Original Article

Minimally invasive space shuttle laminotomy for degenerative lumbar spinal canal stenosis

Shunji Asamoto, Jun Muto1, Hiroyuki Jimbo2

Department of Neurosurgery, Mita Hospital, International University of Health and Welfare, Otawara, 1Department of Neurosurgery, Keio University, School of Medicine, 2Department of Neurosurgery, Hachioji Medical Center, Tokyo Medical University, Tokyo, Japan

Corresponding author: Prof. Shunji Asamoto, Department of Neurosurgery, Mita Hospital, International University of Health and Welfare, 1-4-3 Mita, Minato-Ku - 108-8329, Tokyo, Japan. E-mail: spine-asm@iuhw.ac.jp

Journal of Craniovertebral Junction and Spine 2016, 7:11

Abstract

Study Design: Technical note. Objectives: To show microsurgical technique, considering the meticulous anatomy of the ligamentum flavum (LF). Background: Different methods are available for treating lumbar spinal canal stenosis (LSCS). A minimally invasive surgery, namely, space shuttle laminotomy, has recently been proposed. Here, we describe the surgical method for this novel technique. To conduct this surgery accurately, surgeons must have perfect knowledge of anatomy, especially regarding the LF. Materials and Methods and Results: We use this interlaminectomy technique for all cases of LSCS. All patients with LSCS recovered from their neurological deficits in shorter hospital stays than regular laminectomy. Conclusion: Minimally invasive space shuttle laminotomy (MISSL), which involves a microsurgical technique, is a safe, complication-free procedure.

Key words: Anatomy, decompression, degenerative lumbar spinal canal stenosis, KAIRison, ligamentum flavum (LF), minimally invasive surgery, one-level laminotomy, microsurgery, space shuttle laminotomy, removal of the spinous process

INTRODUCTION

With an aging society, the incidence of degenerative lumbar spinal canal stenosis (LSCS) has been increasing in Japan. Various operative techniques are available for treating LSCS, and minimally invasive surgery has recently been proposed including microscopic surgery and endoscopic surgery. In this report, we describe the surgical technique for minimally invasive space shuttle laminotomy (MISSL) using a microscope, for which surgeons must be very well-versed about normal anatomy, especially the anatomy of the ligamentum flavum (LF).

Background

First, we describe the normal anatomy of the LF in detail. As mentioned above, it is only possible to conduct MISSL safely and accurately if the surgeon knows the anatomy of this ligament well. The LF is thick and short and is symmetrical on both the left and right sides. On each side, the LF divides into a medial

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Asamoto S, Muto J, Jimbo H. Minimally invasive space shuttle laminotomy for degenerative lumbar spinal canal stenosis. J Craniovert Jun Spine 2016;7:55-8.
was discharged the day after surgery without any neurological deficit. The bleeding during the surgery was no more than 12 mL. He underwent the surgery for L4-5 interlaminectomy, MISSL. The operation time was 1.5 h. A 65-year-old male presented with intermittent claudication and came to the hospital with the chief complaint of the sciatic pain in the right lower extremity. Radiological findings showed the lumbar spinal canal stenosis in L4-5. He underwent the surgery for L4-5 interlaminectomy, MISSL. The operation time was 1.5 h. The bleeding during the surgery was no more than 12 mL. He was discharged the day after surgery without any neurological deficit.

**CASE REPORT**

A 65-year-old male presented with intermittent claudication and came to the hospital with the chief complaint of the sciatic pain in the right lower extremity. Radiological findings showed the lumbar spinal canal stenosis in L4/5. He underwent the surgery for L4-5 interlaminectomy, MISSL. The operation time was 1.5 h. The bleeding during the surgery was no more than 12 mL. He was discharged the day after surgery without any neurological deficit.

**MATERIALS AND METHODS AND RESULTS**

MISSL is performed with microscopic assistance. The current article describes basic, one-level laminotomy but if necessary, the technique can be applied to multiple levels. We believe that orthodox laminectomy would serve for treating multiple-level sclerosis just as easily as MISSL; neither has any associated problem. A recent study has proposed the midline spinous process splitting approach or unilateral approach and bilateral decompression but there is no evidence that these surgical procedures are medically advantageous.

The details of MISSL for one-level stenosis are given below. Skin incisions of 3 cm are usually adequate in the case of one-segmental stenosis. Both the rostral and caudal spinous processes of the responsible lesion are opened, and the inferior one-third of the rostral spinous process with the interspinous ligaments is resected until the base of the spinous process. Thus, the facet joint is never sacrificed and the multifidus muscles that cover the facet joint capsule can be preserved to the best possible extent. We should mention that for achieving hemostasis, we avoid using monopolar cautery and use only bipolar cautery since it is more precise. Hemostasis acts as protection for the muscle.

Next, the procedure shifts sequentially to microscopic operation. Although the shape of the facet and width of the spinal canal should be confirmed before the operation, they can be verified on the basis of the diameter of a diamond burr. In terms of the width of the laminotomy for the rostral side lamina against the responsible segment (if it is level L4-5, then the L4 side lamina is involved), about 10 mm is usually adequate. In the case of the caudal side lamina (if it is level L4-5, the L5-side lamina is involved), 16-18 mm is adequate. Maintaining the width at less than 10 mm on the rostral side can protect the facet joint and its capsule. However, this is not always the case, as L1-2 or L2-3 is physiologically narrower than L4-5 or L5-S1, and the width becomes narrower toward the rostral side. In addition to decompression of the canal, decompression of the root sleeve is necessary. Therefore, the width of the decompression must exceed the width of the lamina. This part of the operation is performed using a diamond burr of diameter 6.0 mm. Although any ragged LF or LF obstructing the operation field may be removed, it is better to preserve the LF as far into the surgery as possible. The bone of lamina is removed by the drill until the dura mater is identified at the terminal of rostral side on midline. Therefore, particular care should be taken at this point, since the dura mater emerges suddenly after the laminotomy. The silhouette of the laminotomy resembles a space shuttle [Figure 2] and hence, the designation “space shuttle laminotomy.” Meticulous decompression is performed using a diamond burr of diameter 3.0 mm. The medial side of the inferior facet is drilled off using the burr. While performing the decompression, we used KAI Rison® (a pneumatic Kerrison bone punch; Aesculap AG, Tuttingen, Baden-Württemberg, Germany) and conventional Kerrison bone punches. KAI Rison can be manipulated with a single hand under the microscope. With this punch, decompression can be performed with ease for not only laminae but also floating soft structures such as ligaments and flavum, as these provide strong forces assisted by the compressed air supply in standard operation rooms. During the procedure, it is essential that the operator stand on the opposite side from the side on which the surgery is conducted. While the visual axis of the microscope is inclined, it is pushed forward toward...
Asamoto, et al.: Space shuttle laminotomy

As both the diamond burr gets closer to the lateral recess, the LF naturally floats. In this situation, the LF should be preserved as far as possible because it can protect the dura mater. The drilling is continued in the direction of "rear fender of the space shuttle." Because the most lateral fibers of the LF extend toward the pedicle, the laminotomy can be performed safely. The drilling off toward the "rear fender" should be continued until the point at which the LF gradually tapers off. At this point, the diamond burr is turned toward "the cockpit of the space shuttle" [Figure 2c] where the LF is no longer present. The bone resection area looks like a space shuttle seen from the right side, [Figure 2d] the anterior side [Figure 2e] and the oblique side [Figure 2f]. The postoperative x-ray shows the bone decompression area on X-ray can be seen as if a space shuttle is flying, shown the red in the schema [Figure 2g and h]. The operator's assistant must take care to avoid dural lacerations during drilling off at this point. The procedure is repeated on the reverse side. However, in cases in which the canal is extremely narrow, decompression should not be performed at a stretch on any one side. In such cases, alternating, step-by-step decompression on each side is safer [Figures 3-7]. Once one side is completely decompressed, it is easy to decompress the other side. For multiple-level stenosis, this MISSL procedure is performed sequentially on each segment.

Figure 2: (a) Silhouette of space shuttle laminotomy from the dorsal side (b) The dotted line shows “dome laminotomy” of the “cock pit” of the space shuttle (c) Drilling off over the lateral portion of the LF using diamond burr. The LF protects the dura mater (d) Silhouette of space shuttle laminotomy from the lateral side (e) Axial section of the silhouette of space shuttle laminotomy (f) Three-dimensional image of space shuttle laminotomy (g) The postoperative the lumbar spine x-ray of A-P. The translucent area on the lumbar spine x-ray shows the resection area of the bone to decompress during the surgery that is shown in the red part in the schema (h) The resection is shown in red on the postoperative lumbar spine x-ray

MISSL can be described as laminotomy against the caudal side of the lamina. However, in the strictest sense, it is “removal of the spinous process” of the base of the spinous process against the rostral side of the bone.

CONCLUSION

MISSL, which involves a microsurgical technique, is a safe, complication-free procedure. However, it requires operators to have a good understanding of the anatomy of the LF.
Financial support and sponsorship
The authors have no personal, financial, or institutional interest in any drugs, materials, or devices used.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Naffziger H, Inman V, Saunders JB de CM. Lesions of the intervertebral disc and ligamenta flava: Clinical and anatomical studies. Surg Gynec Obstet 1938;66:288-99.
2. Ramsey RH. The anatomy of the ligamenta flava. Clin Orthop Relat Res 1966;44:129-40.
3. Yahia LH, Garzon S, Strykowski H, Rivard CH. Ultrastructure of the human interspinous ligament and ligamentum flavum. A preliminary study. Spine (Phila Pa 1976) 1990;15:262-8.
4. Yong-Hing K, Reilly J, de Korompay V, Kirkaldy-Willis WH. Prevention of nerve root adhesions after laminectomy. Spine (Phila Pa 1976) 1980;5:59-64.