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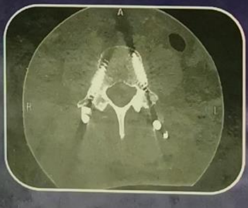

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CHAPTER

Lumbar Canal Stenosis Treated by Transforaminal Endoscopic Access

Satishchandra Gore

ABSTRACT

The endoscopic access in the treatment of lumbar canal stenosis has developed as a boon to the spine surgeons. It is the least invasive technique and helps in early mobilization and faster rehabilitation, especially in older population.This chapter deals with the technique of lumbar decompression using endoscopic access.

INDICATIONS AND CONTRAINDICATIONS FOR TRANSFORAMINAL ENDOSCOPIC INTERVENTION IN STENOSIS

The traditional candidate for surgery is a patient with severe bony or soft tissue compression of DRG or nerve root, severe leg symptoms, moderate or no neurological deficit and, except for patients with degenerative spondylolisthesis, with little or no back pain.[1] There may be a long history of low back pain but the leg symptoms lead to presentation. The symptoms are insidious, presenting in the sixth or seventh decade. The course of spinal stenosis is chronic and benign, but long-term is slow deterioration.

The patient with central canal stenosis has bilateral leg symptoms vague and often described as heaviness, soreness or weakness. The neurogenic claudication presents as numbness, weakness or discomfort in the legs; with walking or prolonged standing and is relieved by sitting or rest. The patients are able to walk further when leaning or walking uphill because spinal flexion increases the space available for the cauda equina and unfolds the ligamentum flavum. The pain-free walking distance is variable.

Patients with lateral recess stenosis present with unilateral radicular symptoms of leg pain along with numbness, paresthesia or burning that may be in a dermatomal distribution. Pain radiates from the buttock to the posterior thigh and lateral calf because most compression occurs at L4–L5. If there is a higher lumbar lesion then anterior thigh pain will be present. The symptoms may come by walking. Many times symptoms start on one side and then present on other. Cauda equina syndrome or major neurological deficits are very rare in the presence of canal stenosis.[2]

PATIENT SELECTION

Choosing a patient for intervention may be facilitated by using this questionnaire:[3] SSHQ

The 10 items on the SSHQ for diagnosis of lumbar spinal stenosis (LSS) require answers of either "yes" or "no". This contains some words patients use to describe when they have symptomatic lumbar spinal stenosis. This is given to patients with instructions "read the list, think of yourself. When you read a sentence that describes you, please circle "yes". If the sentence does not describe you, please circle "no". We always do a preoperative USG to estimate post void residual urine volume "indicative of existing neurogenic bladder", which is very helpful.

1. Numbness and/or pain in the thighs down to the calves and shins. Yes No
2. Numbness and/or pain increase in intensity after walking for a while, but are relieved by taking a rest. Yes No
3. Standing for a while brings on numbness and/or pain in the thighs down to the calves and shins. Yes No
4. Numbness and/or pain are reduced by bending forward. Yes No
5. Numbness is present in both legs. Yes No
6. Numbness is present in the soles of both feet. Yes No
7. Numbness arises around the buttocks. Yes No
8. Numbness is present, but pain is absent. Yes No

9. A burning sensation arises around the buttocks. Yes No

10. Walking nearly causes urination. Yes No

Harris and Macnab described the importance of disk degeneration in the pathogenesis of stenosis.[4] Macnab highlighted the lateral recess beneath the posterior facet joint.[5] Verbiest identified neurogenic claudication as a result of spinal canal stenosis.[6] Lumbar spinal stenosis is narrowing of the central spinal canal, lateral recess or the neural foramen. The term indicates a pathological condition causing compression of neural and vascular structures **(Figure 1)**.[7]

The lumbar spinal canal consists of a central part, two lateral parts and a posterior part corresponding to the interlaminar angle. The central spinal canal is rounded and occupied by the thecal sac. Stenosis of the central portion is almost always associated with stenosis of the lateral corners of the spinal canal reverse may not be true. The nerve-root canal is the semitubular structure through which the nerve root runs from the thecal sac to the intervertebral foramen. The proximal part of the canal, also called the sub-articular or intervertebral portion, is limited anteriorly by the intervertebral disk and posterolaterally by the superior articular process and the facet joint. The distal part of the canal corresponds to the lateral recess, i.e. the lateral corner of the vertebral foramen at the level of the pedicle. The entrance and exit of the intervertebral foramen lie at the medial and lateral borders of the pedicle. Bony hypertrophy of the inferior articular process may cause narrowing of the central portion of the spinal canal. The superior articular process contributes to the deformation of lateral portions of the nerve-root canal. Hypertrophy of the superior articular process produces narrowing of the intervertebral foramen but additional disk protrusion or any degree or region of herniation will also affect the nerves in the thecal sac and foramen.

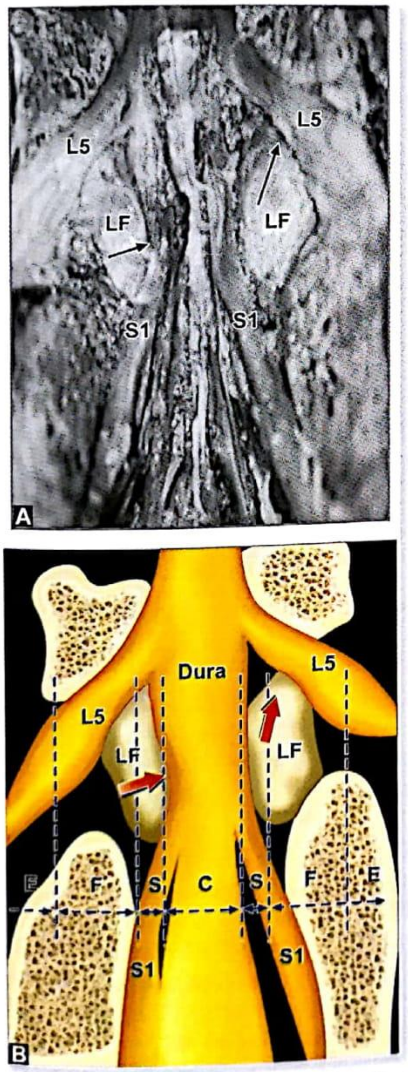


Figure 1: Coronal and sagittal view of stenotic canal for proper visualization of structures

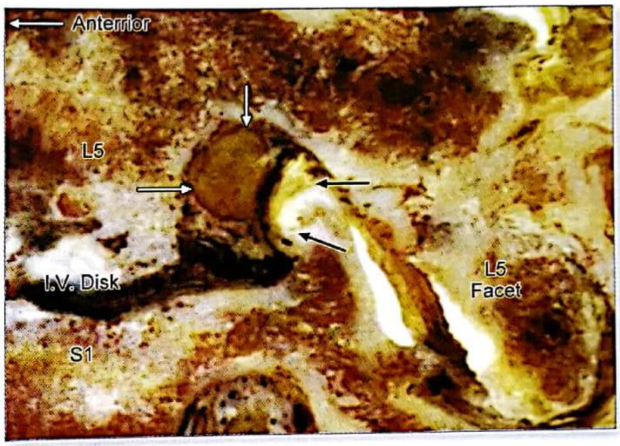


Figure 2: Shows SAP hitting nerve against pedicle or body of the vertebra

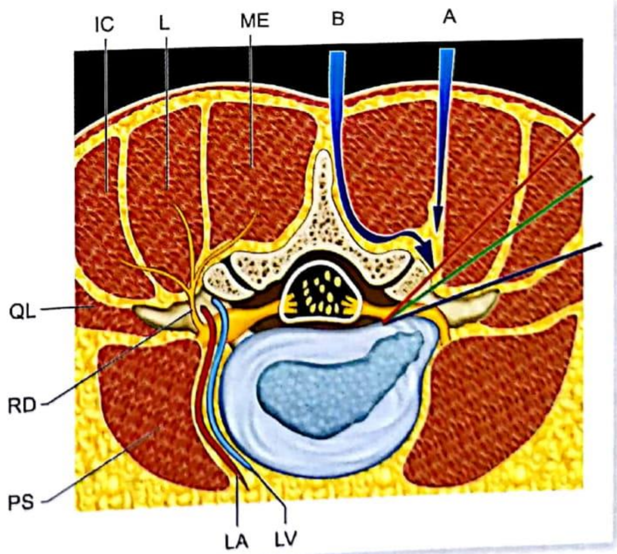
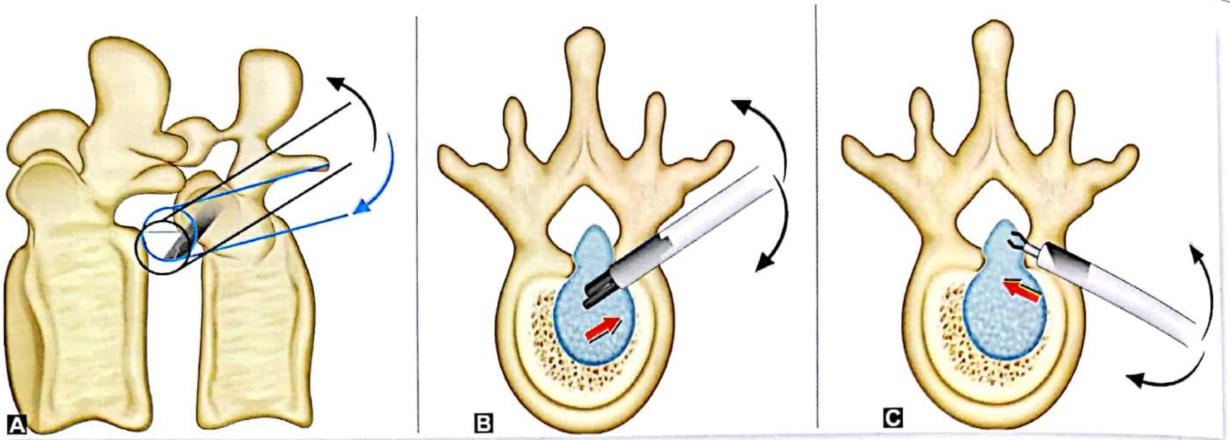
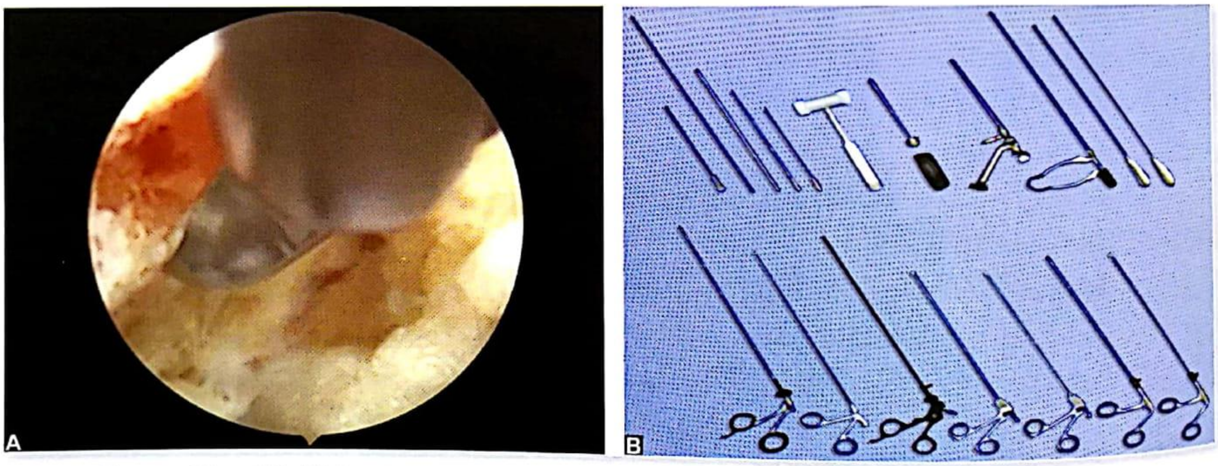


Figure 3: Changed trajectory used to access the subarticular zone or the body and under surface of the facet. Green is basic, red is for undercutting facet and blue is for flat access



Figures 4A to C: Schematic diagrams indicate our access and maneuvers to get the decompression in stenotic canal. The newest technique is to target superior facet and walk the needle down the ventral bony facet, hugging the facet to avoid the exiting nerve and using the facet as a lever arm to perform foraminoplasty and/ or the use the facet as a fulcrum to change trajectories of endoscopic cannulas and instruments

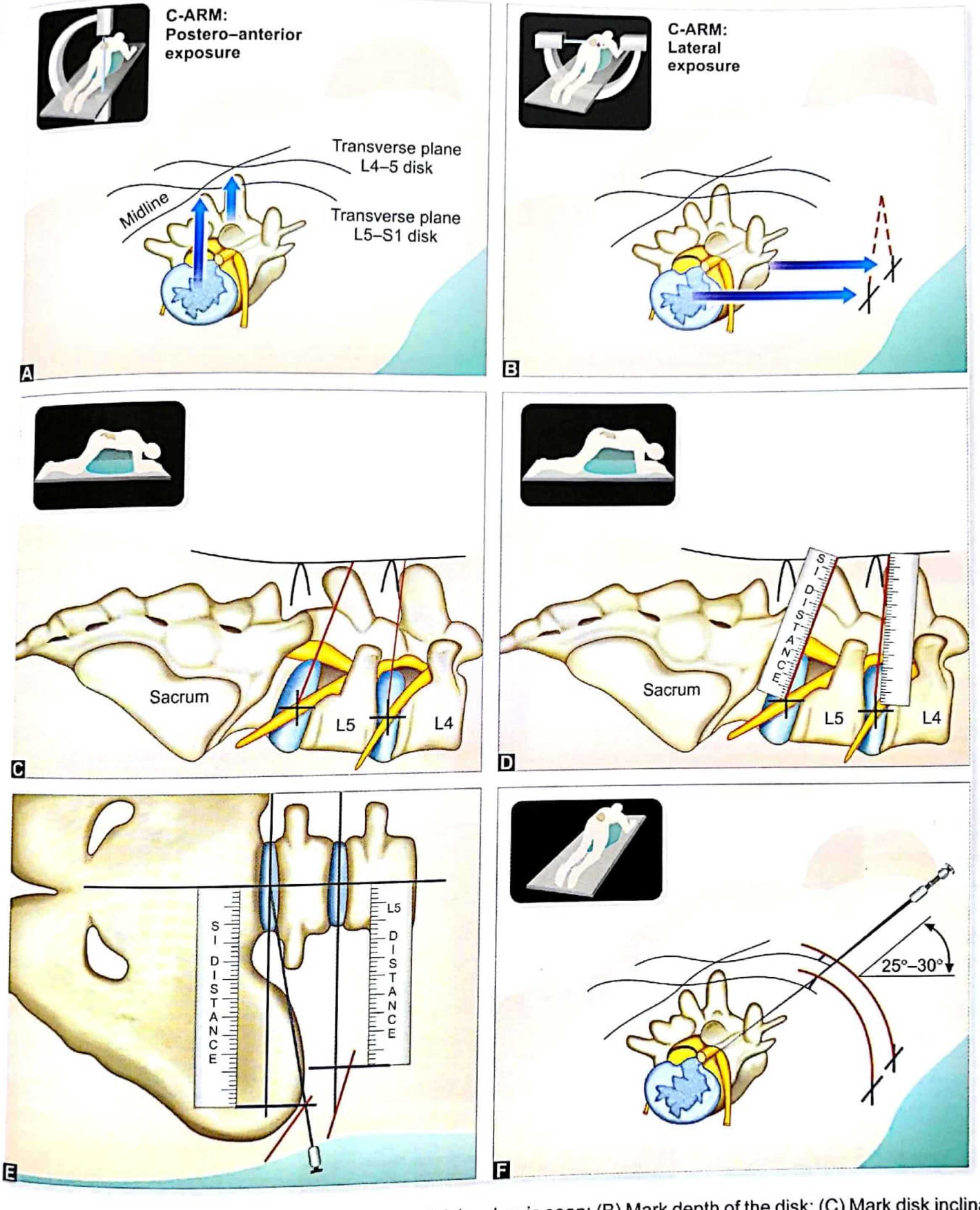


Figures 5A and B: (A) Curette working on SAP under vision, (B) Total GORE SYSTEM ® instruments set

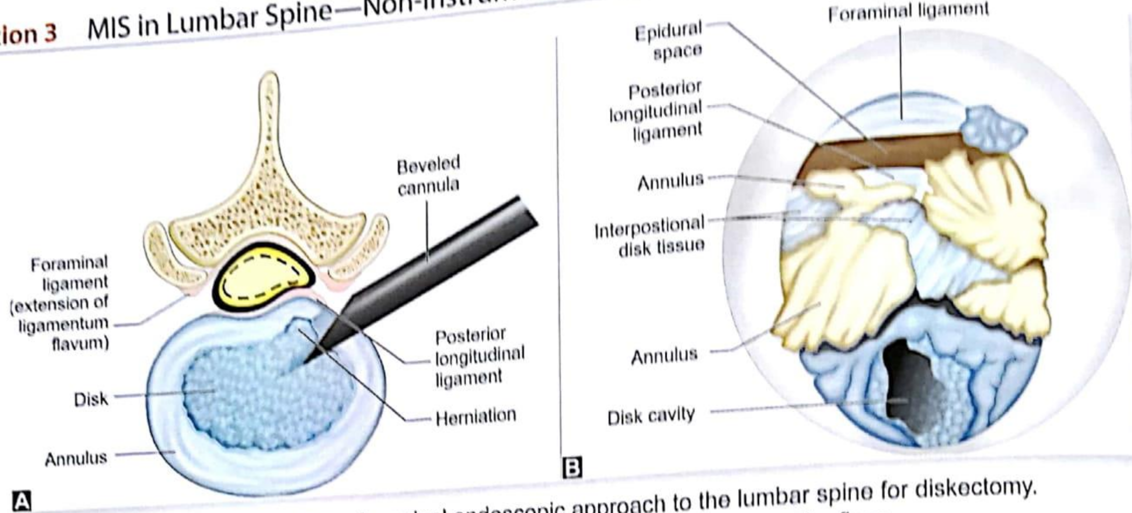
Lee and Rauschning have described how progressive degenerative processes affect the dorsal root ganglion, the mini brain of the nerve, and how it is affected by the disk, facet, synovium of the facet, and osteophytes in the foramen.

The anatomical description of the spinal nerve root pathway, however, is not yet clinically definitive because surgeons do not see the intricacies of the microanatomy during traditional open or even microscopically guided decompression. Burton[8] divided the nerve-root canal into three portions separated by the pedicle in the cross-sectional plane, namely central, foraminal, and extraforaminal. This classification allows easy imaging diagnosis. Lee et al.[9] classified the lateral lumbar spinal canal into three zones: entrance, mild, and exit. This defined the anatomical boundaries of these zones and served as the basis for techniques of surgical decompression when clinically required.

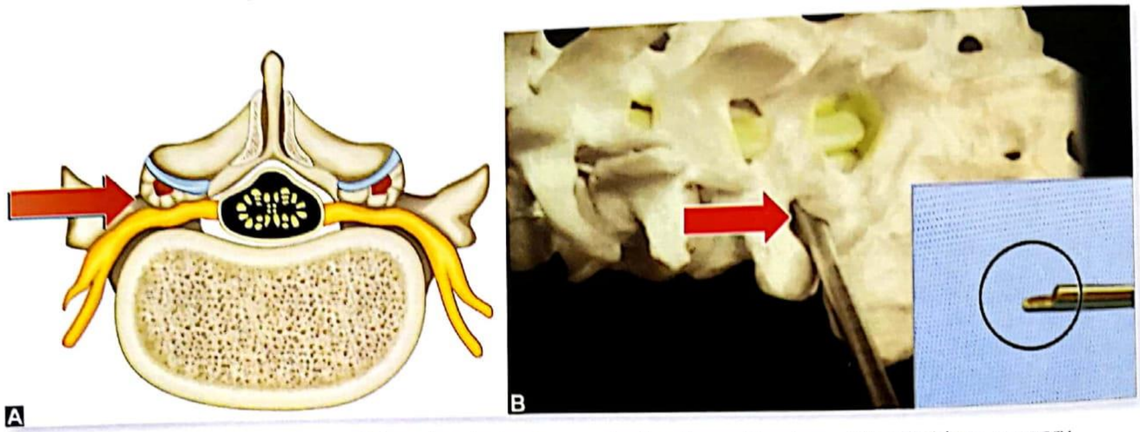
Lumbar spinal foraminal stenosis is an important pathologic entity to recognize in patients with radicular symptoms. On MR imaging Wildermuth, et al.[10] introduced a partially quantitative classification system for grading lumbar spinal foraminal stenosis. They focused on the degree of epidural fat obliteration but did not consider direct nerve-root compression or deformity. Recently, Lee et al.[11] reported a new grading system for lumbar spinal foraminal stenosis. They considered the type of stenosis, the amount of fat obliteration, and the presence of nerve root compression. Yeung and Gore described the pathoanatomy of stenosis as seen from the foramen endoscopically. The absence of fat, vascular pulsation, scarred and fibrotic nerve roots and the axilla between the traversing and exiting nerves with hypertrophied soft tissue on its roof served as a "hidden zone" for unrecognized symptomatic stenosis (**Figure 10**).[12]



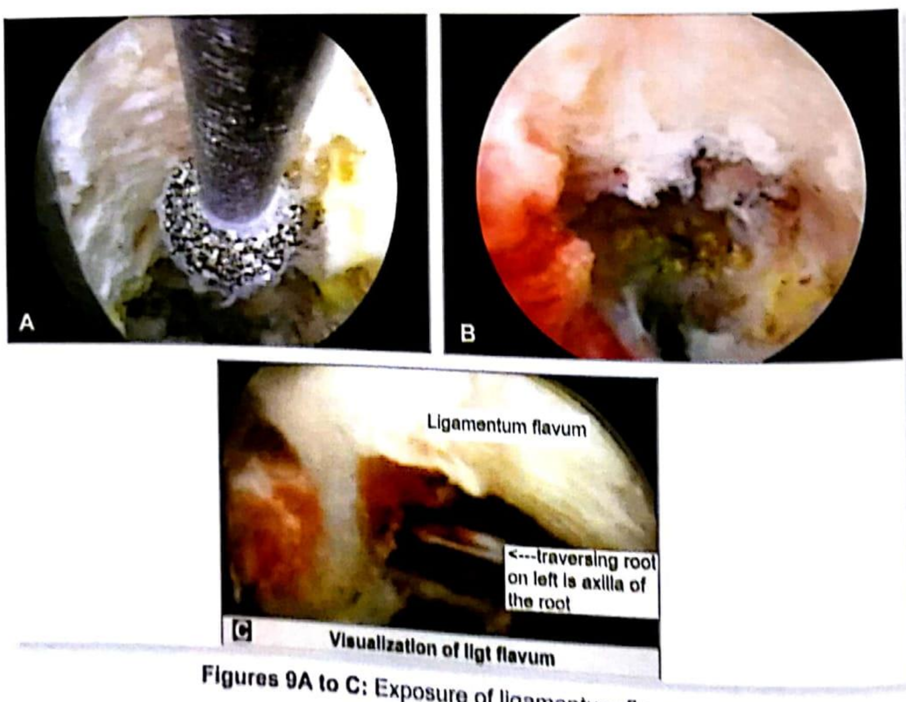
Figures 6A to F: (A) Drawing lines to detect midline and disk level as is seen; (B) Mark depth of the disk; (C) Mark disk inclination and plan for entry; (D) Measuring depth and inclination. For injections we measure up to center of disk typically it is 8 cm. Inclination is always towards the head due to lumbar lordosis; (E) Taking same distance from midline above the original disk line makes us identify point of entry of the needle; (F) Entry was initially at an angle of 25° subfacetal in the foramen thru paraspinal muscles. As techniques evolved, we started more lateral as much as 11 cm away from midline and at 20° but never at 0° because the peritoneal space and internal organs was at risk



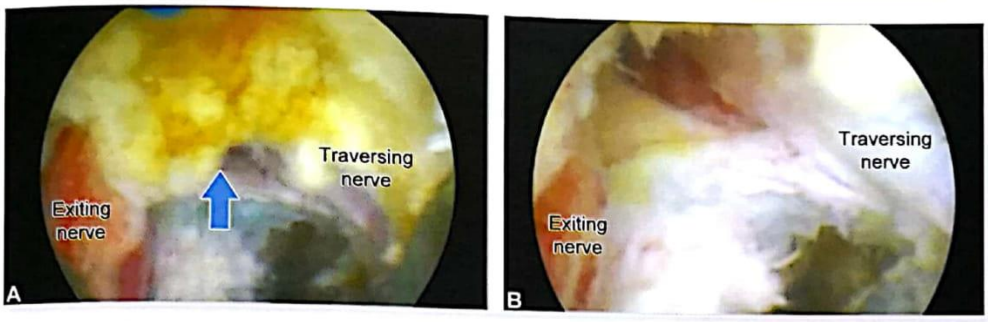
Figures 7A and B: Transforaminal endoscopic approach to the lumbar spine for diskectomy. We work more on the roof in cases of stenosis than on the floor



Figures 8A and B: Concept of foraminoplasty done under local anesthesia and is stitchless surgery



Figures 9A to C: Exposure of ligamentum flavum



Figures 10A and B: (A) Superior foraminal ligament may tether nerve, when posible, resect; (B) Decompressed axilla confirmed

Stenosis or narrowing of the foramen can be in vertical plane due to disk degeneration and collapse. In that case we primarily look at cutting tip of the SAP. In case of narrowing in AP plane we undercut the facet. The facet at times is seen to be touching the annulus in AP plane. It is more like a curtain between foramen and contents of central canal and touches the annulus at the subarticular zone and lateral to traversing nerve. Stenosis also may be a part of residual untreated cause of pain in failed surgery **(Figures 2 to 9)**.

Stenosis usually also affects the exiting nerve. It is possible and important to avoid the exiting nerve in such a case if the stenosis is only affecting the medial and subarticular aspect of the canal and the disk protrusion, simple decompression is enough by simply making more room in the foramen. In cases, e.g. at L5–S1 with a horizontal disk trajectory and entry to disk is not below facet like normal but below isthmus and may be closer to the tip of SAP. Cutting the lateral facet will allow the excision of the medial capsule and ligamentum flavum that acts like a protective curtain between the dural sac and the foramen. This also forms the basis of "outside in" technique. Accessing the dorsal aspect of the canal is possible after cutting the facet's ventral undersurface. The enlarged portion of the foramen easily accommodates the cannula away from the DRG and nerve root.

In a hard and extreme stenosis, it is not only the size but consistency of the tissue. The annulus if too hard,collagenized or even ossified tools like simple graspers which are 3.5 mm, etc. are not very helpful and may break. Trephines, Kerrisons, burrs and specialized cutting instruments or laser are used to alter the stenotic foraminal zone.

Where we contemplate on jacking up the disk, we use fusion by OLIF and use expandable reamers in the disk. Percutaneous insertion of screws and use of cage is done under local anesthesia. In OLIF, since we are inserting the cage through foramen only a partial undercutting of facet may be adequate. There is no need for total facetectomy. This may eventually lead to stand alone intradiscal stabilization with improved intradiscal devices without traditional posterior instrumentation.

COMPLICATIONS

Exiting nerve root can be injured. To prevent it, a better image analysis may be considered. Study by Choi et al.[13] recommends measuring the distance from the exiting root to the facet [SAP] at the lower disk level according to a preoperative MRI scan. If the distance is narrow, an alternative surgical method may be considered. Shortest distance between facet and root at upper endplate level and lower endplate level is measured. If the distance is narrow alternatives may be considered **(Figure 11)**.

In endoscopic surgery through the foraminal approach, however, if a needle can be placed in the axilla between the exiting and traversing nerve and the patient receives good relief from the epidural, it is likely that a blunt obturator can be placed down the path of the needle and the exiting nerve simply gets retracted by the obturator, using the obturator to dilate the disk space enough to get a trephine or burr into the disk and foramen to enlarge the foramen in this very collapsed disk to get relief of stenotic symptoms.

POSTOPERATIVE CARE

Rehabilitation Program after Surgery

In a randomized controlled trial, the addition of a structured rehabilitation program (stabilization exercises, 30 minutes twice a week for 12 weeks) started 2 months after decompressive surgery was not found to be superior to the simple recommendation to "stay active". Best advice given to patient is to stay active once the pain subsides.[14]

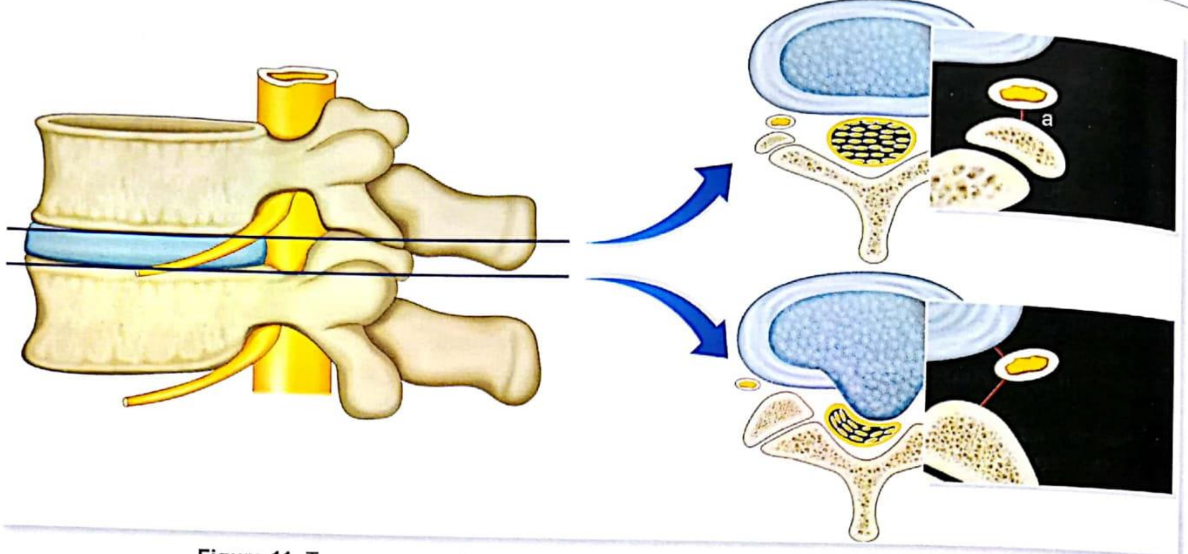


Figure 11: Transverse section highlighting distance between exiting root and facet at upper and lower endplate levels

OUTCOME

The review of the literature by Niggemeyer et al. shows that the least invasive surgical procedure can obtain the best results if the correct diagnosis is made and if the operation is carried out within the first years of the disease.[15]

The possible advantages of transforaminal endoscopic surgery are described in many articles. The procedure can be performed in an outpatient or day-surgery setting. Because of the small incision and minimal internal tissue damage, the rehabilitation period is shorter and scar tissue less. The procedure can be performed in awake patients under local anesthesia and conscious sedation, thereby avoiding the risk of general anesthesia, especially for elderly patients with comorbidities individuals. Transforaminal endoscopic surgery has a steep learning curve for some, but this translates into a long and shallow learning curve after the principles of foraminal decompression is mastered. That requires patience and experience, especially for those unfamiliar with percutaneous techniques.[15]

The literature seems to suggest that after transforaminal endoscopic surgery 69–83% of the patients experience a satisfactory outcome.[16] In our hands, the success rate is at least 85% with less than 1% permanent complication sequel. The success rate is guided by the patients' response to diagnostic and therapeutic injections performed by the surgeon and a SSHQ.

A comprehensive systematic literature review up to November 2009 to assess the effectiveness of transforaminal endoscopic surgery in patients with symptomatic lumbar stenosis was made. Two reviewers independently checked all retrieved titles and abstracts and relevant full text articles for inclusion criteria. Included articles were assessed for quality, and relevant data, including outcomes. The outcomes were extracted by two reviewers independently. No randomized controlled trials were identified in these seven observational studies. The studies were of poor methodological quality and heterogeneous regarding patient selection, indications, operation techniques, follow-up period and outcome measures. Overall, 69–83% reported the outcome as satisfactory and a complication rate of 0–8.3%. The reported reoperation rate varied from 0 to 20%. At present, there is no valid evidence from randomized controlled trials on the effectiveness of transforaminal endoscopic surgery for lumbar stenosis.[16] Randomized controlled trials comparing transforaminal endoscopic surgery with other surgical techniques are desired and needed, but in our Level 5 expert opinion and experience, the surgeon factor giving weight to surgeon experience and technical expertise, high levels results are attainable.

TIPS

1. It is possible to treat patients with severe medical comorbidities as transforaminal endoscopy can be done under local anesthesia.[17]
2. The role for shared decision making: Because patients with LSS may have potentially unrealistic expectations about the risks and benefits of surgery, it is recommended that decisions regarding surgery for LSS should be

based on a shared decision making approach. In terms of what matters most to the patient, e.g. pain relief, improved function, avoiding risk, etc. For patients with LSS, key knowledge would include the moderate benefit associated with surgery that may diminish over time, the likelihood of improvement with or without surgery, potential risk and costs.[18,19]

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