

原 著

A New Surgical Procedure for the Treatment of Lumbar Spinal Canal Stenosis Especially Recommendable for Degenerative and Combined Stenosis

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Abstract

A new surgical procedure which avails widening the lumbar spinal canal and preserving posterior structure of the lumbar spine was reported. After complete removal of yellow ligaments, an osteoplastic partial laminectomy on one side, while Love's fenestration on the other side of the same lamina were performed. Then, partial removal of facets and pedicles were done bilaterally. Osteophytes and herniated disk if exists were removed, a trimming of the under-surface of lamina were added. After the canal was enlarged the osteotomized lamina was replaced in original position. This laminectomy was repeated one level above and below or both when they are responsible. Thirteen cases with degenerative and combined stenosis operated by the method revealed good results.

Introduction

The term lumbar spinal canal stenosis was first introduced by VERBIEST¹⁾ in 1954 when he reported a series of congenitally narrowed vertebral canals as "developmental stenosis". Various types of narrowing of the spinal canal^{1,2)} and nerve root tunnel were reported in the field of basic and clinical research before and after his paper. As a result confusion somehow developed regarding definition and classification of this entity. However, knowledges have been accumu-

Key words: Osteoplastic laminectomy, Lumbar spinal canal stenosis, Experimental myelography, Degenerative stenosis, Combined stenosis.

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lated from various fields and the definition and classification of this entity was put forward by KIRKALDY-WILLIS et al in 1974²⁾. As to the incidence in literatures, among several types of stenosis, degenerative stenosis and combined stenosis are thought to be more common than developmental one.

Surgical treatment becomes necessary to salvage clinical symptoms in severe cases when they no longer respond to conservative treatment. As a conventional method being popularly used at present by a group of surgeons is wide resection laminectomy which, however, is known to be developed by the process of formation of what we call postlaminectomy membrane³⁾ and to destroy posterior structure of the spine as well.

In an attempt to avoid the development of post-laminectomy membrane, WEDGE and KIRKALDY-WILLIS reported a new surgical technique in 1978⁴⁾. Recently in Japan a group of surgeons began to use a technique in which LOVE's interlaminar approach is used bilaterally on a single disk level so as to preserve the posterior vertebral structure for spinal stabilization. In this method, however, surgical exposure is rather limited and the decompression effect is sometimes insufficient.

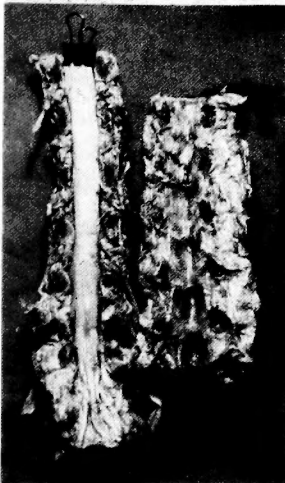
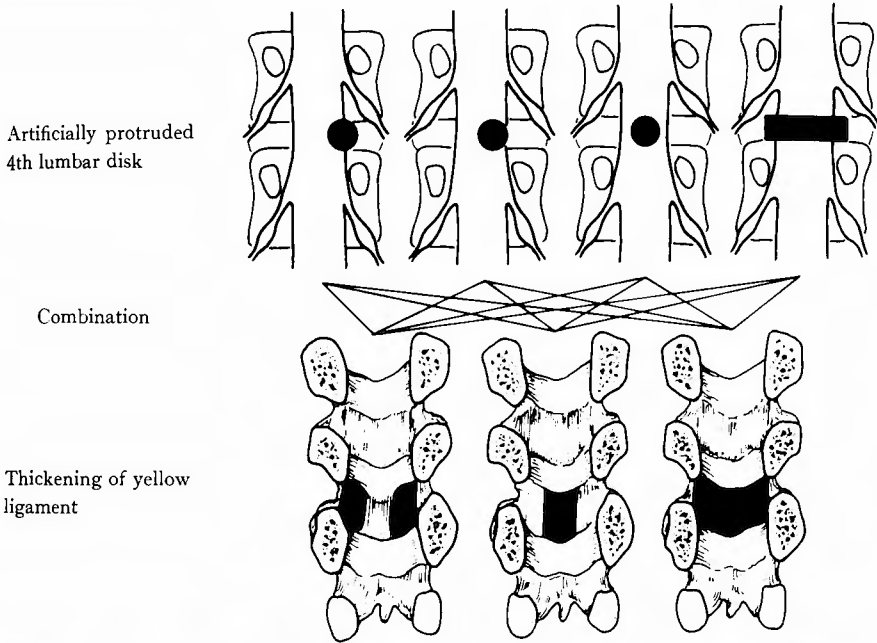
Generally, two measures are available to prevent the formation of post-laminectomy membrane. One is to fill out the dead space with other tissues such as fat or muscle. The other is to minimize this dead space. Our effort has been concentrated on the second one which led us to use our osteo-plastic partial laminectomy technique⁴⁾.

Under the term osteoplastic partial laminectomy, a bony mass which has been removed from around unilateral lamina is put back exactly in the same anatomical position as it was seated preoperatively. This bony mass transiently to be removed from unilateral laminar area en bloc using osteotome has to be put back later into the preoperative position. This procedure was first introduced by E. KONDO in 1949. Following him, M. MORI, his student revised his method in such a way that the size of the bony mass transiently to be removed is smaller than the size in KONDO's method. This is osteoplastic partial laminectomy in this paper. In this method less surgical intervention was introduced than in the original one in such a way that the unilateral apophyseal joint involving main parts of the continuing inferior articular process remains free from being completely dislocated.

The actual surgical technique of this procedure will be described in the later section of this article. Before that, experimental studies must be mentioned in relation with this surgical procedure.

Theoretical Consideration Using Experimental Research

In order to verify the rationality concerning this new surgical technique, behavior of the spinal canal space was investigated using the cadaver specimen of the elderly person. One of us, Y. MORI, in his experimental study⁵⁾, filled intracanal space of the cadaver lumbar spine with resin mould and detected that this moulded resin column showed the real shape and size of the spinal canal. In this moulded column, it was also demonstrated that segmental narrowing was more markedly demonstrated on the disk-yellow ligament level than on the body-lamina level.



Cadaver specimen prepared to examine myelography



Clays in 3mm thickness putting on both lig. flavum



2 mm protrusion of rubber disk

Fig. 1. Experimental myelography developing hourglass constriction

From this experiment, we came to recognize that a spinal canal is composed of integration of these two body-lamina and disk-flavum segments, as already shown in the literature⁶). Among these segments disk-flavum segment is more responsible for spinal canal constriction.

In addition to this experiment, first, centrally protruded lumbar disk herniation was simulated by introducing variously thickened rubber disk plates (Fig. 1) of circular shape of which the diameter is made equal with the height of the 4th lumbar disk. One of these plates was placed right

in front of the 4th disk. Second, a thickened yellow ligament was experimentally simulated by putting variously thickened layers of clay on entire lining of the normal yellow ligament. Then, experimental myelographies using Myodil were done. As the results of this, protrusion of rubber disk plate of 2 mm in height on the center of the 4th disk alone or one layer of clay of 3 mm in thickness put on the entire superficial lining of the normal yellow ligament alone did not show any remarkable filling defect in an oil column. However, if a rubber disk prominence in front of and a clay prominence in back of the canal were built up at the same level, a typical hourglass constriction appeared.

These results seem to explain the fact that disk-flavum segment is responsible for the development of spinal canal stenosis.

Surgical Technique

Now we have to explain our new surgical procedure in more technical detail. Irrespective of using any type of skin incision in the low back, the spinous processes and the laminae are widely exposed symmetrically and bilaterally. Then the yellow ligament is incised and resected by scalpel on both sides. Then a bony mass comprising:

1. distal 3 or 4 fifth of the unilateral one half of the spinous process, cut first in a sagittal and then in a transverse lines by osteotome,
2. distal more than one half of the unilateral laminal arch, and
3. the descending medial part of the inferior articular process is chiseled off en bloc from the posterior spinal structure as illustrated in Fig. 2. The final stage of this procedure just described above is as follows; a sagittal cut line is placed about 3 mm lateral to the medial edge of the articular facet. And then a medial part of the facet itself is chiseled off first from the overlying and then the underlying facets. Then considerable amount of bone along with deep layer of the yellow ligament attached to it is chiseled off from the superior margin of the unilateral lamina just one level below and also from the medial margin of the superior articular process extending from it. This final technique includes what we

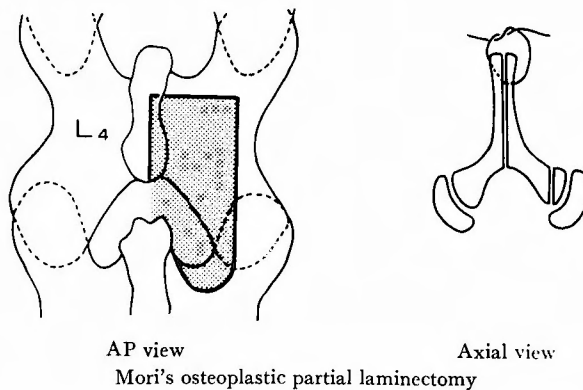


Fig. 2. Osteotomy line and replacement of the osteotomised lamina in situ

call undermining foraminotomy.

At this stage fenestration procedure for the unilateral interlaminar interspace has been completed to a much greater extent than that by interlaminar approach of LOVE. The result is to provide a surgeon with much wider surgical exposure than the conventional interlaminar approach. Using this wide surgical exposure one can remove marginal osteophyte or centrally prolapsed disk herniation without difficulty after hemostasis inside the canal has been completed and the spinal dura and the nerve root have been retracted toward the midline.

The entrapped nerve root has to be decompressed by use of undermining foraminotomy technique. The intervertebral foramen is not opened surgically. Following this a bony mass which has been removed en bloc is required to be replaced into the original anatomical position as it was seated before (Fig. 2).

To do this, two pieces of sagittally cut spinous process are united with each other to have the preoperative appearance by suturing two silk threads passing through drill holes opened in the spinous process. We must say for the surgical treatment of lumbar spinal canal stenosis that the osteoplastic partial laminectomy is available only on one side of the lamina. On the other side the conventional LOVE's interlaminar approach is enough.

The outline of the above explanation is summarized as follows:

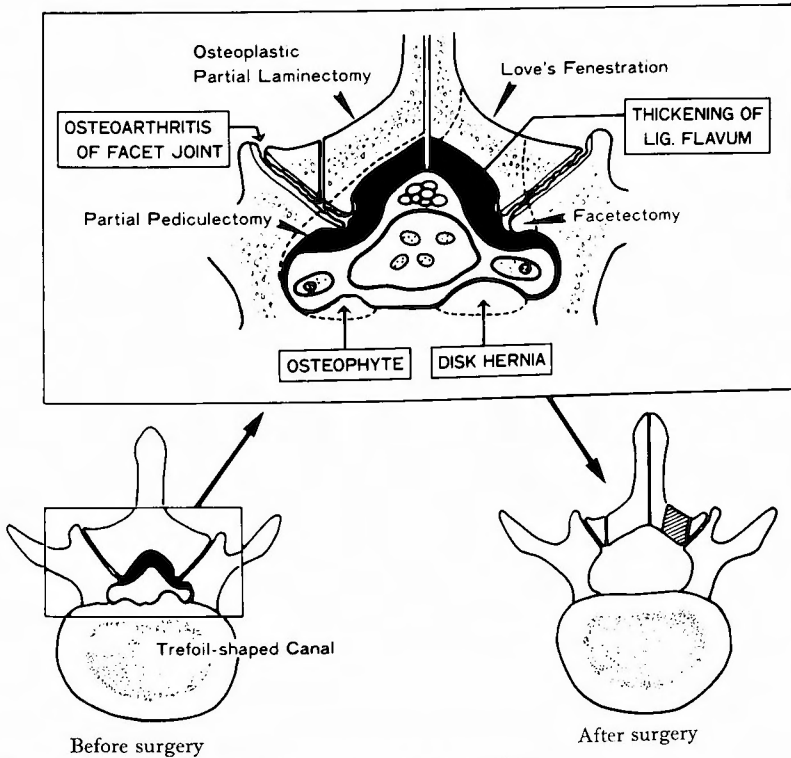


Fig. 3. Schematic drawing of our new surgical procedure. Note enlargement of the lumbar spinal canal before and after the operation without destroying posterior structure of the spine.

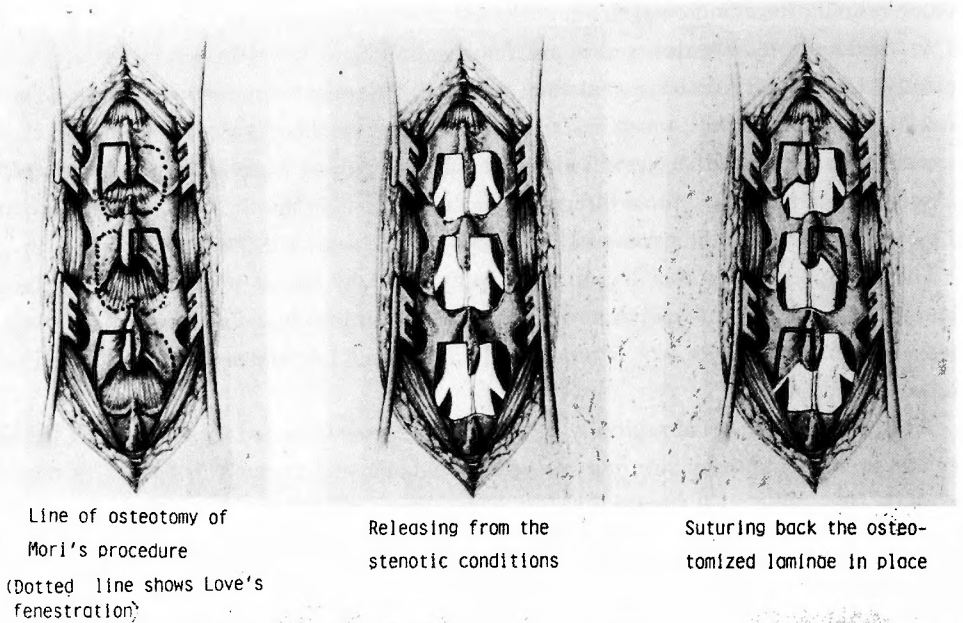


Fig. 4. Our new surgical procedure for degenerative and combined lumbar spinal canal stenosis

1. Complete removal of yellow ligament on both sides.
2. An osteoplastic partial laminectomy on one side of the lamina, then, LOVE's fenestration on the other side of the same lamina.
3. Facetectomy and then thin layer removal from the medial wall of bilateral pedicles.
4. Chiseling off marked osteophytes as well as excision of disk herniation if they exist in the spinal canal.
5. Trimming or flaking off undersurface of the lamina which is fenestrated on both sides, and chiseling off superior margin of the just neighboring lamina one level below and medial margin of the superior articular process continued with it, plus additional usage of undermining foraminotomy technique around the nerve roots on both sides (Fig. 3).

Among these 5 procedures, procedure 1 and 2 are most likely to contribute to the prevention of postlaminectomy membrane formation, and procedure 3, 4 and 5 are to contribute to widening effect of the narrow canal. These procedures often have to be extended to neighboring laminae, just above and below, and in doing so care must be taken to change the pattern after placement of two different kinds of interlaminar approach to one of which the position of placement is reversed as shown in Fig. 4. However, in special cases of lumbar spinal canal stenosis in which intermittent cauda equina claudication is only on unilateral side and myelographic findings show the need of spinal canal decompression on only unilateral side (Fig. 5), then the use of this surgical procedure is enough only on the unilateral side.

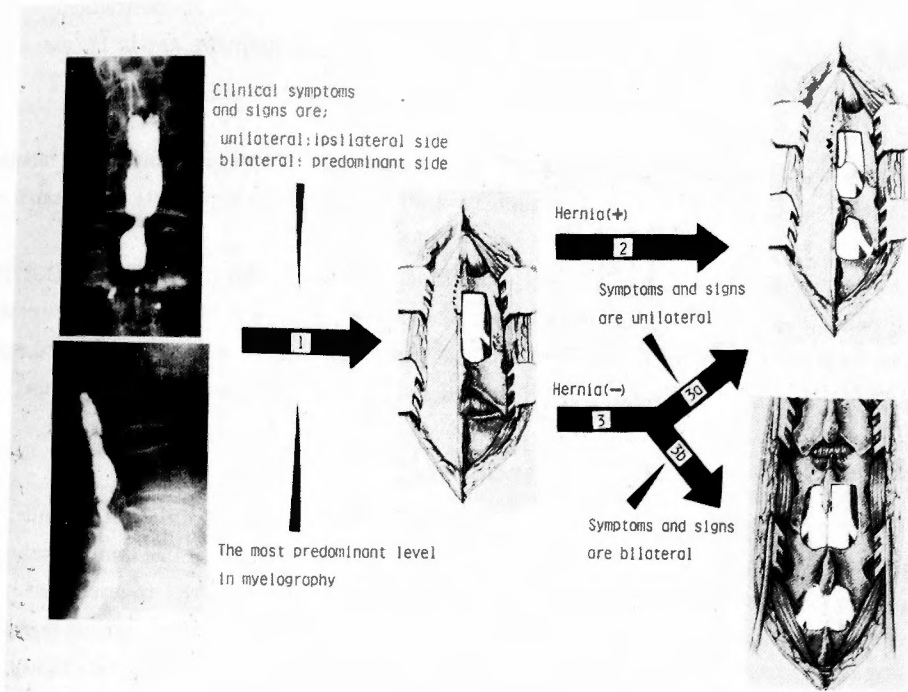


Fig. 5. Our surgical protocol for degenerative and combined lumbar spinal canal stenosis.

Postoperative Treatment

After sutures have been removed, the patient is allowed to walk freely with a short plaster jacket worn from the level of about 5 cm above the umbilical line to a midline between the anterior superior iliac spine and the pubic symphysis at about 10th or so postoperative day. This plaster jacket is continued for one month thereafter and then is replaced by a conventional soft body jacket. The patient is expected to return to his previous work about 3 months following surgery.

Surgical Series

(1) Clinical materials

The surgical series so far were with 13 cases in which our new surgical procedure was used.

Preoperative findings of these 13 cases included the following: Age distribution ranged from 35 to 68 years of age and in an average of 52 years. Sex distribution was 10 males and 3 females. Preoperatively all these cases complained of low back pain and disturbance in gait. Cauda equina claudication was positive in 8 patients. Positive but slight Lasègue phenomena were seen in 5 cases.

Positive neurological signs such as weakness, atrophy of lower extremities were present in 6 cases, while absence of Achilles tendon reflex were in all cases.

Simple X-ray examination showed marked spondylotic changes in all patients.

Myelographic findings revealed complete block and/or hour-glass constriction in all cases.

The fourth and the third lumbar disk levels were the most common sites of constriction.

At surgery, all patients had a marked thickening of the yellow ligament, and in 11 cases disk herniation was detected at least in one level.

(2) Surgical results

12 patients were followed up and examined after an average period of 5 years and 5 months following surgery. Cauda equina claudication preoperatively seen in 8 patients disappeared in 7 cases.

The overall results were evaluated by the criteria of WEINSTEIN, EHNI and WILSON (1977)⁹⁾. According to their criteria, full employment or retirement activity was obtained in 6 patients. Full employment but still troubled condition was in 4 patients. There was no deteriorated case. No instability or occurrence of spondylolisthesis was seen in any postoperative X-ray films.

Conclusion

We believe that this technique should be widely used for the treatment of the patient suffering from any type of spinal canal stenosis, particularly for preventing postlaminectomy membrane development. And this procedure seems especially recommendable for the treatment of both degenerative and combined lumbar spinal canal stenosis patients because of preserving posterior structure of the spine and of providing a wide surgical exposure for intervertebral disk space. This wide surgical exposure for the disk space in the low back enables a surgeon to remove marginal osteophyte or prolapsed large central disk herniation by using chisel or scalpel under direct vision on the anterior wall of the spinal canal without difficulty.

References

- 1) Epstein BS: Lumbar stenosis, spondylosis and spondyloarthritis. *In* The Spine, Lea & Febiger, Philadelphia, 1976, p. 398.
- 2) Kirkaldy-Willis WH, Paine KWE, et al: Lumbar spinal stenosis. *Clin Orthop* **99**: 30-50, 1974.
- 3) LaRocca H and Macnab I: The laminectomy membrane. Studies in its evolution, characteristics, effects and prophylaxis in dogs. *J Bone Joint Surg* **56-B**: 545-550, 1974.
- 4) Mori M and Ogawa R: Osteoplastic partial laminectomy for removing the lumbar disk herniation. *Arch Jap Chir* **35**: 873-878, 1966.
- 5) Mori Y: An experimental study on mechanism of developing what we call "Hour-glass shaped myelogram", with special reference to lumbar disk herniation, thickening of yellow ligament and degenerative spondylosis lumbar spinal canal stenosis. *J Kansai Med Univ* **33**: 174-201, 1981.
- 6) Schmorl G and Junghans H: Function of the axial organ spinal column. *In* The Human Spine in Health and Disease. 2nd Am. ed. Grune and Stratton Inc., New York, 1971, p. 35.
- 7) Verbiest H: A radicular syndrome from developmental narrowing of the bony lumbar vertebral canal. *J Bone Joint Surg* **36-B**: 230-237, 1954.
- 8) Wedge JII, Kirkaldy-Willis, et al: Lumbar spinal stenosis. *In* Disorders of the Lumbar Spine edited by Helfet AJ and Gruebel Lee DM: J.B. Lippincott Comp., Philadelphia, Tronto, 1978, p. 51.
- 9) Weinstein PR, Ehni G, et al: Clinical features of lumbar spondylosis and stenosis. *In* Lumbar Spondylosis. Diagnosis, Management and Surgical Treatment. Year book publishers Inc. Chicago, London, 1977, p. 115.

和文抄録

腰部脊柱管狭窄症特に変性性および混合型狭窄症に対する
骨形成的椎弓切除術による新術式

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1966年筆者の1人森（益）が発表した骨形成的部分的椎弓切除術は脊椎後方構築を破壊すること少なく、後方関節の一時的脱臼や永続的破壊を行うことなく神経根、硬膜の広い展開と、圧迫因子の解明、広い直視視野下での除去を可能にする方法である。この手術法は腰部椎間板ヘルニアに適応されてきたが、1974年頃より腰部脊柱管狭窄の病態が普及してからは、脊椎後方構築を椎弓と椎間関節まで広く切除し脊柱管を開放する通常術式に代り、これらを保存しうる手術法として適応を拡大した。これと並行して森（良）は、屍体脊柱管の鋳型標本を作製し、狭窄は椎間板—黄色靭帯の可動性部分に存することを認め、椎間板部の突出と、黄色靭帯の肥厚を実験的に作製して、両者の突出と肥厚が併存してはじめて臨床上観察される脊髓造影の砂時計狭窄像が再現しうることを明らかにした。これらの結果から本文に詳述した新しい手術法が確立されるに至った。すなわち骨形成的部分的椎弓切除術を

一側に行い、Love氏椎弓間開窓術を他側に施行し、椎間関節内側、椎弓根内面、椎間板突出、骨棘を除去し脊柱管の前方、側方、後方を拡大する。狭窄は通常多椎間にわたるので、上下の黄色靭帯—椎間板レベルに同じ術式で行うが、骨形成的椎弓切除を1椎間ごとに左右入れかえて行う。脊柱管の所定の開放が終れば、一時的に鑿除しておいた椎弓を原位置に還納同定する。後方構築は再建され死腔は少なく術後瘢痕の防止に役立つ。

13症例に本手術を施行した。内訳は35歳より68歳の男10例、女3例である。腰痛と歩行障害が共通した主訴であり、馬尾性間歇性跛行は8例に陽性であった。アキレス腱反射は全例に消失がみられた。うち12例、平均5.5年の手術成績は優：6、良：4、不変：2で悪化はなかった。以上から腰部脊柱管狭窄症に用いてよい手術法であり、特に変形性脊椎症によるものと混合型狭窄症により適応があると結論した。