ORIGINAL ARTICLE

Cost-Effectiveness Analysis between Percutaneous Endoscopic Lumbar Discectomy (PELD) and Conventional Lumbar Discectomy for Herniated Nucleus Pulposus (HNP)

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Background: Herniated nucleus pulposus (HNP) occurs when the annulus fibrosus is weakened and torn. Because research is limited, evidence is unclear as to whether percutaneous endoscopic lumbar discectomy (PELD) is superior to conventional surgery for patients with lumbar disc herniation in Thailand, particularly in terms of the costs for all treatment options.

Objective: To evaluate from societal and hospital perspectives the clinical outcomes, cost, and cost-effectiveness of PELD, and conventional lumbar discectomy (CLD) in patients with herniated discs.

Materials and Methods: The decision tree model was developed to capture the cost and effectiveness for patients with herniated discs under both procedures. Pre- and postoperative evaluations were performed with the Oswestry Disability Index (ODI), visual analog scale (VAS) for health state valuation and pain score. The following surgical variables were collected from medical records and analyzed, surgical time, blood loss, and presence of complications, length of hospital stay, and total days off. The cost of each surgery was collected from the hospital database and references.

Results: Statistically significant differences were found in the length of hospital stay, surgical time, blood loss, size of the incision, the number of days off, and the ODI score. The cost of PELD was lower than CLD from the societal perspective but higher than CLD from the hospital perspective. The incremental cost-effectiveness ratio (ICER) was 29,742.92 Baht per ODI score from the societal perspective.

Conclusion: PELD seemed to be more cost-effective than CLD in the present study.

Keywords: Percutaneous endoscopic lumbar discectomy; Herniated nucleus pulposus; Cost-effectiveness analysis

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Herniated nucleus pulposus (HNP) is caused by the annulus fibrous were weakened and torn, causing the nucleus pulposus to push through, creating a bulging or herniated disc. Patients with a herniated disc often have back pain radiating to one leg. If more severe, there may be numbness in the dermatome of the pressed nerve root or weakness of the leg and/or foot. In some cases, the herniated disc is large and Cauda-equina syndrome may lead to compression, which is back pain radiating to both legs, numbness and weakness on both sides, difficulty urinating, and constipation. Immediate surgical treatment is required to prevent permanent disability.

This type of herniated disc is most common in patients aged 21 to 50 who are hard working. Especially in the industrial sectors such as carrying on the load, lifting heavy objects, and those who are injured after playing sports or accidents, 90% of patients experience herniated dislocation at levels L4 to 5 and L5 to S1. The highest prevalence was among people aged 30 to 50 years, with a male to female ratio of 2:1[(1)].

According to the Occupational and Environmental Disease Situation and Health Hazards Report[(2)], the total number of work-related injuries or illnesses in 2014, most of the illnesses were caused by the musculoskeletal system problems that arise due to work for 81.65%. The intervention aims to relieve

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pain, increase mobility and function, and improve quality of life[1].

There are three standard surgeries to treat a herniated disc which are:

1. Standard surgery (conventional) in general anesthesia requires partial removal of the part of the laminar to be able to remove the herniated disc that moves over the nerve. The average hospital stay is 6 to 7 days and rehabilitation takes 2 to 3 months.

2. Microdiscectomy is using an operating microscope combination with smaller incision, less traumatic approach, and better visualization of the operative field than the standard open discectomy.

3. Percutaneous endoscopic lumbar discectomy (PELD) can be operated as an outpatient. Use a local anesthetic or stay in hospital for one night and do physical rehabilitation 4 to 6 weeks[3].

The treatment of herniated discs using endoscopic surgery can only be done in a few government hospitals. Making difficult access to services and some expenses cannot be reimbursed even if any type of claim, except for the private insurance group. Most patients are responsible for the additional expenses.

The cost-effectiveness analysis can be an evidence base for developing a practice guideline for patients with a herniated disc, policymakers can use it to make informed decisions about herniated disc patient care planning. Even though, a lot of evidences show PELD is superior to the conventional surgery for patients with lumbar disc herniated in terms of early clinical outcomes and the length of hospital stay[3]. However, the comparison of cost-effectiveness between the 2 procedures has never been investigated before. The objective of the present study was to evaluate the cost-effectiveness of PELD, and conventional lumbar discectomy (CLD) in patients with herniated discs.

Materials and Methods

The present study was approved by the Ethics Committee of Hospital (005/2561). The Decision tree model was developed to capture the cost and effectiveness for patients with the herniated disc under the two procedures: Endoscopic lumbar discectomy and the open discectomy. Time horizon in this model was one year. The model was validated by a specialist surgeon showing the choices (boxes) and opportunities (circles) made in practice. The patient population in each group included men and women with intervertebral herniated discs received treatment between 2007 and 2016, aged between 20 and 65 years. The exclusion was the patients with lumbar disc herniation who did not come for follow-up.

Treatment effectiveness

To evaluate treatment effectiveness, postoperative evaluation consisting of a functional outcome was used the Oswestry Disability Index (ODI) by interviewed patients (pre, post-3 months, and last follow-up). Scores for ODI range from 0 to 100 with the highest level of impairment represented with 100[4,5]. The surgical variables analyzed were collected from medical records which are surgical time (minutes), blood loss (mL), length of hospital stay (days), and total day off (days). Visual analog scale (VAS) for health state valuation provided a direct current state of health (full score=100), worst (0) to best imaginable state of health (100). The VAS for Pain score, (VAS: full score=10) was utilized to measure neurologic pain outcomes: no pain (0) to worst possible (10) to determine the pain intensity.

Resource utilization and cost

To estimate direct medical cost consisting of the capital cost which was the depreciation of the surgical instrument and facility, labor cost, and the material cost were calculated from operating room database, inpatient department (IPD) cost was collected from the hospital database. Direct non-medical care cost and the indirect cost were estimated from a patient a specific selection interview such as travel expenses, food expense, and accommodation for receiving services, income loss due to illness. The interview was the prospective study by interview patients and relatives at the outpatient department (OPD) and ward. Cost represented cost in the year 2020.

Incremental cost-effectiveness ratio

The cost-effectiveness analysis of PELD compared with CLD in the societal and hospital perspective were shown with the incremental cost-effectiveness ratio (ICER) using the economic model as shown in Figure 1. Figure 1 shown that patients with herniated discs had two surgical treatment options available which were PELD, and CLD. A patient who has surgery in each method has a chance to complete surgery and relieve pain or may encounter problems during surgery. When endoscopic is unsuccessful then switched to open surgery. There are chances of complication in each procedure. In case of open surgery, if unsuccessful then consider to redo surgery or redo conjunction with insertion of instrumentation and fusion. If there was a complication in open surgery, it's considered drug

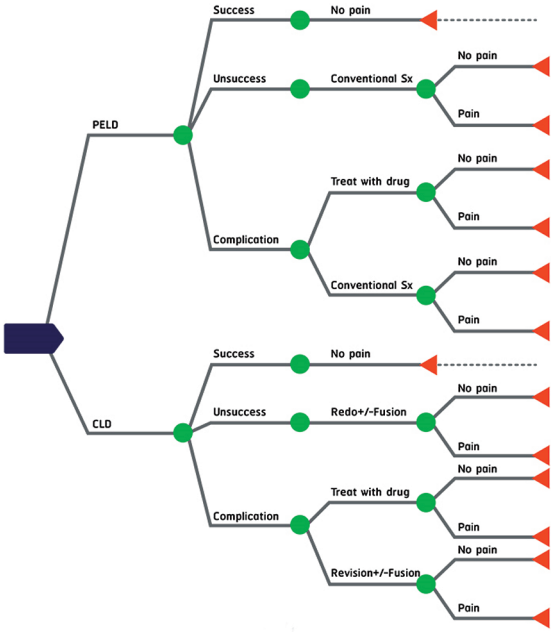

Figure 1. Decision tree model for treatment and results.

therapy or revision or instrumentation and fusion. The outcome of this model was no pain which was from a pain score less than three after surgery for three months. The time horizon in this model was one year (Table 1).

To estimate the ICER, average total costs and ODI from baseline to last follow-up were estimated for two groups of surgery. The ICER was defined as the difference in mean total cost between groups divided by the difference in mean ODI score (%).

Statistical analysis

Parametric data were calculated as mean, standard deviation (SD) and compared the data that were continuous in the two groups and were related to each other, the t-test was used for normal distribution. Nominal data were compared via the chi-square test. The p-value less than 0.05 was considered statistically significant by using IBM SPSS Statistics, version 23.0 (IBM Corp., Armonk, NY, USA), Microsoft Excel 2016.

Results

Patient population

A total of 76 patients for PELD, 38 for CLD were included. The mean ages were 49.5 years (SD 12.8 years) for patients underwent PELD, and 43.8 years (SD 8.6 years) for patients underwent CLD. There were no differences in age between groups.

Table 1. Variables and probability used in the model reference from medical record

Variables	Probability
The success rate of endoscopic	0.96
Probability of no pain in success in PELD	0.99
The complication rate of endoscopic	0.03
Probability of switch to open surgery in case of unsuccessful	0.01
Probability no pain after a switch to open surgery in unsuccessful	0.99
Probability of treat with drug after a complication in endoscopic	0.99
Probability of no pain after treating with a drug in complicated endoscopic	0.99
Probability of no pain after redo in unsuccessful PELD	0.99
Probability of no pain after a switch to open surgery in complicated endoscopic	0.99
The success rate of open surgery	0.89
Probability of recurrent in open surgery	0.02
Probability of no pain in recurrent in successful in open surgery	0.99
The complication rate in open surgery	0.01
Probability of revision +/– fusion after a complication in open surgery	0.01
Probability of no pain after revision +/– fusion in complicated open surgery	0.99
Probability of no pain after treatment with drug in complicate open surgery	0.99
Probability of no pain after redo in unsuccessful in open surgery	0.99

PELD=percutaneous endoscopic lumbar discectomy

Table 2. Demographic data for PELD and CLD

Variable	PELD (n=76)	CLD (n=38)	p-value
Age (years); mean [SD]	49.5 [12.8]	43.8 [8.6]	0.005
Sex; n (%)			
Male	35 (46.1)	23 (60.5)	0.025
Female	41 (53.9)	15 (39.5)	
Length of hospital stay (days); mean [SD]	3.4 [2.8]	8.6 [5.5]	<0.001
Surgical time (minutes); mean	73.7	82.2	<0.001
Blood loss (mL); mean [SD]	16.3 [5.2]	200 [4.8]	<0.001
Total day off (day); mean [SD]	24.6 [9.2]	80.3 [8.5]	<0.001

PELD=percutaneous endoscopic lumbar discectomy; CLD=conventional lumbar discectomy; SD=standard deviation

Mean surgical time was 73.7 minutes in PELD and 82.2 minutes in CLD. Length of hospital stay was 3.4 days in PELD and 8.6 days in CLD. Blood loss was 16.3 mL in PELD and 200 mL in CLD (Table 2).

Clinical outcomes

The mean VAS for pain score at the last follow-up was 2 in PELD and 9 in CLD. The mean VAS

Table 3. Clinical outcomes

Variable	PELD (n=76) mean [SD]	CLD (n=38) mean [SD]	p-value
VAS for pain score	2	9	<0.001
VAS for health state valuation	91	72	<0.001
ODI (%)			
ODI score (before operation)	25.5	24.6	0.040
ODI score (3 months post-op)	12.6	11.8	0.297
ODI score (last follow-up)	4.6 [8.5]	10.5 [12.8]	0.024
Satisfied (%)	90.48	83.29	<0.001

PELD=percutaneous endoscopic lumbar discectomy; CLD=conventional lumbar discectomy; ODI=Oswestry Disability Index; SD=standard deviation

Table 4. Costs for each surgery

Costs	PELD; mean	CLD; mean
Direct medical costs (Baht)		
Cost of surgery (per case)	79,926.47	53,614.67
Cost of OPD visit (per case per year)	5,529.60	7,776
Cost of IPD (per case)	8,755	22,145
Direct non-medical costs (per case) (Baht)		
Food	809.09	1,605.93
Travelling	15,684.77	22,056.71
Accommodation	1,080.35	982.14
Indirect cost (Baht)		
Income loss during hospital stay and recuperate at home	67,200	213,240

PELD=percutaneous endoscopic lumbar discectomy; CLD=conventional lumbar discectomy; OPD=outpatient department; IPD=inpatient department

for health state valuation was 91 in PELD, and 72 in CLD. The mean last follow-up ODI score was 4.6 in PELD and 10.5 in CLD. The average follow-up period was 6 months (Table 3).

Cost

The total cost was 180,777.50 Baht for PELD and 356,260.75 Baht for CLD in a societal perspective. The details of costs were shown in Table 4.

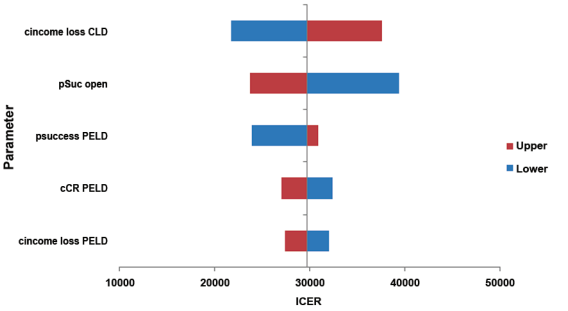

Figure 2. One-way sensitivity analysis.

Cost-effectiveness analysis

Cost-effectiveness analysis results were shown in Table 5. Figure 2 shown the analysis of uncertainty by one-way sensitivity analysis. Variables that affected the ICER were income loss in CLD, success rate in CLD, and success rate in the PELD group, respectively.

Discussion

The purpose of the present study was to compare the clinical outcomes, evaluated health care cost included patients cost (societal perspective), and find out cost-effectiveness analyses using the ICER among CLD, and PELD in patients with lumbar disc herniation.

The CLD has been regarded as a standard technique. PELD has been the alternative procedure. The results of the present study showed that PELD has better clinical data which were: a length of hospital stay, surgical time, blood loss, and a total day off. The other important outcomes were the health-related quality of life, VAS for pain score, daily activities (ODI) of PELD were also better than the conventional surgery. CLD trended to be more days of hospitalization and more rehabilitation, so the cost of patient or societal perspective was higher than PELD. Meanwhile, the cost of PELD in hospital perspective was higher than CLD due to PELD required expensive equipment and supplies.

Table 5. Cost-effectiveness analysis results

	PELD	CLD	Incremental
Cost in hospital perspective (Baht)	95,164.03	93,309.07	1,854.96
Cost in a societal perspective (Baht)	180,777.50	356,260.75	–175,483.25
ODI score (%)	4.60	10.50	–5.90
Cost-effectiveness in hospital perspective (Baht)			–314.40
Cost-effectiveness in a societal perspective (Baht)			29,742.92

PELD=percutaneous endoscopic lumbar discectomy; CLD=conventional lumbar discectomy; ODI=Oswestry Disability Index

The clinical outcomes in the present study corresponded with the conclusion of many studies shown that minimally invasive surgery treated lumbar disc herniation was more beneficial than the conventional surgery[6-8]. A huge systematic review and meta-analysis, 16 randomized controlled trial (RCT) and 13 non-RCT studies (4,472 patients) were included. The study compared minimally invasive surgery and conventional microdiscectomy for patients with lumbar disc herniation. There was moderate to low quality evidence of clinical outcomes that were not different between the surgery types[9].

Another systematic review and meta-analysis were performed to evaluate the clinical results of PELD and conventional lumbar microdiscectomy (CLM) for treatment of lumbar disc herniation. A total of 1,389 patients were included in this systematic review and the meta-analysis included RCTs or non- RCTs. The results of this study showed that no statistically between-group in terms of preoperative VAS-BP score, postoperative VAS-BP score, postoperative ODI, complication rate, or reoperation rate but PELD has shorter operation time and hospital stay[10].

The RCT of 40 patients with lumbar disc herniation treated with open discectomy (19 patients) and microscopic discectomy (21 patients) technique. The few parameters (incision size, length of hospitalization, operative time, and VAS for pain score at 12 hours) were found to be statistically different between groups[11].

Two-year follow-up 55 patients with PELD were associated with improvement in back pain and improvement in quality of life. Evaluated by the North American Spine Score (NASS), SF-36, and VAS for pain score[12,13].

Also, the present study considered the cost of PELD and conventional surgery. The cost of surgery included equipment/instruments and anesthesia techniques. PELD was higher than CLD due to the difference in equipment, surgical approach, and anesthesia techniques. The difference cost of IPD in each treatment was depended on the hospital's length of stay. The CLD trend to be more hospital stay day that may increase the cost. Complication cases had a high cost due to the cost of drugs and hospital stays.

There were a few economic studies that compare PELD and CLD directly. There was a literature review performed to summarize cost and clinical efficacy in PELD. Endoscopic approaches decreased morbidities but the high cost of the instrument[14].

In general, the cost-utility of lumbar discectomy was reported ranges from a cost-saving to $79,000/QALY gained compared with nonsurgical treatment[15-20].

The strength of the present study is the use of primary data (outcomes and medical costs) collection of Rajavithi Hospital. The present study finding represents an important step of analysis of spine surgery care in Thailand. These data can be used as a reference for future studies.

Limitation

The present study has several limitations. It is a small sample size in each group. The hospitalization cost was collected from the charge price in the hospital medical database. The clinical outcomes were short-term. The recall bias maybe on patient self-report of the ODI but the authors minimized this bias by asked patient status at the last follow-up. The data collection was only on the Rajavithi Hospital.

Future research should use the utility of the disease or health-related quality of life in herniated disc patients from the Thai EQ-5D or SF-36 which would be able to compare with another disease. Long-term follow-up is needed to determine the different.

Conclusion

PELD compare to CLD seems to be cost-effective in the present study. From a societal perspective, PELD was cost-effective, it can save 29,742.92 Baht per decrease in an ODI score. From a hospital perspective, PELD was more expensive (314.40 Baht) but it can improve the ODI score. However, to introduce endoscopic uses in the country, they should concern the factors as follow; costly investment in a diagnostic and surgical instrument, the technology is complicated and requires expertise to perform the procedure. The human resource which is physicians and nurses should be standard trained and treated for good treatment results, safe and cost-effective.

What is already known on this topic?

PELD is more effective than the CLD which is now the standard surgery for patients with HNP. PELD is performed in few public hospitals due to the high cost of equipment that making it difficult for patients to access services. Therefore, the cost-effectiveness of this technology is studied.

What does this study add?

PELD is cost-effective from a societal perspective compared to the CLD. The cost savings of 29,742.29 Baht per reduction of ODI score. This Technology

should be widely applied in Thailand.

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Conflicts of interest

The authors declare no conflict of interest.

References

1. Jordan J, Konstantinou K, O'Dowd J. Herniated lumbar disc. BMJ Clin Evid 2009;2009:1118.
2. The Bureau of Occupational and Environmental Diseases, Report in diseases and health hazards of occupational and environmental [Internet]. 2012 [cited 2018 May 5]. Available from: http://envocc.ddc.moph.go.th/uploads/situation/01_envocc_situation_57.pdf.
3. Kanno H, Aizawa T, Hahimoto K, Itoi E. Minimally invasive discectomy for lumbar disc herniation: current concepts, surgical techniques, and outcomes. Int Orthop 2019;43:917-22.
4. Sanjaroensuttikul N. The Oswestry low back pain disability questionnaire (version 1.0) Thai version. J Med Assoc Thai 2007;90:1417-22.
5. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine (Phila Pa 1976) 2000;25:2940-52.
6. Wu J, Zhang C, Zheng W, Hong CS, Li C, Zhou Y. Analysis of the characteristics and clinical outcomes of percutaneous endoscopic lumbar discectomy for upper lumbar disc herniation. World Neurosurg 2016;92:142-7.
7. Gadjradj PS, van Tulder MW, Dirven CM, Peul WC, Harhangi BS. Clinical outcomes after percutaneous transforaminal endoscopic discectomy for lumbar disc herniation: a prospective case series. Neurosurg Focus 2016;40:E3.
8. Dabo X, Ziqiang C, Yinchuan Z, Haijian N, Kai C, Yanbin L, et al. The clinical results of Percutaneous Endoscopic Interlaminar Discectomy (PEID) in the treatment of calcified lumbar disc herniation: A case-control study. Pain Physician 2016;19:69-76.
9. Kamper SJ, Ostelo RW, Rubinstein SM, Nellensteijn JM, Peul WC, Arts MP, et al. Minimally invasive surgery for lumbar disc herniation: a systematic review and meta-analysis. Eur Spine J 2014;23:1021-43.
10. Ruan W, Feng F, Liu Z, Xie J, Cai L, Ping A. Comparison of percutaneous endoscopic lumbar discectomy versus open lumbar microdiscectomy for lumbar disc herniation: A meta-analysis. Int J Surg 2016;31:86-92.
11. Righesso O, Falavigna A, Avanzi O. Comparison of open discectomy with microendoscopic discectomy in lumbar disc herniations: results of a randomized controlled trial. Neurosurgery 2007;61:545-9.
12. Peng CW, Yeo W, Tan SB. Percutaneous endoscopic discectomy: clinical results and how it affects the quality of life. J Spinal Disord Tech 2010;23:425-30.
13. Peng CW, Yeo W, Tan SB. Percutaneous endoscopic lumbar discectomy: clinical and quality of life outcomes with a minimum 2 year follow-up. J Orthop Surg Res 2009;4:20.
14. Allen RT, Garfin SR. The economics of minimally invasive spine surgery: the value perspective. Spine (Phila Pa 1976) 2010;35(26 Suppl):S375-82.
15. Hansson E, Hansson T. The cost-utility of lumbar disc herniation surgery. Eur Spine J 2007;16:329-37.
16. Kepler CK, Wilkinson SM, Radcliff KE, Vaccaro AR, Anderson DG, Hilibrand AS, et al. Cost-utility analysis in spine care: a systematic review. Spine J 2012;12:676-90.
17. Malter AD, Weinstein J. Cost-effectiveness of lumbar discectomy. Spine (Phila Pa 1976) 1996;21(24 Suppl):69S-74S.
18. Tosteson AN, Skinner JS, Tosteson TD, Lurie JD, Andersson GB, Berven S, et al. The cost effectiveness of surgical versus nonoperative treatment for lumbar disc herniation over two years: evidence from the Spine Patient Outcomes Research Trial (SPORT). Spine (Phila Pa 1976) 2008;33:2108-15.
19. van den Hout WB, Peul WC, Koes BW, Brand R, Kievit J, Thomeer RT. Prolonged conservative care versus early surgery in patients with sciatica from lumbar disc herniation: cost utility analysis alongside a randomised controlled trial. BMJ 2008;336:1351-4.
20. Falavigna A, Scheverin N, Righesso O, Teles AR, Gullo MC, Cheng JS, et al. Economic value of treating lumbar disc herniation in Brazil. J Neurosurg Spine 2016;24:608-14.