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ORIGINAL PAPER

Evaluation of transforaminal endoscopic lumbar discectomy in the treatment of lumbar disc herniation

Kun Wang[1] · Xin Hong[2] · Bao-Yi Zhou[1] · Jun-Ping Bao[2] · Xin-Hui Xie[2] · Feng Wang[1] · Xiao-Tao Wu[2]

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Abstract
Purpose The purpose of this study was to evaluate the efficacy of transforaminal endoscopic lumbar discectomy (TELD) in the treatment of lumbar disc herniation (LDH) and to identify the relationship between TELD efficacy and age.
Methods A total of 207 consecutive LDH patients who had undergone TELD with the THESSYS system from January 2013 to September 2014 were divided into two groups on the basis of their age, with 108 cases in the ≤45-year-old age group and 99 cases in the >45-year-old group. The Oswestry Disability Index (ODI) was used to quantify the pain relief. The degree of pain and disability were measured on the basis of the visual analog scale (VAS) and the modified MacNab criteria. Complications, duration of hospital stay, surgical costs, and operation time were recorded and compared between the two groups. Spearman's coefficient of rank correlation was used to assess the learning curves for TELD.
Results The mean pre-operative and postoperative VAS and ODI scores significantly improved in both age ≤45 group and age >45 group, with no significant differences between them. In age ≤45 group, 56 % had excellent outcomes, 28 % good, 14 % fair, and 3 % poor. In the age >45 group, 51 % had excellent outcomes, 20 % good, 25 % fair, and 4 % poor. The average lengths of hospital stay for the age ≤45 group and age >45 group were 6.8 and 8.4 days, respectively. The mean time to return to work or normal activities was ten days for the age ≤45 group and 15 days for the age >45 group. The mean operative time for the age ≤45 group was 94 minutes and that for age >45 group was 97 minutes. The surgical cost of age ≤45 group was 15,480 RMB, which was lower than the 16,381 RMB of age >45 group. A total of 14 patients in the age ≤45 group and 13 patients in age >45 group used analgesic medications. Three and five recurrences were reported in the age ≤45 group and age >45, respectively. The steep learning curves of operative time plotted against the number of surgeries conducted suggest that the TELD technique can be mastered quickly in terms of reducing the duration of operation.
Conclusions The efficacy of TELD is relatively good for the selected young and elderly patients in this study. Therefore, age is not a predictor of TELD surgery-related outcomes.

Keywords Transforaminal · Endoscopic · Discectomy · Lumbar disc herniation · Age

Introduction

Lumbar disc herniation (LDH) is a common orthopaedic disease that produces medical and economic burdens to families and society [1]. Most patients with disc herniation can be relieved or even cured via conservative treatment, but a considerable number (a reported prevalence of 1–3 %) of invalid patients must still eventually undergo surgical operation [2].

With the development of minimally invasive endoscopic methods in spine surgery, microendoscopic discectomy has been recognized by doctors and patients. Transforaminal endoscopic lumbar discectomy (TELD) has matured as a technique in recent years [3]. To date, the clinical outcome of TELD is relatively good. Lee et al. [4]reported a 96.7 % success rate of percutaneous endoscopic discectomy in clinical

Kun Wang and Xin Hong contributed equally to this work.

✉ Xiao-Tao Wu
wuxiaotao@medmail.com.cn

[1] Medical School of Southeast University, Nanjing 210009, Jiangsu, China

[2] Department of Orthopaedics, Zhongda Hospital, Southeast University, Nanjing 210009, Jiangsu, China

outcomes. Similarly, Jasper [5] reported that the overall success rate of this procedure is 93.8 % as defined using the MacNab criteria. Kim et al. [6] reported good to excellent results in 84.7 % of their patients who received TELD. In the study by Arts et al. [7], 71 % of the patients assigned to tubular discectomy documented good recovery after two years of follow-up.

According to the Mayo Clinic, people at middle age (around 45 years old) who were often described as a watershed in life are more likely to have a slipped disc and it was reported that the prevalence of herniated disks are highest among people 35–45 years old [8]. This is because the discs begin to lose some of their protective water content with age. The obvious clinical symptoms that were observed in young patients were mostly due to disc herniation, whereas those observed in elderly patients were due to spinal stenosis [9]. To the best of our knowledge, however, little is known about TELD efficacy between young patients and elderly patients. From January 2012 to September 2013, a total of 207 LDH patients at our centre were treated by TELD with THESSYS and were followed up continuously for more than a year. The present study aimed to evaluate the efficacy of TELD in the treatment of LDH and to identify its relationship with age.

Materials and methods

Participants

For this type of study formal consent is not required. We retrospectively examined 207 consecutive patients with sciatica and single-level LDH who underwent TELD at our spine centre between January 2012 and September 2013. The mean age of our cases was 45.7; therefore, we chose 45 years of age as the cut-off to identify the relationship between TELD efficacy and age. The 207 included patients were divided into two groups, namely, age ≤ 45 group and age > 45 group. The inclusion criteria were as follows: (1) history of concordant radicular leg pain refractory to conservative treatment for longer than six months; (2) leg pain must be greater than back pain; (3) without cauda equina syndrome, progressive neurologic deficit, or bilateral lower extremity symptoms; and (4) no combined lumbar infection, fracture of lumbar vertebra, tumor, II° and above spondylolisthesis, lumbar spinal stenosis, and lumbar scoliosis with a degree larger than 15°. The baseline characteristics of the included patients are shown in Table 1.

Surgical techniques

The patient was placed in the prone position on a radiolucent table (Fig. 1a). At pre-operation, we used a C-arm radiograph to confirm the surgical disc. After routine disinfection, the skin and subcutaneous tissue were infiltrated with a local anaesthesia (1 % lidocaine). The anaesthetic was titrated to allow the patient to communicate with the surgeon throughout the procedure. The entry point was generally 10–14 cm from the midline, and a long 18-gauge spinal needle was inserted from the entry point toward the midline, in the anterior–posterior view, under intermittent fluoroscopic guidance. A guide wire was inserted into the disc; amethylene blue and iohexol mixed solution was injected via the puncture needle. Subsequently, the dilator and working cannula was inserted into the foramen under fluoroscopic guidance (Fig. 1 b, c). An endoscopic rongeur was used to remove the blue-stained degenerated nucleus, which was then sent for pathological examination. The pulsation of the dural tube and the nerve root was confirmed and used to indicate decompression (Fig. 1 d). Hemostasis was performed with bipolar diathermy. The endoscope was removed after no active bleeding was confirmed, and then a one-point stitch was performed. The amount of blood loss was minimal (less than 1–5 ml) during the entire procedure. Patient activity was not restricted on the next day after operation.

Assessment of clinical outcome

Follow-up visits were scheduled at one, three, six and 12 months after TELD. We considered the following variables as primary outcomes: (1) pain was measured by the visual analog scale (VAS) for each sciatica and LBP, (2) functional outcomes, including daily activity and return to work, were measured by scales such as the Oswestry Disability Index (ODI), (3) MacNab criteria were applied to each patient: excellent for no pain and no restriction of activity; good for occasional back or leg pain of sufficient severity to interfere with work or normal activities; fair for improved functional capacity but handicapped by intermittent pain of severity to curtail or modify work or leisure activities; poor for no improvement or insufficient improvement to enable increase in activities. A rating of poor indicates that further operative intervention is required. Excellent and good results were deemed satisfactory. We also considered the following variables as second outcomes: (1) complications of surgery, including mortality and common thrombosis, surgical site and other infections, recurrent disc herniation, dural tear, nerve root injury, (2) duration of hospital stay, (3) surgical cost, and (4) operation time.

Statistical analysis

Continuous variables were expressed as mean±standard deviations; categorical variables were expressed as a percentage of the number. Continuous variables were analysed using the paired *t*-test or independent-samples *t*-test. The Mann–Whitney *U* test and the χ^2 test were used for categorical data. The learning curves for the TELD were assessed by Spearman's

Table 1 Clinical characteristic of patients in each group

Baseline characteristics	Group age≤45 (n=108)	Group age >45 (n=99)
Mean age, years	34.0±9.3	58.4±10.0
Male sex, n (%)	76 (70.1)	47 (47.5)
Smokers, n (%)	10 (9)	8 (8)
Duration of sciatica, weeks median (min–max)	12 (1–240)	12 (1–336)
Left-side leg pain, n (%)	61 (56.5)	60 (60.6)
Sensory disturbance, n (%)	38 (35.2)	33 (33.3)
Muscle weakness, n (%)	2 (2.0)	3 (3.0)
Disk herniation level, n (%)		
$L_{3–4}$	1 (1.2)	9 (9.1)
$L_{4–5}$	51 (47.2)	59 (59.6)
$L_5–S_1$	56 (51.6)	31 (31.3)

coefficient of rank correlation. Nonlinear regression analysis was applied to construct optimal curves for data. Statistical significance was set at $p<0.05$.

Results

The average lengths of hospital stay for the age ≤45 group and age >45 group were 6.8 and 8.4 days, respectively, including the time of short-term postoperative rehabilitation. The mean time to return to work or normal activities was ten days for the age ≤45 group and 15 days for age >45 group ($p< 0.05$), except for those who still experienced leg or low back pain. The mean operative time for the age ≤45 group was 94 minutes, which was slightly shorter than the 97 minutes mean operative time for age >45 group ($p>0.1$). The learning curves (Fig. 2) were steep indicating that the TELD technique can be mastered at a fast rate in terms of reducing the duration of operation. Operative time was rapidly reduced in the early phase, and then tapered to a steady state for the 50 cases. The surgical cost in the age ≤45 group was 15,480 RMB, which was lower than the 16,381 RMB in the age >45 group. A total of 14 patients (13 %) in age ≤45 group and 13 patients (13 %) in the age >45 group used analgesic medications mainly because of incision pain during the first one or two post operative hospital stays (Table 2).

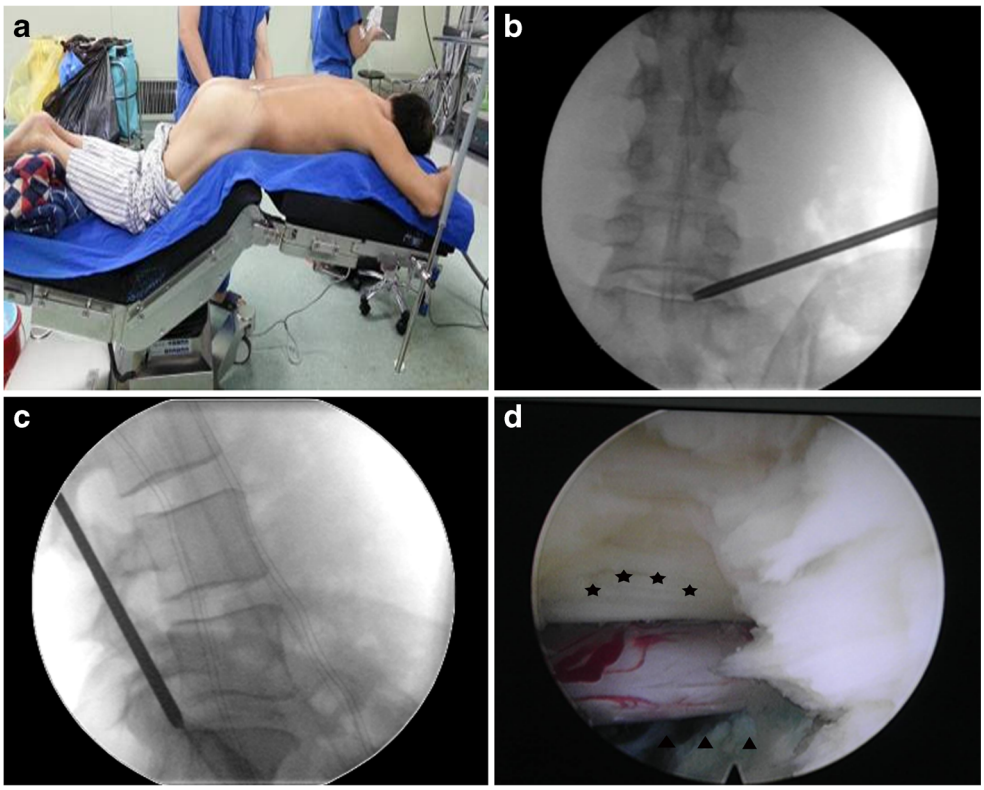

Fig. 1 **a** Patient is placed in the prone position. **b,c** Posteroanterior and lateral radiographs showing placement of the working tube. **d** Intraoperative view in transforaminal approach with the ligamentum flavum (*stars*), and blue-stained nucleus pulposus(*triangle*)

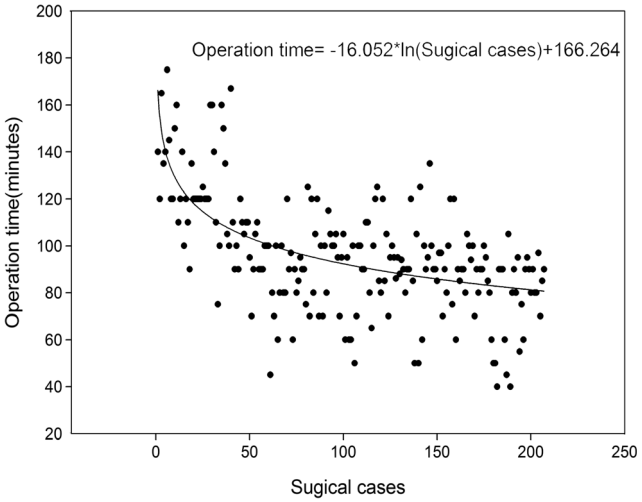

Fig. 2 Learning curve related to operation duration

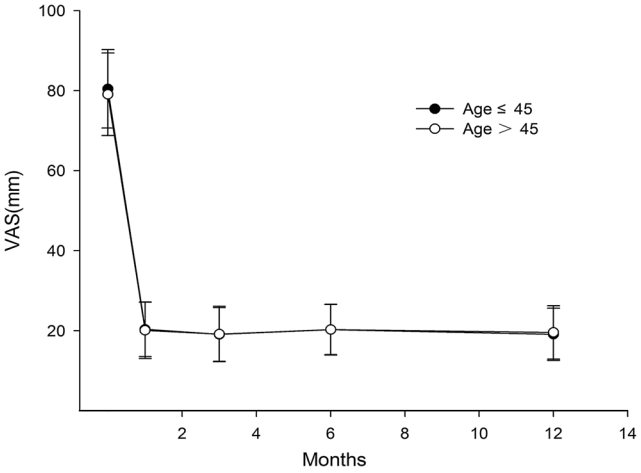

Fig. 3 Curves of the mean scores on the visual analog scale (VAS). Mean scores on the VAS for intensity of pain. The scales range from 0 to 100 mm, with higher scores indicating more intense pain. The pain relief during the followup was statistically significant, but showed no significant differences at one-, three-, six- and 12-month follow-up (p >0.05)

All the patients that were included successfully underwent TELD without surgical site and/or other infections, thrombosis, or local haematoma. Six patients in age >45 group had increased leg pain and decreased anaesthetic effect at postoperation probably because of mis-operation during paracentesis or working cannula insertion. These six patients were treated with low doses of hormone treatment, dehydration, and detumescence before being released.

The pain relief during the follow-up was statistically significant, as evaluated by the VAS (Fig. 3). The mean preoperative and postoperative Oswestry scores for the two groups of patients significantly improved (Fig. 4). The two groups showed no significant difference at one-, three-, six-, and 12-month follow-up (p >0.05). The ODI and VAS scores in the two groups are shown in Table 3. On the basis of the modified MacNab criteria (Fig. 5), the patients were all assessed at 12 months, whereby 56 % of age ≤45 group had excellent outcomes, 28 % good, 14 % fair, and 3 % poor. In the age >45 group, 51 % had excellent outcomes, 20 % good, 25 % fair, and 4 % poor. The satisfactory (excellent and good) outcomes in the age ≤45 group were better than the age >45 group (p=0.03, χ^2=4.85).The recurrence rates at 12 months post operation were 3 % and 5 % (p<0.001), with three and five recurrences in the age ≤45 group and age >45 group, respectively. Symptoms in both groups significantly improved after transpedicular screw internal fixation of vertebral body and intervertebral bone graft fusion. One patient (0.9 %) in the age ≤45 group and one (1.0 %) in the age >45 group suffered dural tears, and two patients (1.9 %) in age ≤45 group and one patient (1.0 %) in the age >45 group suffered nerve root injuries.

Discussion

To obtain fair post operative treatment outcomes in patients with lumbar disc herniation, an adequate evaluation of the prognostic factors is mandatory alongside the accurate determination of surgical indications. Several previous studies have already analysed various prognostic factors. Aside from age, other potential factors that may influence surgical outcome include sex [10], smoking [11], working status, and type and level of disc herniation [12]. In the present study, we controlled these factors to balance the two treatment groups, and age was the only comparison factor. TELD can be

Table 2 Comparisons of perioperative parameters of two groups

Parameter	Group age≤45	Group age >45	p-value
Hospital stay (days)	6.8±1.8	8.4±4.0	<0.001
Operative time (min)	95.0±30.8	97.2±27.6	0.535
Operative costs (RMB)	16381±3202	15480±1914	0.018
Mean time to return to work (days)	4.8±1.5	6.5±2.7	<0.001
The use of analgesic, n (%)	14 (13)	13 (13)	0.99
Recurrent disc herniation, n (%)	3 (3)	5 (5)	<0.001
Dural tear	1 (0.9)	1 (1)	0.96
Nerve root injury	2 (1.9)	1 (1)	0.61

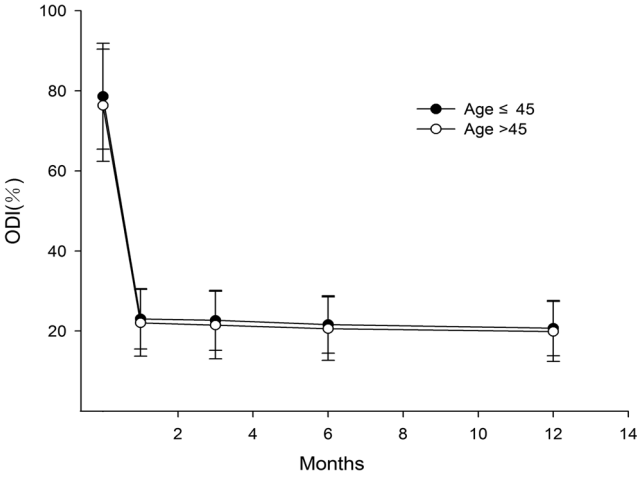

Fig. 4 Curves of the mean scores on the Oswestry Disability Index (ODI). The mean pre-operative and post operative Oswestry scores for the two groups of patients significantly improved, but showed no significant differences at one-, three-, six- and 12-month follow-up (p >0.05)

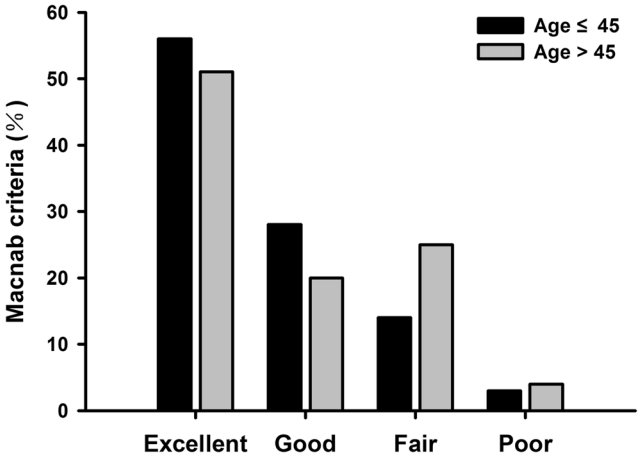

Fig. 5 Success of TELD defined by MacNab criteria in the age ≤45 group and age >45 group. Excellent and good results were deemed satisfactory. The satisfactory outcomes in the age ≤45 group were better than age >45 group (p=0.03, χ^2=4.85)

successfully performed on 16–85-year-old patients who suffer from back and radicular pain due to disc herniation. The post operative quality of life of elderly patients is not high [13], but the outcome of lumbar discectomy in elderly patients is as good as that in younger patients in other studies [14, 15].

Our study included 207 patients with LDH and were treated by the TESSYS technique in our centre. The VAS and ODI scores in both groups were obviously improved as compared with their pre-operative counterparts, but a comparison of the follow-up time points of two groups showed no statistical significance postoperatively. We hypothesized that the patients who were treated with TELD only need one month to recover. The level of satisfaction based on the MacNab criteria was lower in the age >45 group than in age ≤45 group. We considered the following reasons to explain this phenomenon. First, the degeneration of the vertebra in the age >45 group was more severe than that in the age ≤45 group, which can lead to facet joint osteophytes, laxity of spinal ligaments, and segmental instability. Second, the back and leg pain of the elderly patients have other causes aside from LDH. Examples of these other causes include lumbar muscle strain, lateral femoral cutaneous neuritis, superior gluteal cutaneous neuritis, hypertrophic ligamentum flavum, and foraminal stenosis.

Unlike Europe, in China, most patients receive rehabilitation exercise under the instruction of doctors after the operation. In addition, with nucleus pulposus removed, the patients may have secondary neurological edema for two to three days and feel more pain than immediately after the operation. Only when relieving the pain by analgesic, they are allowed to leave the hospital. In our study, the patients in the age >45 group had a longer hospital stay and higher costs than those in the age ≤45 group because the elderly need a long recovery period. The two groups did not differ in the use of analgesic, dural tear, and nerve root injury, but the recurrence rate of the age >45 group was obviously higher than that of the age ≤45 group. This result can be attributed to three reasons. First, although the disks compressing the nerve root and dural sac were removed, the stenosis resulting from the vertebral degeneration was not completely decompressed. Second, segmental instability is common for elderly patients because of osteophyte hyperplasia and capsule relaxation of the facet joint, which account for the recurrence of back and leg pain. Last, elderly patients usually suffer from LDH for more years and have more severe vertebral degeneration than younger patients; thus, the clinical outcomes of elderly patients were not good when the radiofrequency ablation for annuloplasty was performed. Actually the recurrence rate of both groups in our study was not low, similar to the study of Cheng et al. [16], recurrent herniation occurred in TELD more than other similar techniques.

Age exerted minimal influence on pain relief and function recovery at post-operation. That is, the young and elderly patients showed no significant differences in pain relief and

Table 3 Pre-operative and follow-up assessment

Outcome	Month	Group age≤45	Group age >45	*P* value
VAS (mm)	Preoperation	80.46±9.80	79.09±10.31	0.33
	1	20.37±6.86	20.10±7.07	0.78
	3	19.08±6.73	19.19±6.95	0.81
	6	20.29±6.38	20.30±6.30	0.98
	12	19.13±6.55	19.60±6.69	0.32
ODI (%)	Preoperation	78.61±13.21	76.36±14.01	0.28
	1	23.05±7.57	22.06±8.35	0.47
	3	22.68±7.50	21.49±8.45	0.37
	6	21.64±7.17	20.59±7.93	0.42
	12	20.70±6.91	19.89±7.51	0.56

VAS visual analog scale, *ODI* Oswestry Disability Index

function recovery at post-operation. However, the elderly had a high recurrence rate at 12 months post-operation. Therefore, clinicians must inform elderly patients of the possible outcomes before surgery. Considering the comparison of the two groups, we suggest that TELD be performed with TESS YS in young patients. For old patients, we should adopt individualized treatment protocols that consider the clinical symptoms and signs to cautiously expand the indications of TESSYS.

This study has some limitations. First, this study is retrospective, and a high number of patients were lost to follow-up, which may have complicated our outcome analysis. In the future, a prospective controlled study will be conducted to provide detailed information without the loss of follow-up of patients. Second, several factors that can affect the treatment outcomes are unknown; thus, the results of this research may inevitably produce bias. Third, negative results are easily obtained because of the limited number of samples. More case data should be obtained with time to further study this problem.

Conclusion

The efficacy of TELD is relatively good for the selected young and elderly patients in this study, and TELD is safe, easy to follow and quick to learn. Age influenced a little on pain relief and function recovery at post-operation. That is, age was not a predictor of TELD surgery-related outcomes.

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Conflict of interest No potential conflict of interest relevant to this article was reported.

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