CRP is a phylogenetically highly conserved plasma protein and a member of the pentraxin protein [23]. CRP has been reported to participate in the systemic response to inflammation [24]. CPK is clarified predominantly in myocardial and skeletal muscle cells [25]. These factors would induce inflammatory response and hold back recovery. In the present study, the CRP and CPK levels in PELD group were lower than that in OD group and the differences were statistically different.

Due to the statistically significant difference in CRP, CPK and IL-6 between the two groups, the PELD had less tissue damages to the

Table 3
Comparison of preoperative and postoperative CRP between open surgery and endoscopic surgery ($\bar{x} \pm$ SD).

	Pre-op	Post-op 1 h	Post-op 6 h	Post-op 12 h	Post-op 24 h	Post-op 48 h
OD	0.17 ± 0.10	0.22 ± 0.09	0.28 ± 0.09	0.29 ± 0.11	1.84 ± 0.74	2.61 ± 0.93
PELD	0.15 ± 0.07	0.16 ± 0.07	0.21 ± 0.05	0.26 ± 0.06	0.18 ± 0.09	0.10 ± 0.04
F value	0.498	2.526	4.282	1.035	48.966	73.089
P value	0.490	0.129	0.053	0.322	0.000*	0.000*

PELD is percutaneous endoscopic lumbar discectomy and OD is the open lumbar discectomy. Pre-op and Post-op stand for pre-operation and post-operation. Meanwhile, CRP is C-reactive protein. *$P < 0.05$.

Table 4
Comparison of preoperative and postoperative CPK between open surgery and endoscopic surgery ($\bar{x} \pm$ SD).

	Pre-op	Post-op 1 h	Post-op 6 h	Post-op 12 h	Post-op 24 h	Post-op 48 h
OD	64.28 ± 4.69	139.87 ± 14.15	220.54 ± 23.49	298.11 ± 26.03	270.87 ± 43.50	185.5 ± 21.06
PELD	78.03 ± 7.17	77.04 ± 8.17	105.05 ± 17.23	121.82 ± 22.03	123.56 ± 13.08	102.41 ± 14.68
F value	25.762	147.800	157.106	267.294	105.149	104.762
P value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

PELD is percutaneous endoscopic lumbar discectomy and OD is the open lumbar discectomy. Pre-op and Post-op stand for pre-operation and post-operation. Meanwhile, CPK represents creatine phosphokinase. *$P < 0.05$.

Table 5
Comparison of preoperative and postoperative IL-6 between open surgery and endoscopic surgery ($\bar{x} \pm$ SD).

	Pre-op	Post-op 1 h	Post-op 6 h	Post-op 12 h	Post-op 24 h	Post-op 48 h
OD	0.25 ± 0.04	0.30 ± 0.02	0.87 ± 0.05	0.93 ± 0.12	0.98 ± 0.09	1.07 ± 0.10
PELD	0.25 ± 0.05	0.33 ± 0.05	0.26 ± 0.05	0.22 ± 0.07	0.26 ± 0.05	0.25 ± 0.06
F value	0.002	2.948	684.406	248.296	408.912	460.738
P value	0.963	0.111	0.000*	0.000*	0.000*	0.000*

PELD is percutaneous endoscopic lumbar discectomy and OD is the open lumbar discectomy. Pre-op and Post-op stand for pre-operation and post-operation. Meanwhile, IL-6 is interleukin-6. *$P < 0.05$.

human body than the traditional OD surgery in clinical. In addition, the patients underwent PELD had less recovery time and shorter hospital stay compared to the patients treated with OD. Thus, the PELD had promotional value in a long time for long learning curve. Recently, minimally invasive surgery had a significant rising trend in every surgery departments, especially in spinal surgery, with quite obvious helps to patients [26]. The traditional OD needed a general anesthesia which might cause greater pressure to the elderly and patients with serious relevant medical diseases [27]. The PELD was a kind of spinal minimally invasive surgery without general anesthesia, which could avoid the effects of complications caused by general anesthesia and intraoperative massive bleeding to patients [28]. The patients underwent PELD surgeries are in the waking state under the endoscope, so the patients could interact with surgeons, which provides more extensive diagnostic values than OD [29].

PELD has been changed from original application of simple disc herniation, inclusive and non-inclusive intervertebral disc herniation to infectious intervertebral disc and recurrent intervertebral disc disorders. Especially the recurrent intervertebral disc disorders, which do not have to be entered from the posterior scar position, undergo direct excision of recurrent lesions from the lateral. Meanwhile, the chemical substances causing pains in flushing have advantages of simple, avoiding damages of rear skeletal muscle structures and needing not implants and fusion surgery, just like the endoscopy applied in knee surgery. It is believed that several years later, PELD surgery could be widely applied in the treatment of lumbar intervertebral disc diseases and degenerative lumbar diseases, or even anterior spinal fusion, artificial nucleus pulposus implantation, spinal cell implantation, and so on.

Conflicts of interest statement

The authors declare no conflict of interest.

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