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A Minimally Invasive Lumbar Spine Surgery Technique Using a Modified Thoracoport : Proposal of a New Tubular Retractor

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Recently the trend of surgical procedure for treatment of lumbar benign disease is a minimally invasive surgery due to small incision, minimal blood loss, and a short hospital day. By using a microscope or an endoscope, and other surgical equipment, a delicate manipulation in a narrow space became feasible, consequently, to secure a wider view with small incision, appropriate retractors are required. But the various tubular retractor systems are expensive and have some problems. We modified Thoracoport (Auto Suture Co., Norwalk, CT) by making a window at the distal end of trocar and used it as a tubular retractor in surgical procedure for treatment of lumbar benign disease. This modified tubular retractor is docked closely on the curved lamina and provides a wider view. We used it as a tubular retractor also in lumbar bilateral decompression involving a unilateral approach. But this trocar has the limited sizes (diameter and length), and also it is difficult to fix the retractor or change the direction of retractor. And then, we propose a more modified Thoracoport with various sizes and attaching the settling holders to the head of tubular retractor to be able to fix the retractor.

KEY WORDS : Thoracoport · Lumbar spine · Minimally invasive surgery.

Introduction

Since Dandy[1] introduced a surgical procedure for the treatment of herniated lumbar discs, surgical techniques have been improved from such conventional treatments to more non-invasive treatments. A minimally invasive spine surgery was introduced and results in reduction of hospitalization and rehabilitation periods, and thus decreased overall costs[3,14,15]. Particularly, by using a microscope, endoscope, and other surgical equipments, a delicate manipulation in a narrow space became feasible, and consequently, to secure a wider view with small incision, appropriate retractors were required, and various lumbar retractors have been introduced[8-10,12,18]. And for a small incision and getting a good view, a trend utilizing a microscope or an endoscope together with tubular retractor system is on the rise[2-4,7,13,16]. Among them, the representatives are microendoscopic discectomy system (MED, Medtronic Sofamor Danek, Memphis, TN)[5,17,19], and its derivatives; METRx system (Med-tronic Sofamor Danek, Memphis, TN)[19], ENDOSPINE system (Karl Storz GmbH & Co., Tuttlingen, Germany)[8], Atavi system (Endius Inc., Plainville, MA) that is designed to allow the posterior fixation using screws, and MaXcess system (Nuvasive Inc, San Diego, CA)[16], etc.

However, due to a narrow surgical view and the significant learning curve until becoming familiar with the application of these equipment, surgical manipulation is difficult, and because of it, sufficient decompression of neural canal and discectomy are difficult. In addition, the cost of the tubular retractor system used in each equipment is high, and it becomes a financial burden.

Because of such problems, Authors modified Thoracoport (Auto Suture Co., Norwalk, CT) by making a V-shape window at the distal end of the trocar and used it as a tubular retractor in surgical procedure for treatment of lumbar benign disease (Fig. 1). In patients with the herniated lumbar disc or the spinal stenosis, endoscopic or microscopic surgeries using a modified Thoracoport tubular retractor were performed for unilateral partial hemilaminectomy, discectomy or foraminotomy. In addition, authors propose a more optimized tubular retractor by modifying a Thoracoport and changing its shape.

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Materials and Methods

Case review

In our hospital, for 30 consecutive patients with the herniated lumbar disc or the spinal stenosis, endoscopic or microscopic surgeries using a modified Thoracoport tubular retractor were performed for unilateral partial hemilaminectomy, discectomy or foraminotomy. The cases underwent unilateral partial hemilaminectomy and simultaneous bilateral subsequent decompression were performed in three cases.

A 49-year-old male presented with low back pain and a radiating pain to the right calf that had developed gradually over a period of several weeks. Straight leg raising test was limited on the right side. Magnetic resonance imaging showed huge disc herniation at the L4-L5 level, and with a modified Thoracoport tubular retractor, endoscopic discectomy was performed. After the surgery, the pain subsided markedly (VAS 10−>2).

A 54-year-old female patient had a low back pain from 10 years ago, and complained of a radiating pain, severe hypoesthesia along the left 5th lumbar dermatome area and weakness of the dorsiflexion of both great toes. But straight leg raising test was not limited. Magnetic resonance imaging showed a severe narrowing of spinal canal at the L4-L5 level, endoscopic hemilaminectomy on the left side was performed, and simultaneous bilateral decompression was performed. After surgery, motor weakness of both great toes was still existed, nevertheless, the pain in the lumbosacral area, the left radiating pain, and hypoesthesia were improved significantly (VAS 9−>1).

Surgical procedure

The study subjects were patients who underwent simple discectomy due to herniated lumbar discs or decompression for spinal stenosis. Under general anesthesia, operations were performed on prone position until the surgeon became skilled in this surgical techniques, when skilled, the 30-degree forwardly inclined lateral decubitus position was taken. In the distal end of a Thoracoport with 15mm inner diameter, V-shape resection was done and a window was created (Fig. 1). After the insertion of the tubular retractor, the window at the distal end of retractor was placed toward the medial side making a wider operating view. The view was secured by using a microscope or an endoscope, and primarily an endoscope (Karl Storz Endovision, Karl Storz GmbH & Co., Tuttling, Germany. angle of view : 0 degree, field of view : 90 degree) 4mm in diameter was used. The skin incision approximately 2cm in length was made in the lesion vertical to the spinous process, subcutaneous tissues were retracted bilaterally using a small self-retaining retractor. Upon the exposure of the lumbar fascia, it was incised by an electrical cutting coagulator, and a route was made in the posterior paravertebral muscles along

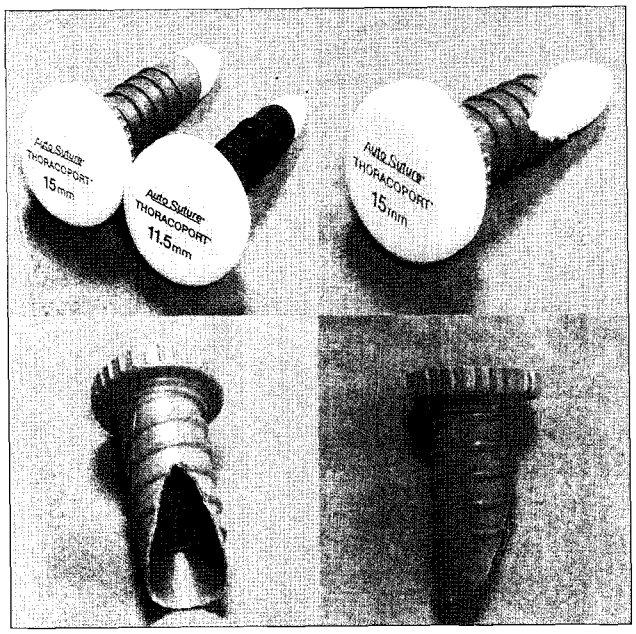

Fig. 1. Modified Thoracoports with a V-shape window at the distal end.

the spinous process with the index finger of surgeon. Upon the palpation of the interlaminar space, muscles and ligaments attached to this structure were detached or splitted with the index finger. When it was confirmed that an appropriate route was made by the assessment with the index finger, the obturator with a modified Thoracoport was inserted and reached the interlaminar space, and then a modified Thoracoport was inserted by clockwise rotation. Surgery was performed by removing the obturator and subsequently inserting an endoscope into the tubular retractor or using a microscope.

By using a high speed drill, partial hemilaminectomy was performed and the ligamentum flavum was removed, and after confirming nerve roots, the disc was removed by making a hole in the posterior annulus. If decompression of the opposite side was required, the opposite ligamentum flavum was removed sublaminally through the space under the spinous process. The opposite nerve root was retracted sufficiently and decompressed. Because of the medial window in the distal end, it offered further view of medial side and made the opposite approach possible without changing the direction of the tubular retractor (Fig. 2). After confirming the sufficient decompression of the nerve root, the wound was sutured.

Discussion

Among various equipment for microendoscopic discectomy, MED system is a more advanced equipment than previous endoscopic systems and is consisted of a guide, a dilator, a tubular retractor, and self retractor. However, the maximum diameter of the tubular retractor is 16mm, and the

retractor protrudes above the skin level during surgery. Therefore, the operative field and the working angle are narrowed, and it makes the retractor less proficient. In addition, the angle of view of endoscope is 25 degree and thus it provides a biased view that is different from anatomy viewed by naked eye directly, hence, it is unfamiliar and the surgical approach is difficult.

METRx system is more advanced than MED system and compensates such problems by tubular retractors with various diameter and length, nevertheless, its unnecessary dilator and its high cost become problems[2,11]. Additionally, Atavi system by Endius and MaXcess system by NuVasive are available, however, these equipments also have the problems described above.

Therefore, to compensate such problems, authors modified the Thoracoport and used it as a retractor.

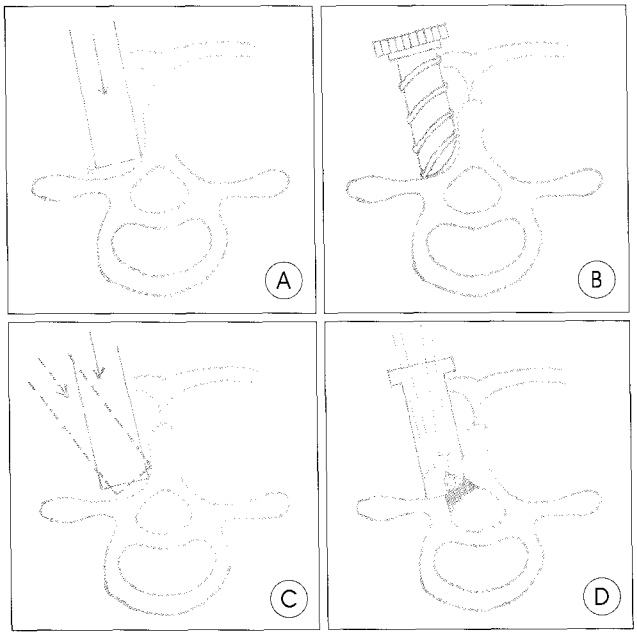

Fig. 2. Comparison between a round tubular retractor with a modified Thoracoport. A : A round tubular retractor could not be closely docked on the hard structure and soft tissues are entered into the operating field (The red star shows the gap). B : By changing the shape of distal end of a trocar, the gap is minimized. C : For the approach to the contralateral side, a change of the direction of round tubular retractor is necessary. D : The medial side window secures a further medial side view and a bilateral decompression is feasible by unilateral approach without changing the direction of a tubular retractor.

In 1999, Jho et al introduced a thoracoscopic tubular trocar to thoracic disc removal[6]. In 2004, this modified trocar was introduced by Hsieh and Wang who cut the distal end of Thoracoport in U-shape and used it as a tubular retractor in lumbar discectomy[5]. Authors cut the distal end of Thoracoport (15mm in diameter) in V-shape and created a window (Fig. 1). It could be docked closely on the curved lamina (Fig. 2). As the distal end of conventional tubular retractors is round, the gap between the distal end of tubular retractor and contacting hard structure (especially lamina and facet joint) is larger than surgeon's expectation (Fig. 2). However, by changing the shape of distal end, the gap becomes smaller due to the shape of distal end similar to the curve of the adjacent contacting structures (Fig. 2). It is helpful to prevent the soft tissue from bulging into the tubular retractor. In addition, the window at the tip of tube is placed to face the medial side of operating field, and thus the operating view is widened in the medial side (Fig. 2, 3). It secures further medial view and then, by such sufficient surgical view (particularly in the medial side), bilateral decompression is feasible by unilateral approach without changing the direction of the tubular retractor (Fig. 2). This distal window of tubular retractor also represents a landmark on the video image and helps surgical orientation. In addition, as the operating field is seen directly through the endoscope, not biased, the disorientation of the image detected during surgery was eliminated, therefore, surgery could be performed readily. It has been reported that in the previous tubular retractors a soft tissue dilator was used to minimize muscle injuries prior to the insertion of tubular retractor[2]. However, based on our experience, it is considered that if the fascia is cut, the retractor route in muscles could be formed by a finger and an obturator. Therefore, in our hospital, expensive dilators were not required.

This equipment is made of plastic, therefore, the length could be adjusted readily to minimize its protrusion above the skin level and increase the working angle. Nevertheless, if the patient is big and thus a longer retractor is required, its use is limited since the length of previous products is 6 centimeter. Various different retractors with a wide range in its diameter and length are not available (previous product diameter: 15mm, 11.5mm). Furthermore, previous Thoracoport lacks an equipment to fix a tubular retractor, and thus it is difficult when the fixation of retractor or change of the retractor angle was required. Therefore, to compensate such problems, authors propose a modified Thoracoport with diverse sizes

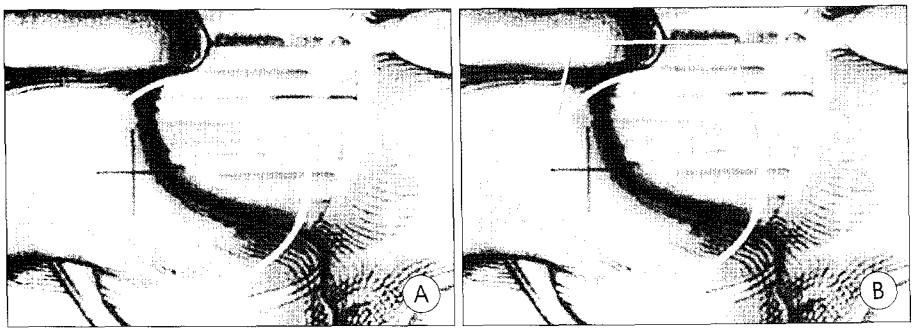

Fig. 3. Schematic view of the operating field in a tubular retractor system. A : The white circle is the operating field in a round tubular retractor. B : The window at the tip of a trocar was placed to face the medial side of operating field, and it secures a further medial side view (red line).

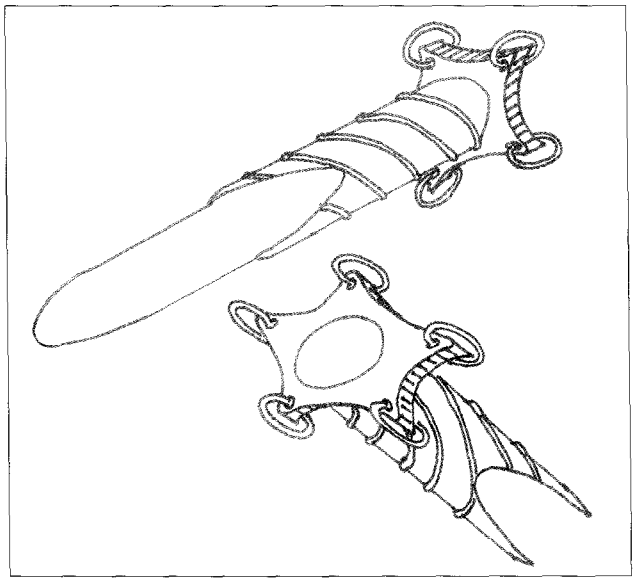

Fig. 4. A proposal of a new tubular retractor by modifying a Thoracoport and changing the shape of it. We propose a modified Thoracoport of diverse size and length with settling holders at the head of a tubular retractor to be able to retract and fix the retractor.

and attaching the settling holders to the head of tubular retractor to be able to retract or fix the retractor. We also need longer obturator (Fig. 4).

Conclusion

Microendoscopic discectomy is a minimal invasive surgical method that a small scar and minimal injury to the soft tissues and bones allow early return to a routine life. However, narrow surgical view and approach angle limitation of surgical equipment are the main obstacles until the operator becomes familiar with the equipment. Authors have made attempts to compensate such problems by employing a modified Thoracoport and more optimized tubular retractor.

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