The Effect of Learning Curve on the Results of Percutaneous Transforaminal Endoscopic Lumbar Discectomy

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Objective: *To demonstrate the correlation of postoperative visual analog scale (VAS) of leg pain and adequacy of disc decompression with the learning curve of the surgeon who performed PTELD.*

Material and Method: *The authors retrospectively reviewed 50 matched criteria patients arranged into 5 groups which were categorized by the period of operation from January 2010 to May 2011 successively. Each patient's preoperative and postoperative VAS of leg pain at 1-week, 3-week, and 6-week follow-up were analyzed and demonstrated the correlation with the learning curve. Additionally, the authors also showed the alteration of thecal sac expansion between the preoperative and the postoperative MRI to demonstrate the learning curve during the different operative period.*

Results: *The VAS of leg pain as well as the mean differences of VAS of leg pain in each groups of patient were improved at each postoperative period follow-up and have a statistically significant improvement at 6-week follow-up. When the authors analyzed the mean differences VAS at pre- and post-operative 6-week follow-up among each groups of patients, it demonstrated that the learning curve had the progressive effect on the result of the operation. Also for the adequacy of disc decompression, the improvement of the thecal sac expansion was established when the amount of surgical volume was increased.*

Conclusion: *The amount of surgical volume in focus of PTELD has an influence in the improvement of the VAS of leg pain and the adequacy of disc decompression. However, the patient selection such as types of disc herniation is also play an important role in accomplishment.*

Keywords: *Learning curve, Percutaneous transforaminal endoscopic lumbar discectomy (PTELD)*

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Lumbar disc degeneration is recognized as a cause of low back pain with or without sciatica[1]. The common manifestation of lumbar disc degeneration is lumbar disc herniation[2]. Although lumbar disc prolapse, protrusion and extrusion are considered only 5% in the low back problems, they are determined as the most common causes of sciatica followed by surgical interventions[3,4]. Despite it has been generally accepted that lumbar disc herniations have favorable outcomes, there are some patients whose symptoms do not respond well to the conservative treatments[5,6]. Nowadays although the standard surgical management of symptomatic lumbar disc herniations is microsurgical discectomy, there are other methods to improve quality of life[7-10]. The full-endoscopic discectomy is one of the alternative options. It seems to have advantages due to minimize damage of paraspinal muscles during the approach, that made the patients receive minimal postoperative pain, accelerate recovery and reduce pain-control drug consumption[11]. Nevertheless having advanced instruments and imaging modalities, to accomplish the goals not inferior to the traditional one, the learning curve of the surgeon may be required[14,15].

The purpose of the present study was to demonstrate the correlation of the learning curve whether it has an importance role in postoperative VAS of leg pain and the adequacy of disc decompression or not.

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Material and Method

The authors enrolled 50 patients who matched the criteria from January 2010 to May 2011 (Table 1). These patients were arranged into 5 groups categorized by the period of operation from January 2010 to May 2011 successively (Fig. 1). Each group contained

10 patients. While the first group of patient was performed the operation in the period of 1st January-31st March 2010, the following groups were performed in the period of 1st April-30th June 2010, 1st July-30th November 2010, 1st December 2010-31st January 2011and 1st February-31st May 2011 orderly. The procedures were performed by one surgeon (PS) who received well-trained of endoscopic discectomy but had not done the operation in the real patient before.

Surgical technique

The percutaneous transforaminal endoscopic lumbar discectomy (PTELD) using an endoscope to continuously visualize the disc removal through posterolateral or lateral access was the full-endoscopic technique that was performed by the surgeon[12-14]. All of the operating instruments and optics were products supplied by WOLF (Richard Wolf GmbH, Knittlingen, Germany).

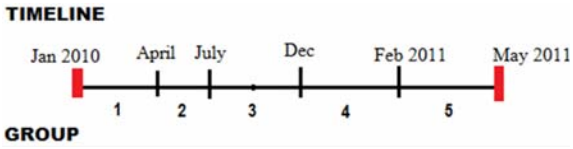

Fig. 1 Group of patients performed PTELD according to the period of operation

1st group-group of patient who was performed PTELD during 1st January-31st March 2010
2nd group-group of patient who was performed PTELD during 1st April-30th June 2010
3rd group-group of patient who was performed PTELD during 1st July-30th November 2010
4th group-group of patient who was performed PTELD during 1st December 2010-31st January 2011
5th group-group of patient who was performed PTELD during 1st February-31st May 2011

When the patient was in the prone position, the target site by fluoroscopic guidance was located. Generally, the skin entry point was located at 8-14 cm from the midline[13,16,17]. The 1% xylocain was the drug usage for local anesthesia in all patients. However, intravenous sedation can be given in case of severe pain during the operation. After pain control was done, the 18-guage spinal needle was punctured at the marked skin aiming to the disc at the pathological level. Then, the spinal needle was replaced by the guide wire and followed by the dilator after making 8-mm incision wound with a small blade. A metal sheath with bevel opening ventrally was slid over the dilator till seating on the facet and turned 180° away from the associated exiting nerve root. Finally after removed the dilator, the endoscope was inserted and discectomy was performed by intradiscal or inside-out technique.

Outcome assessment

The evaluation of the pre- and post-operative visual analogue scale (VAS) of leg pain was the main part in the present study[17,18]. The VAS ranging from 0 (absence of pain) to 100 (worst pain ever experienced) was assessed by the reviewer (CC), who did not involve in the surgical procedures. Each of patients was recorded the VAS in the day before operation, 1-week, 3-week and 6-week postoperative period, successively. Additionally, the difference of thecal sac compression by herniated disc was also evaluated by comparing the involved section of preoperative axial MRIs and postoperative ones at 6-week follow-up periods. The adequate disc decompression was defined when the thecal sac at the involved section was expanded to 100% of the sac area.

Demographic data of patients were analyzed by using one-way ANOVA and Fisher's exact test. Preoperative VAS, 1-week, 3-week and 6-week postoperative VAS were analyzed by one-way ANOVA.

Table 1. Inclusion and exclusion criteria

Inclusion	Exclusion
Patients who receivedPTELD due to herniated disc between January 2010 to May 2011 by PS	Previous back surgery Cauda equina syndrome
Straight leg raising test positive	Sequestered disc thatseparate and migrate from the mother disc space
Disc herniation limited to L3-4, L4-5 or L5-S1 intervertebral spaces	Degenerative spondylolisthesis
Corresponding MRI findings	

The authors compared the mean differences of VAS between the preoperative and 6-week postoperative periods of each groups to determine the surgeon's skill improvement by using paired t-test and then plotted the learning curve. Finally, the adequacy of herniated disc decompression to determine the surgeon's skill improvement was evaluated by the Fisher's exact test.

Results

For demographic data (Table 2), the age distribution among each groups of patient was not statistically different (p-value 0.986). According to Spengler et al[19], the types of disc pathology can be classified into disc protrusion 20.69% (12/58), disc sequestered 25.86% (15/58) and disc extrusion 51.72% (30/58) respectively. By analyzing the distribution of disc pathology, it showed no statistically significant difference among types (p-value 0.578). And lastly, the 1-level procedures were 84% (42/50) whereas the 2-level procedures were only 16% (8/50).

The severity of pain perception among each groups of patient in preoperative periods was not statistically different but after the operation it demonstrated that the VAS of leg pain at every follow-up periods was reduced in all groups of patient (Table 3). Interestingly, the VAS of leg pain demonstrated the statistically significant reduction only in the 6-week postoperative periods (Table 4). When the authors analyzed the mean differences of VAS at pre- and postoperative 6-week follow-up periods among each groups of patient, it demonstrated that the learning curve had the progressive effect on the pain score except in the fourth group of patient (Fig. 2). The adequacy of disc decompression was also showed the tendency of progression that began from the second group of patient which started in April 2010 (Table 5).

Discussion

Recently, many authors stated that the full-endoscopic technique can give clinical results as same as the microsurgical technique, especially in the experienced hands. It can provide a good to excellent outcomes even in the complicated problems such as migrated discs or recurrent disc herniations[2,20-23].

From the present, it demonstrated that the perception of pain score was reduced unequivocally in every groups of patient. It can assumed that the outcomes of surgical management in the symptomatic disc herniations is quite favorable as in the original study of Mixter and Barr[24]. The mechanisms to lessen sciatica pain of PTELD appear form reduction of compression pressure to the affected nerve root and elimination of cytokines via continuous saline irrigation[5,25]. The mean VAS of leg pain among each groups of patient when compared between the preoperative times with the 6-week postoperative times was statistically different. When the authors used the mean differences of VAS among groups of patient to plot the learning curve, it demonstrated that more surgical number of PTELD were performed, the better mean differences of VAS were obtained. Even though from the Maine Lumbar Spine Study, the authors concluded that the amount of the surgical volume did not influence the results of spine surgery other than

Table 2. Demographic data of patients

	Group					p-value
	1	2	3	4	5	
Age (years)						
Mean ± SD	34.90 ± 11.07	34.80 ± 12.1	35.90 ± 13.91	36.80 ± 13.77	35.60 ± 13.07	0.986
Min-Max Gender (M/F)	7/3	9/1	7/3	8/2	7/3	
Type of disc hemiation (%)						
Protrusion	2 (20.00)	2 (16.67)	4 (33.33)	3 (25.00)	1 (8.33)	0.578
Extrusion	7 (70.00)	7 (58.33)	6 (50.00)	5 (41.67)	5 (41.67)	
Sequestered	1 (10.00)	3 (25.00)	2 (16.67)	4 (33.33)	6 (50.00)	
Disc level						
L3-4	2					
L4-5	8	8	8	5	7	
L5-S1				3	1	
L3-4, L4-5		1	1			
L4-5, L5-S1		1	1	2	2	

Table 3. This table demonstrated preoperative and postoperative VAS of leg pain among each groups of patient

	Group					p-value
	1	2	3	4	5	
VAS (Mean ± SD)						
Pre	80.20 ± 5.92	80.00 ± 6.34	78.50 ± 9.75	74.58 ± 9.87	81.50 ± 9.79	0.348
1 wk	24.50 ± 9.23	31.42 ± 6.22	27.67 ± 11.11	23.33 ± 8.11	25.92 ± 8.20	0.201
3 wk	29.20 ± 10.91	33.83 ± 87.77	27.75 ± 12.43	23.00 ± 11.84	23.17 ± 11.84	0.110
6 wk	34.00 ± 9.65	30.42 ± 8.99	22.75 ± 12.10	21.50 ± 10.88	16.00 ± 7.90	0.001

Table 4. All groups showed the statistically significant reduction of mean differences of VAS between preoperative and 6 -week postoperative periods.

Group	Compared VAS	Mean ± SD	Paired Differences (Mean ± SD)	p-value
1	Preoperative	80.20 ± 5.92	46.20 ± 9.78	< 0.001
	6 week	34.00 ± 9.65		
2	Preoperative	80.00 ± 6.34	49.58 ± 14.40	< 0.001
	6 week	30.42 ± 8.99		
3	Preoperative	78.50 ± 9.75	55.75 ± 10.10	< 0.001
	6 week	22.75 ± 12.10		
4	Preoperative	74.58 ± 9.87	53.08 ± 11.07	< 0.001
	6 week	21.50 ± 10.88		
5	Preoperative	81.50 ± 9.79	65.50 ± 9.60	< 0.001
	6 week	16.00 ± 7.90		

Table 5. The table demonstrated the progression of the adequacy of disc decompression in each groups of patient.

Adequacy of discdecompression (%)	Group					p-value
	1	2	3	4	5	
Adequate	3 (30.00)	7 (58.33)	10 (83.33)	11 (91.67)	10 (83.33)	0.012
Inadequate	7 (70.00)	5 (41.67)	2 (16.67)	1 (8.33)	2 (16.67)	

the patient selection and patient factors[26], but the present showed that the increased experience by performing the focused procedure repeatedly will improve the outcomes and solve more difficult problems. However the learning curve of the surgeon had a little drop in the period of 1st December 2010 to 31st January 2011 or in the fourth group of patient. This phenomenon may occur from the number of the performed levels combine with the complexity of types of herniated disc. However, after the surgeon was able to pass this period, the learning curve returned to the progressive stage.

From our current knowledge, there are no studies that assess the adequacy of disc decompression by PTELD postoperatively by MRI. Although many studies claimed that the size of disc herniation correlated poorly with pain, the reduction of nerve root traction and compression may ameliorate back and sciatica pain[5]. The mechanical compression on nerve root may cause the situation of blood flow and nutrient deficiency that trigger the nerve root more susceptible to injure[27]. From the present, the authors found that the adequacy of disc decompression was also improved when the amount of performed operation was increased. The authors learned that the skin entry

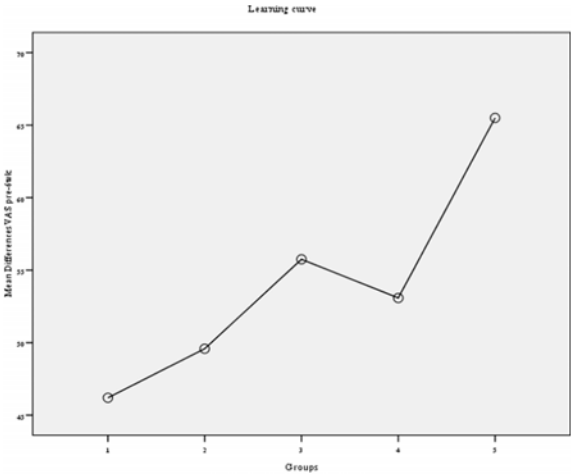

Fig. 2 Learning curve of the surgeon during perform PTELD from 1st group to 5th group of patient using the mean differences of VAS of leg pain as an indicator.

point and trajectory of the endoscope are the predictors of successful disc decompression in PTELD[22,28]. Furthermore, the adequacy of disc decompression depended on the location of herniated discs. The central herniated disc especially in the lower lumbar segment such as L5-S1 was encountered to be difficult to extract by PTELD. This type of hernaition may be appropriate to select the other techniques of full-endoscopic lumbar discectomy to cope with, for example, interlaminar technique[29]. The short term follow-up is one of the study's drawbacks. The authors have a plan to take the longer surveillance for studying the complications after PTELD such as recurrent disc herniation which can occur in the literature[16].

Conclusion

The learning curve of surgeon has an influence on the outcomes, especially in VAS of leg pain and the adequacy of disc decompression, after performing PTELD in patients with symptomatic herniated disc. After practiced PTELD repeatedly, the authors discovered that the skin entry point and the trajectory of the endoscope are predictors of successful outcomes. However, the patient selection such as types of disc herniation is also play an important role in accomplishment.

Potential conflicts of interest

None.

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การศึกษาถึงความชำนาญในการผ่าตัดหมอนรองกระดูกสันหลังต่อผลการรักษาของผู้ป่วยที่มีภาวะหมอนรองกระดูกสันหลังกดทับเส้นประสาทด้วยการผ่าตัดผ่านกล้อง Endoscope

ชัยศิริ ชัยชาญกุล, สมภพ ภู่พิทยา, วรัท ทรรศนะวิภาส

วัตถุประสงค์: *เพื่อแสดงถึงความสัมพันธ์ของความชำนาญในการผ่าตัดหมอนรองกระดูกสันหลังผ่านกล้อง endoscope ของศัลยแพทย์ว่ามีผลต่ออาการปวดร้าวลงขาและปริมาณของหมอนรองกระดูกสันหลังที่กดทับเส้นประสาทหลังการผ่าตัดหรือไม่*

วัสดุและวิธีการ: *ผู้นิพนธ์แบ่งผู้ป่วยจำนวน 50 รายที่เข้าได้กับข้อกำหนดของการศึกษานี้ เป็น 5 กลุ่ม โดยใช้ช่วงเวลาที่ทำการผ่าตัดเป็นตัวแบ่ง การเก็บข้อมูลเริ่มเก็บในผู้ป่วยที่ได้การผ่าตัดหมอนรองกระดูกสันหลังผ่านกล้อง endoscope ตั้งแต่เดือน มกราคม ปี 2010 ถึง เดือน พฤษภาคม ปี 2011 ข้อมูลสำคัญที่นำมาคือ ระดับความปวดร้าวลงขาก่อนได้รับการผ่าตัดผ่านกล้อง endoscope และ หลังจากได้รับการผ่าตัดแล้วที่ 1, 3 และ 6 สัปดาห์ โดยนำข้อมูลดังกล่าวมาแสดงถึงความสัมพันธ์ของความชำนาญในการผ่าตัดหมอนรองกระดูกสันหลังผ่านกล้อง endoscope ของศัลยแพทย์ นอกจากนี้ผู้นิพนธ์ยังได้นำภาพรังสีแม่เหล็กไฟฟ้าของหมอนรองกระดูกสันหลังที่กดทับเส้นประสาทก่อนและหลังผ่าตัดที่ 6 สัปดาห์ มาแสดงถึงความสัมพันธ์ดังกล่าวอีกด้วย*

ผลการศึกษา: *พบว่าระดับความปวดร้าวลงขามีค่าที่ลดลงหลังการผ่าตัดตั้งแต่สัปดาห์ที่ 1, 3 และ 6 โดยมีค่าลดลงอย่างมีนัยสำคัญทางสถิติที่สัปดาห์ที่ 6 เมื่อนำค่าความแตกต่างของระดับความปวดร้าวลงขาก่อนได้รับการผ่าตัดและที่ 6 สัปดาห์หลังการผ่าตัดของผู้ป่วยแต่ละกลุ่มมาวิเคราะห์ พบว่าเมื่อศัลยแพทย์ได้ทำการผ่าตัดผ่านกล้อง endoscope มากขึ้น ค่าระดับความปวดร้าวลงขาของผู้ป่วยมีแนวโน้มที่ดีขึ้น ซึ่งรวมไปถึงปริมาณของหมอนรองกระดูกสันหลังที่กดทับเส้นประสาทจากภาพรังสีแม่เหล็กไฟฟ้าก็มีลักษณะที่ดีขึ้นด้วย*

สรุป: *ปริมาณการผ่าตัดหมอนรองกระดูกสันหลังผ่านกล้อง endoscope ของศัลยแพทย์เป็นหนึ่งในปัจจัยที่มีผลทำให้การรักษาผู้ป่วยที่มีภาวะหมอนรองกระดูกสันหลังกดทับเส้นประสาทประสบความสำเร็จ แต่อย่างไรก็ตามยังมีปัจจัยอื่นที่ต้องพิจารณาด้วย เช่น ลักษณะของพยาธิสภาพของหมอนรองกระดูกสันหลังที่กดทับเส้นประสาท เป็นต้น*