Surgical treatment for lumbar lateral recess stenosis with the full-endoscopic interlaminar approach versus conventional microsurgical technique: a prospective, randomized, controlled study

Clinical article

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Object. Extensive decompression with laminectomy where appropriate is often still described as the method of choice in surgery for lateral recess stenosis. Nonetheless, tissue-sparing procedures are becoming more common. Endoscopic techniques have become the standard in many areas because of the advantages they offer in surgical technique and in rehabilitation. Transforminal and interlaminar access provide 2 full-endoscopic (FE) techniques for lumbar spine surgery. The goal of this prospective randomized controlled study was to compare the surgical results for the FE technique via the interlaminar approach with those of the conventional microsurgical technique in patients with degenerative lateral recess stenosis.

Methods. A total of 161 patients with FE or microsurgical decompression underwent follow-up for 2 years. In addition to general and specific parameters, the following measuring instruments were used: visual analog scale, German version of the North American Spine Society instrument, and the Oswestry low-back pain disability questionnaire.

Results. The results show that 74.5% of patients reported no longer having leg pain, and 20.5% had only occasional pain. The clinical results were the same in both groups. The rate of complications and revisions was significantly reduced in the FE group. The FE techniques brought advantages in the following areas: operation, complications, traumatization, and rehabilitation.

Conclusions. The clinical results of the FE interlaminar technique are equal to those of the microsurgical technique. At the same time, there are advantages in the operation technique, such as reduced traumatization. The FE interlaminar spinal decompression procedure is a sufficient and safe supplement and alternative to microsurgical procedures. (DOI: 10.3171/2008.7.17634)

Key words • endoscopic spinal decompression • lateral recess stenosis • minimally invasive spine surgery • neurogenic claudication • spinal stenosis

Degenerative lumbar lateral recess stenosis is caused by osseous, discal, capsular, or ligamentous structures. The compression may lead to the classic clinical symptoms of neurogenic claudication with radicular signs, that is, leg pains, possibly with neurological deficits. Back pains are more likely attributable to the degenerative secondary phenomena, such as segmental instabilities. There are various hypotheses to explain the onset of pain associated with lateral recess stenosis, and they include mechanical neural, vascular, and inflammatory as well as biomechanical components. There is no unequivocal correlation between the extent of stenosis observed in imaging procedures and the clinical symptoms.

Therapeutically, conservative measures are the treatment of choice. Surgical intervention can be considered in cases of decompression or intolerable persistence. In this respect, decompression, fusion, or a combination of the 2 procedures should be considered due to the possible leg and back symptoms. Numerous surgical procedures have been described, some of which are still controversial. Overall over the past years, there appears to be a trend away from more aggressive (laminectomy) to more selective (undercutting...
decompression) techniques. The tendency at present in patients with predominantly leg symptoms who have no signs of segmental instability and who have been treated with stability-preserving decompression techniques is to dispense with fusion, whereby there is no clear-cut definition of the criteria "segmental instability" and "stability-preserving techniques." These days it appears certain that decompression can improve neurogenic claudication and neurological deficits. The required extent of decompression and the circumstances in which additional fusion is necessary remain unclear.

One consequence of conventional surgery is scarring of the epidural space, which may become clinically symptomatic in 10% or more of cases and makes revision surgery more difficult. An analysis of study results in patients who underwent decompression revealed the occurrence of surgery-induced destabilization due to the necessary resection of spinal canal structures. The point of access influences the stabilization and coordination system in the innervation area of the dorsal roots of the spinal nerves. The use of microsurgical techniques has reduced tissue damage and its consequences. Although conditions of postoperative pain are treatable, continuous technical optimization should be attempted. The goal of a new procedure must be to achieve results commensurate with current results while minimizing traumatization and its negative long-term consequences.

In spine surgery, open interlaminar access has been described since the early 20th century. Percutaneous operations have been performed since the early 1970s. In the late 1970s, a surgical procedure involving a microscope was developed to gain interlaminar access. The FE transforaminal operation with posterolateral access has been used since the 1990s. Endoscope-assisted interlaminar procedures were reported in the literature in the late 1990s. The lateral access in FE transforaminal surgery to optimize the route to the spinal canal has been performed since the late 1990s. However, the osseous perimeter of the foramen and the exiting nerve can limit the working mobility. Moreover, the pelvis and the abdominal structures may block access. Thus, there can be limitations to the transforaminal procedure. The development of the FE interlaminar access occurred at the same time, and it enables the extirpation of pathological entities that cannot be successfully removed using the transforaminal technique.

The goal of this prospective randomized controlled study was to compare the surgical results for the FE technique via the interlaminar approach with results of the conventional microsurgical technique in patients with degenerative lateral recess stenosis.

Methods

Patient Characteristics

In this prospective randomized controlled study, we enrolled 192 patients with clinically symptomatic degenerative lateral recess stenosis who underwent surgical decompression between 2003 and 2005. There were 88 female and 104 male patients whose ages ranged from 38 to 86 years (mean 64 years). The duration of symptoms ranged from 2 to 78 months (mean 19 months). One hundred eighty-two patients had received a mean of 6 months of conservative treatment. The amount of time the patients were able to walk averaged < 15 minutes. Eleven patients had previously undergone surgery in another segment. The indication for surgery was defined according to present-day standards based on radicular pain symptoms or neurogenic claudication and existing neurological deficits.

Study Groups

One hundred patients underwent conventional MI, and 92 underwent FE interlaminar decompression. Randomization was not blinded, because the patients are able to identify the surgical procedure. After determination of the general indication for surgical decompression by experienced physicians who were not involved in the operation, randomized assignment was made by nonphysician study staff. This was accomplished using a balanced block randomization to the end of the study, which means that the number of each surgical procedure performed was a given, but the assignment of the patient was random. All operations were performed by 2 surgeons who have many years of experience in both techniques. The results in the study group (FE group) were compared with those in the control intervention group (MI group). The patients were informed preoperatively about the procedure that was to be used for them. The later examiners were not informed about which operative procedure was applied.

Forty-three interventions were performed at the L5–S1 level (14 patients underwent MI and in 29 the FE technique was used); 131 at L4–5 (76 treated with MI, 55 with FE); 14 at L3–4 (9 with MI, 5 with FE); and 4 at L2–3 (1 with MI, 3 with FE).

In addition to FE interlaminar access, FE transfomedinal access is also available for operations on the lumbar spine. This has defined inclusion criteria with respect to the access and mobility. Unlike lumbar disc herniation, lumbar recess stenosis only fulfills these criteria in individual cases, so that the FE transfomedinal access was not included in the study.

Inclusion Criteria

The following clinical inclusion criteria applied: neurogenic claudication with unilateral leg pain with or without paresis; back pain with maximum score of 20 of 100 points on the VAS; and conservative therapy exhausted or no longer indicated due to the symptoms. The imaging inclusion criteria were as follows: monosegmental recess stenosis; no foraminal stenosis in the lower level; no disc herniation; degenerative spondylolisthesis with maximum Meyerding Grade I; no multidirectional rotation slide; scoliosis, maximum curvature 20°; and no prior surgery in the same segment. In summary, an attempt was made to define inclusion criteria that do not represent a clear indication for additional fusion, taking also clinical symptoms into account.
Operative Technique

The conventional microsurgical operations were performed via paramedian interlaminar access. The skin incision was 3 cm long. Retraction of the soft tissue was made using modified Caspar retractors for microscope-assisted operations. After applying the retractor, the rest of the procedure was microscope-assisted in the known standardized undercutting technique. Decompression was accomplished (depending on the pathological features) by cranial and caudal laminotomy, partial facetectomy, and ligamentum flavum resection.

The FE interlaminar operation was performed using the technique described earlier. A dilator is inserted bluntly to the lateral edge of the interlaminar window and an operating sheath with a beveled opening is directed toward the ligamentum flavum. Thereafter, the procedure is performed under visual control and constant irrigation. The medial edge of the ascending facet is prepared depending on the anatomy and pathological features. At this point, the decompression itself begins by means of resection of bones and flavum segments by using burrs and punches (Figs. 1 and 2).

The operation was performed in all groups after induction of general anesthesia. Drainage was applied only in the MI group. There was no opening of the annulus for performance of intradiscal nucleotomy.

Instruments Used for the FE Procedure

The rod-lens optics have an outer diameter of 6.9 mm. The optics contain an intraendoscopic, eccentric working canal with a diameter of 4.1 mm. The angle of vision is 25°. The working sheaths used have an outer diameter of 7.9 mm and a beveled opening, which enable creation of visual and working fields in an area without a clear anatomically preformed cavity. All of the operating instruments and optics were products supplied by Richard Wolf GmbH.

Follow-Up Protocol

Follow-up examinations were conducted at Day 1 (192 patients) and at Months 3 (184 patients), 6 (179 patients), 12 (171 patients), and 24 (161 patients) after surgery. All patients received the appropriate questionnaire by mail 4 working days before their procedure. They came to the clinic for follow-up examinations. The examinations were performed by 2 doctors in the clinic who were not involved in the operations. In addition to general parameters, other information was obtained using the following instruments: a VAS for back and leg pain, the German version of the NASS instrument, and the Oswestry low-back pain disability questionnaire (yielding the ODI score).

Statistical Analysis

The Wilcoxon rank-sum test and the Mann-Whitney U-test were applied for the comparison of pre- and postoperative global results and comparison of results in the MI versus the FE group at various times. The McNemar test was used to compare the characteristics of the groups.

The descriptive assessments and analytical statistics were performed depending on the group characteristics with the software program package SPSS. A positive significance level was assumed at a probability level < 0.05.

Results

Baseline Characteristics

After 2 years, 161 patients (83.9%) were included in follow-up assessments (80 had undergone MI, and 81 had been treated with the FE technique). The remaining 31 cases were lost for the following reasons: 2 deaths unrelated to the operation (13 and 18 months postoperatively); 2 patients moved away and left no forwarding address; 22 patients did not respond to letters or telephone calls; and 5 patients required revision surgery with conventional microsurgical decompression due to persistent leg pain. Due to progrediant back pain, 3 of these patients additionally underwent fusion. All revision operations were performed during the follow-up observation period; the earliest was done after 8 months of observation. For this reason, the patients who underwent revision surgery were only included in descriptive statistics and not in the analysis. The patient population was equal in the MI and FE groups. Overall, there were no differences in results between the individual surgeons.

Operative Technique

The mean operating time in the FE group was 34 minutes (range 28–57 minutes), and it was significantly shorter (p < 0.05) than in the MI group, at 48 minutes (range 32–79 minutes). The mean intra- and postoperative blood loss was 67 ml (range 15–275 ml) in the MI group; there was no measurable blood loss in the FE group. However, blood loss in the FE group cannot be precisely measured due to continuous lavage. No drainage was required in the FE group, and the patients in this group were mobilized immediately postoperatively, depending on the effects of the anesthesia.
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Fig. 2. Drawing showing how bone decompression is accomplished using a 4-mm bur.

Perioperative Complications and Revisions

Dura mater injuries occurred 3 times (2 in the MI and 1 in the FE group); there were no injuries to nerves, and no cauda equina syndrome. Ten patients developed a transient postoperative dysesthesia (7 in the MI and 3 in the FE group), and 3 patients experienced transient urinary retention (2 in the MI and 1 in the FE group). In the MI group, 1 patient developed an epidural hematoma requiring revision, 2 had delayed wound healing, and 2 had a soft-tissue infection. There were no other complications (such as spondylodiscitis or thrombosis). Apart from transient dysesthesia and transient urinary retention, the complication rate was 5% (8.8% in the MI and 1.2% in the FE group), and was significantly higher in the MI group ($p < 0.05$).

Five patients required revision surgery with conventional microsurgical decompression due to persistent leg pain (2 in the MI and 3 in the FE group). Due to progradient back pain, 3 of these patients additionally underwent fusion. All revision operations were performed during the follow-up observation period, the earliest after 8 months of observation.

Clinical Outcome

Figures 3 and 4 show VAS pain scores, ODI scores, and NASS scores. There was constant and significant ($p < 0.001$) improvement in leg pain and daily activities in all groups. After 2 years, 120 patients (74.5%) no longer had leg pain (58 in the MI group [73%] and 62 in the FE group [76.5%]); 33 (20.5%) had pain occasionally or the pain was greatly reduced (16 in the MI group [20%] and 17 in the FE group [21%]); and 8 (5%) experienced no essential improvement (6 in the MI group [7%] and 2 in the FE group [2.5%]) (Fig. 5). Walking time improved from an average of < 15 minutes to > 45 minutes. In general, there was slight deterioration during the follow-up period between the 1st and 2nd years, but it was not significant. The differences in results between the groups were not significant. Seven patients suffered progradient back pain (6 in the MI and 1 in the FE group; $p < 0.01$).

Overall, 5 patients (3.1%; 2 in the MI and 3 in the FE group) underwent revision with decompression (2 patients) and with additional fusion (4 patients, including 3 with progradient back pain, as mentioned above). Neurological deficits were significantly reduced ($p < 0.001$) when the patient's history of weakness was < 4 weeks. Overall, the clinical results were significantly better ($p < 0.01$) if the general anamnesis time was < 1 year.

One hundred forty-four patients (89%) reported subjective satisfaction and would undergo the operation again (69 in the MI group [86%] and 75 in the FE group [92%]). Overall, 15 patients had a poor result in terms of no reduction in leg pain (9 patients) or had to undergo conventional revision surgery later for persistent pain (6 patients).

FIG. 3. Bar graphs showing the mean VAS leg and back and ODI scores in the MI group (upper) and in the FE group (lower). Numbers on the y axes designate the VAS and ODI scores in both panels, and the numbers above individual bars denote the number of patients in each category.
Postoperative pain was determined over 5 days by using the VAS (Fig. 6). Postoperative pain medication use was defined by need. Opioids WHO Class III were available for the 1st postoperative day, and metamizol and ibuprofen or paracetamol were available starting on the 2nd postoperative day. Postoperative pain and use of pain medication were significantly reduced in the FE group (p < 0.01). The maximum time in hospital was 6 days in the MI group and 3 days in the FE group.

Figure 7 shows pre- and postoperative CT scans obtained after FE interlaminar decompression.

**Discussion**

Conventional decompression of degenerative lumbar lateral recess stenosis with laminectomy or extensive resection has been and still is frequently described as the technique of choice. Scarring of the epidural space can be problematic, and may become clinically symptomatic, and may lead to “tethering” of the cauda equina due to the postoperative connection between the epidural space and paravertebral musculature. The resection of stability-preserving structures may promote surgically induced segmental instability. The resection of joint and soft-tissue structures in the lateral and ventral area is also especially required for decompression of degenerative lateral recess stenosis. This is made possible with more tissue-sparing techniques, which are finding increasing use, and are also used in other indications. Technical advances have been made in surgery for disc herniations in the cervical and lumbar spine, which these days enable an FE procedure under continuous irrigation in nearly all cases and can provide the advantages of a truly minimally invasive procedure.

The development of new surgical accesses and optics with a 4.1-mm intracapsular working canal and corresponding instruments and burrs has expanded the indication spectrum for FE operations on the lumbar spine. One essential point was the possibility of sufficient bone resection under continuous visual control. This also enabled use of this technique in surgery for spinal canal stenoses. The lateral transfemoral access optimizes the route to the spinal canal. Nevertheless, there are still limitations in performing transfemoral procedures, even with a lateral approach. For this reason, the indications, as previously described, could be helpful. Due to the anatomy and pathological features, only a very few recess stenoses fulfill the inclusion criteria for a transfemoral procedure, so that, although this access is generally less traumatic and would thus be the first choice, it remains reserved for individual cases. Kambin et al. described transfemoral arthroscopic decompression of lateral recess stenosis with posterolateral access, but their patient cohort included cases of stenoses with concurrent disc herniations and these investigators did not decom-
press under visual control in the sense of resection of the medial edge of the ascending facet and the ligamentum flavum. We use the interlaminar approach in cases which, because of the pathological entity, are technically inoperable with the transfornaminal technique.83,85,87,88,93,94

The mean operation time of 34 minutes in the FE group was significantly shorter than in the MI group, which had a mean time of 48 minutes. No blood loss was observed in the FE group, and no drainage was required. The necessity of resection of stabilizing structures was reduced in the FE group. Reduced trauma of the ligamentum flavum appears to have certain advantages.8,18

The reduction in operating time, traumatization, and operation-related sequelae in the FE group is also found in comparison with results reported in the literature on discectomies.13,65,81,105,112

The clinical results with the FE technique were equal after 2 years to those obtained with the microsurgical technique and correspond to data reported in the literature.3,11,23–25,27,32,34,40,51–53,57,67,79,99,113,115 This has been taken as the minimum prerequisite for new techniques. A significant improvement was achieved in the MI and FE groups after 2 years without significant differences. A slow deterioration in surgical results over time has been

Fig. 6. Bar graph showing pre- and postoperative leg and back pain in the MI and FE groups. Numbers above individual bars designate the number of patients in each category, and numbers on the y-axis denote the VAS scores.

Fig. 7. Left: Preoperative CT scan obtained in a patient with degenerative lateral recess stenosis. Right: Postoperative CT scan obtained after FE interlaminar decompression.
Significantly more patients in the MI group suffered progradient back pain. When resection of spinal canal structures is avoided or the extent reduced, a minimally traumatic procedure appears capable of reducing operation-induced consequences. Postoperative pain and medication effects were significantly reduced in the FE group. The results of these parameters in a literature comparison also favor the FE group.

The goal of surgical treatment of lumbar recess stenosis is sufficient decompression, with minimization of operation-induced traumatization and its consequent sequelae. Overall, no disadvantages were found in this study in using the FE interlaminar technique. At the same time, there are advantages in the surgical technique and minimally invasive procedure around the access and the spinal canal structures. It must be emphasized that the present results apply only to lumbar recess stenosis with the indication criteria described, and not to central stenosis of the spinal canal.

In patients with the indication monosegmental stenosis with unilateral symptoms on which this study was based, it appears that additional fusion can be dispensed with when stability-preserving surgical techniques are used as long as there are no clear-cut signs of instability or axis deviations. We do not use the over-the-top technique in cases of bilateral symptoms, but opt for a new access via the same incision on the opposite side to preserve the medial ligamentum flavum and the surrounding structures.

Conclusions

The FE operation for lumbar degenerative lateral recess stenosis is a sufficient and safe supplement and alternative to the conventional microsurgical procedure in the undercutting technique. Due to limitations of the transforaminal access, the FE interlaminar access is usually used. This is a minimally invasive surgical technique for spinal decompression, which has long been a validated and established standard procedure. In our opinion, the following advantages are offered: facilitation for the surgeon due to excellent visualization, good illumination, and expanded field of vision with 2.5° optics; cost-effective procedure due to short operating time, rapid rehabilitation, and low postoperative costs of care; reduced anatomical trauma; facilitation of revision operations; and availability of a monitor image as a training basis for assistants. The following must be considered disadvantages: limited possibility of extending the approach in the event of unforeseen hindrances, and the difficult learning curve.

Attention must be paid especially to the last point of the demanding learning curve to avoid complications. Prior observation of and/or assisting at procedures and workshops with practice on cadavers could be meaningful. "Simple" cases, in which no difficulties are to be expected because of the anatomical situation, should be surgically treated at the outset. The possibility of an intraoperative switch to a standard procedure is helpful if problems are encountered.

Disclaimer

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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