Original Article

Comparison of Tissue Damages after Traditional Open Decompression and Biportal Endoscopic Decompression for Lumbar Spinal Stenosis

Yingyong T, MD[1], Jaroon J, MD[1]

[1] Department of Orthopedic Surgery, HRH Maha Chakri Sirindhorn Medical Center, Faculty of Medicine, Srinakharinwirot University, Nakhon Nayok, Thailand

Background: Posterior decompression has been the most common surgical procedure for lumbar spinal stenosis. Endoscopic decompression is a new surgical technique for spinal stenosis decompression. Subjective outcomes after the procedure, VAS and functional scores, were very satisfying but there were no reports published on the amount of tissue damage for this procedure.

Objective: To evaluate the paravertebral muscles and soft tissue destruction between two methods of spinal decompression by muscle enzyme, CRP and size of muscle destruction.

Materials and Methods: Study design. A cohort series of two groups of the patients, open decompression and BPED, who underwent spinal stenosis decompression were compared in postoperative outcomes such as modified Macnab criteria, VAS, CPK, and CRP.

Results: The CRP and CPK level were significantly lower in BPED group than in open decompression group at 24 and 72 hours after surgery ($p<0.05$). Size of soft tissue destructions after BPED were 35±18 milliliters.

Conclusion: Postoperative CPK and CRP level of BPED were statistically significant lower than conventional laminectomy.

Keywords: Endoscope, Biportal, Two portal, Spinal stenosis, Decompression, CPK, CRP, Muscle enzyme, Tissue damage

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The paravertebral muscle and soft tissues are destroyed during the traditional lumbar spinal stenosis decompression, which can induce spinal structural damage and instability[1-5]. The surgical trauma leads to a series of reactions, production of abnormal metabolic phenomenon, as well as pro-inflammatory cytokines[6,7]. The systemic cytokines caused by tissue damages could produce a series of adverse reactions and affect the important organs in the human immune system. The minimally invasive surgery aimed to achieve the least amount of trauma to soft tissue structures by changes to special instruments and progress of surgical techniques and technologies. The damage to the tissue and immune response due to surgical trauma were reduced[8] therefore the levels of systemic cytokines and muscle enzymes could be used to assess the postoperative tissue damages.

Recently biportal endoscopic decompression (BPED) for lumbar spinal stenosis were the minimally invasive surgery that could improve postoperative recovery by causing less damage to paravertebral muscles and ligamentous structures[9,10]. In spite of limited skin incision in endoscopic technique, soft tissue inside the operative field could be destroyed as much as conventional technique. Many investigators have received favorable outcomes and faster postoperative recovery periods after endoscopic spinal decompression[9,10]. Even though various examinations for soft tissue damage have been conducted, these evaluations had been focused on the overall operative procedures by using the visual analogue scale for pain, Oswestry Disability index and modified Macnab criteria for function. There were not any reports that evaluated the inflammatory cytokines to confirm that BPED could cause less tissue damages than traditional open decompression. This study aimed to compare the soft tissue and paraspinal muscle damage between BPED and conventional decompression by comparison between preoperative and postoperative changes of creatinine phosphokinase (CPK) and C-reactive protein (CRP). In addition, volume of muscle destruction and the clinical results of both procedures were analyzed.

Correspondence to:

Torudom Y.

Department of Orthopedic Surgery, HRH Maha Chakri Sirindhorn Medical Center, 62 Moo 7 Rangsit-Nakorn Nayok Road, Ong-karuk , Ong-karuk, Nakorn Nayok 26120, Thailand.

Phone: +66-37-395085 ext. 11408

E-mail: torudom@hotmail.com

Materials and Methods

The present study was approved by the Ethics Committee of Faculty of Medicine, Srinakharinwirot University and undertaken between June 2013 and May

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2015 (SWUEC/C 262/2554). The inclusion criteria were as follows: 1) The patients who had clinical and radiographic findings consistent with spinal stenosis, 2) The patients who failed conservative measures, including physical therapy, anti-inflammatory medications, narcotics, physical therapy and epidural corticosteroid injection. The exclusion criteria were set as: 1) Patients who had undergone surgery for a non-degenerative etiology such as tumor or infection. 2) Patients who showed spinal instability in dynamic radiographs or required spinal instrumentation. 3) Patients who had systemic diseases, such as diabetes, heart diseases and hepatic diseases.4) Patients who had more than two levels of decompression and 5) Patients who had previous lumbar spine surgery. Patients who were included in this study would be randomized to the open decompression and BPED group.

Surgical technique of BPED

The patients were positioned in knee-chest position after general anesthesia. The operated level was identified with fluoroscope. Viewing portal and working portal were inserted through the two separated skin incision and docked onto the lamina (Figure 1). The localization was reconfirmed with lateral view of fluoroscopy before starting the procedure. We performed unilateral laminotomy for decompression of the central canal and bilateral lateral recesses. Decompression of the ipsilateral lateral recess was achieved by partial facetectomy. In order to preserve integrity of the facet joint as much as possible, the authors used instruments such as high-speed pneumatic burr and Kerrison ronguer to undercut the facet joint. Then the endoscope was tilted to the central canal and contralateral lateral recess. This step was performed by moving the endoscope over the dural sac. Then the ligamentum flavum and lamina were excised. The adequacy of decompression was determined by observing the dural sac and probing the exiting nerve roots for mobility. Case demonstration was shown with Figure 2 to 5. After the procedure, the size of muscle destruction during BPED were measured in milliliter by the balloon that used with urine catheter. The catheters were loaded with saline while the surgeon saw the balloon filled the surgical site under direct vision through endoscope (Figure 6).

Surgical technique of open decompression

Under general anesthesia, skin incision is made down at midline of the back over the planned operative vertebra. The length of the incision depends on how many segments of the lamina are to be operated. Back muscles are spilt down in the middle then they are bluntly retracted to either side for exposing the lamina. Once the bone is exposed, the spinous process is removed with rongeur. Then the ligamentum flavum that connected the lamina of the vertebra below with the lamina above are excised.

Pre-operative and post-operative assessment

General data of the patients were collected. VAS and modified MacNab Criteria were used to evaluate the post-operative outcomes and hospital stays of patients in the two groups were recorded. Enzyme-Linked immuno-sorbent assay (ELISA) was used to measure pre-operative and post-operative changes of CRP and CPK 12 hours, 24 hours and 72 hours.

Statistical analysis

The data was presented as the mean and standard deviation (SD). 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 $p<0.05$.

Results

There were thirty one and twenty nine patients in BPED and open decompression group respectively. Two patients in the BPED group and three patients in open decompression group were lost due to loss of follow-up.

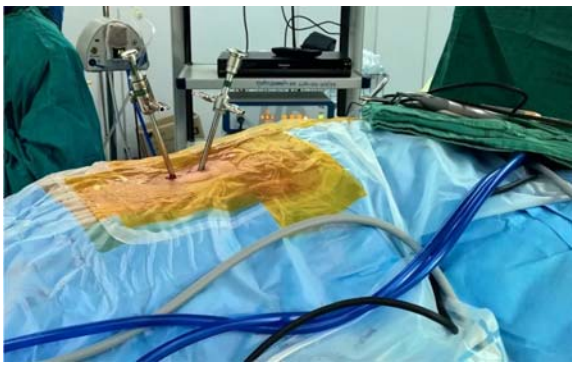

Figure 1. Endoscope and working portal were inserted from separated incision.

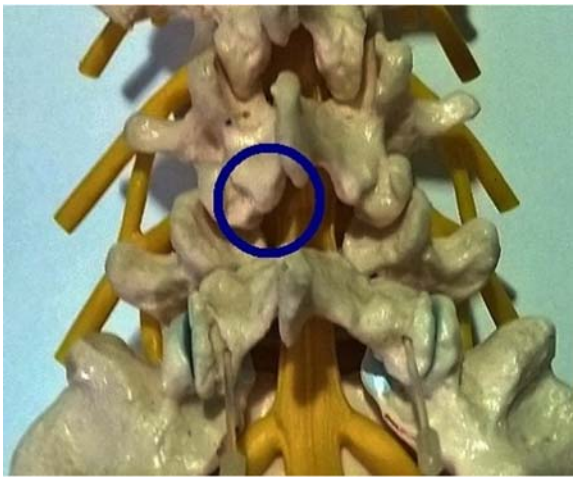

Figure 2. Blue circle represents area that used for operation.

Figure 3. The lamina was partially burred.

Figure 4. The ligamentum flavum was removed.

Figure 5. The adequacy of decompression was checked.

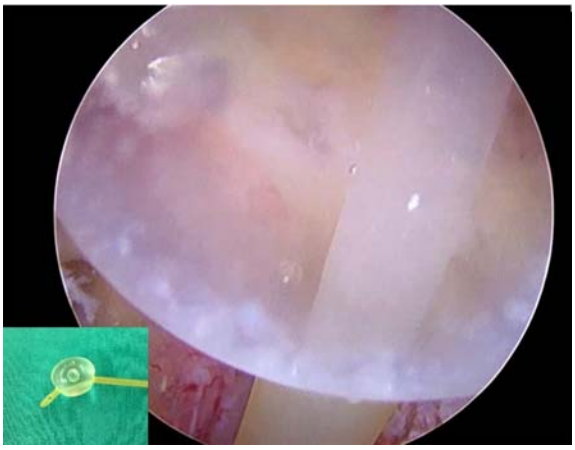

Figure 6. The balloon that used for estimate size of soft tissue destruction after BPED.

Demographic data in both group were in Table 1. Postoperative VAS of BPED group was lower than open decompression group (p<0.05). The length of hospital stay was remarkably shorter in BPED group than open decompression group (p<0.05). Modified MacNab criteria were used to evaluate 6 months and one year postoperative clinical satisfaction, with a 90% satisfaction in the BPED group (18/29 excellent, 8/29 good and 3/29 fair) and approximately the same satisfaction (88%) in the open decompression group (17/26 excellent, 6/26 good and 3/26 fair). Five patients in BPED group had complications. Two of them had postoperative leg paresthesia, they improved after four weeks follow-up. The most common complication in BPED group were second degree burn around surgical site. All of the patients (three cases) were treated with daily sterile dressing and healed without complication (Figure 7). Two patients in open decompression group had incidental durotomy. All of the tear could be repaired primarily. The average BPED surgical sizes that measured with balloon were 35$\pm$18 millimeters. Postoperative CRP level was significantly lower in BPED group than that in open decompression group at 24 and 72 hours after surgery (p<0.05) (Table 2). After the BPED operation, the CRP level was increased initially, and then decreased. Furthermore, before and after the corresponding surgery, the CPK levels in BPED and open decompression groups were significantly different (p<0.05). In detail, the CPK level was lower in BPED group than that in open decompression group (Table 3).

Discussion

The standard surgical approach for lumbar spinal stenosis was midline open decompression[1]. The damage to paraspinal muscles depended on the retraction duration and pressure during the usage of self-retaining retractor[11,12]. Endoscopic decompression was developed in order to reduce paraspinal muscles and soft tissue damage. In contrast to conventional laminectomy, endoscopic decompression confined the paraspinal muscles dissection from the vertebral arch only one side so multifidus muscle and surrounding soft tissue were destroyed in a limited area[9]. There were two forms of endoscopic spinal decompression, single portal and biportal[13] techniques. As the popularity of biportal endoscopic spinal decompression has increased, various studies had been conducted to evaluate the invasiveness of this method. In the past, the degree of invasiveness was compared based on the post-operative pain score, function after the operation and recovery period. In the present study the blood biochemical examinations, CRP and CPK levels, were investigated as indices of surgical trauma. Both of the parameters were lower in BPED group and were statistically significant. The extent of paravertebral muscle destruction, measured by balloon catheter, was approximately 35 ml but the size of tissue injury after open technique were large and cannot be evaluated. From the above information, the soft tissues and muscles around the spine were minimally damaged with BPED techniques.

Figure 7. The white arrow was second degree burn after the procedure. The black arrows were the scar from the BPED portal sites.

There were some limitation of this study. Firstly, CRP is not a specific cytokine that increases after soft tissue trauma. There were many situations that could increase CRP level such as diseases of the immune system and infections so the interpretation must be done carefully. Secondly, size of the muscles destruction from BPED that were measured might be under estimated. Surgical field volume might be of other shapes but we used a spherical shape to estimate the extent of operation. So some parts of the operative field might not have been included by the balloon shape. Finally, although paravertebral structures damage were reduced after BPED, postoperative clinical outcomes could not only rely on soft tissue destruction. The other factors that could influence the postoperative outcome were adequacy of the decompression, instability after the surgery and severity of the nerve injury during the procedure.

Table 1. Demographic data of the patients

	Open decompression	Biportal endoscopic decompression
Age (years)	65.3±5.4	63.8±6.1
Sex (percent)		
Male	16 (62)	19 (66)
Female	10 (38)	10 (34)
Duration of symptoms (years)	3.5±1.4	2.9±1.1
Level involved (percent)		
1	18 (69)	21 (72)
2	8 (31)	8 (28)
Length of hospital stay (hour)	96±19*	36±12*
Pre-op VAS	7.1±2.4	6.5+3.1

The star (*) mean when compare the open decompression to BPED there is statistical significant at $p<0.05$

Table 2. Comparison of preoperative and postoperative CRP between open surgery and endoscopic surgery (mean ± SD)

	Pre-op	Post-op 12 h	Post-op 24 h	Post-op 72 h
OD	2.2±1.4	4.5±1.1	35.8±5.4*	11.2±2.6*
BPED	1.9±1.3	3.6±0.9	19.2±3.5*	4.6±3.1*

BPED = biportal percutaneous endoscopic decompression; OD = the open decompression; Pre-op and Post-op = pre-operation and post-operation; CRP = C-reactive protein
The star (*) mean when compare the post-operative CRP to pre-operative level there is statistical significant at $p<0.05$

Table 3. Comparison of preoperative and postoperative CPK level between open surgery and endoscopic surgery (mean ± SD)

	Pre-op	Post-op 12 h	Post-op 24 h	Post-op 72 h
OD	98±32	425±54*	391±49*	321±36*
BPED	87±21	196±41*	175±52*	166±39*

BPED = biportal percutaneous endoscopic decompression; OD = the open decompression; Pre-op and Post-op = pre-operation and post-operation; CPK = creatine phosphokinase
The star (*) mean when compare the post-operative CPK to pre-operative level there is statistical significant at $p<0.05$

Conclusion

This pioneered study measured the degree of muscles and soft tissue damage after BPED via muscle enzyme, CRP and size of muscle destruction. The results confirmed that both functional outcomes after the operation and quantitative measurements of soft tissue injury were less than conventional operation.

What is already known on this topic?

Minimally invasive surgery such as tubular retractor could reduce soft tissue injury and cytokine released in spinal stenosis surgery.

What this study adds?

Biportal endoscopic decompression could reduce cytokines and muscle enzyme release compared with conventional surgery.

Potential conflicts of interest

The authors declare no conflict of interest.

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