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Operation of Lumbar Zygoapophyseal Joint Cysts Using a Full-Endoscopic Interlaminar and Transforaminal Approach: Prospective 2-Year Results of 74 Patients

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Abstract

In appropriate situations, extensive decompression with laminectomy often continues to be described as the method of choice for operations involving lumbar zygoapophyseal joint (z-joint) cysts. Tissue-sparing procedures are nevertheless becoming more common. Endoscopic techniques have become the standard procedures in many areas because of the advantages they offer in terms of surgical technique and in rehabilitation. One key aspect in spinal surgery was the development of instruments for sufficient bone resection carried out under continuous visual control. This enabled endoscopes to be used when operating on z-joint cysts. The objective of this prospective study was to examine the technical possibilities for the full-endoscopic interlaminar and transforaminal technique in lumbar z-joint cysts. A total of 74 patients were followed up for 2 years. The results show that 85% of the patients no longer have any leg pain or that the pain had been almost completely eliminated, and 11 % experience occasional pain. The complication rate was low. The full-endoscopic techniques brought advantages in the following areas: operation, complications, traumatization, and rehabilitation. The recorded results show that full-endoscopic resection of a z-joint cyst using an interlaminar and transforaminal approach provides an adequate and safe supplement, and is an alternative to conventional procedures when the indication criteria are fulfilled. It also offers the advantages of a minimally invasive intervention.

Keywords

zygoapophyseal joint cyst, juxta facet cyst, z-joint cyst, endoscopic spinal decompression, minimally invasive spine surgery

Introduction

Synovial cysts and ganglion cysts are often described in combination with pathologies of joints and tendon structures. Disk herniations and bony spinal stenosis are the most common reasons for radicular pain in the lumbar spine. Cysts of the zygoapophyseal joints (z-joints) are much less common causes for these symptoms.

The first reports of intraspinal ganglion cysts were made in the year 1880.[1] Kao et al[2] introduced the term juxta articular cyst in 1974. The pathology is described in the literature by different names such as synovial cyst, ganglion cyst, facet cyst, juxta-facet cyst. Synovial cysts can be differentiated histologically from ganglion cysts. The synovial cyst is filled with serous, clear or xanthochrome fluid. The wall of the cyst is lined with a layer of synovial cells. The ganglion cyst has no layer of synovial cells inside and contains viscous fluid. The cyst is surrounded by a layer of loose connective tissue. Some reports have suggested a theory that both types of cyst may be different stages of the same pathology.[3,4]

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The histological differentiation between the types is not relevant for the clinical symptoms of the patients and the treatment of the pathology.

The etiology of z-joint cysts continues to remain unclear today. A number of different theories are currently being discussed. Some are based on histopathological findings such as the nonspecific proliferation of mesenchymal cells, extensive production of hyaluronic acid by fibroblasts or the myxoid degeneration of collagen tissue in the neighborhood of a joint.[2,5,6] Other theories for the development of cysts in the z-joints are based on mechanical reasons such as destruction of the synovial layer of the joint and extravazation of synovial fluid. Most of the cysts are found at the level L4/5. This level is affected most in pathologies like hypermobility and instability.[5,7-9] One triggering macrotrauma is also discussed as a possible etiology, as well as repetitive microtraumatic events.[10-13]

Magnetic resonance imaging (MRI) is the diagnostic imaging of first choice. The higher content of proteins inside the cyst compared to the cerebrospinal fluid means that the cyst often presents as hypointense in T1 compared with the dural sac. In the case of a serous cyst content, the T1 signal is isointense and the T2 signal hypointense. The membrane of the cyst often presents in T2 with a hypointense signal.[14] The cyst content often appears hypointense in the computed tomography (CT) apart from the hyperintense appearance of calcified membranes of the cyst. Myelography and/or myelo-CT is described as being helpful in differentiating between a z-joint cyst and a Tarlov cyst.

Similar to the therapy for radicular symptoms caused by other pathologies, for example, disk herniations, the therapeutic options vary between conservative treatment, invasive procedures like percutaneous cyst aspiration or destruction and surgical treatment. [15-18] Surgical intervention can be considered when one of the options referred to above fails or in cases of decompensation, or where symptoms persist at an intolerable level. Numerous surgical procedures have been described. Some of these procedures are still subject to controversial discussion.

Over recent years, there appears to be an overall trend away from more aggressive to more selective techniques. The present trend for predominantly radicular symptoms without any signs of greater segmental instability is to use cyst resection techniques to preserve stability and avoid fusion. However, there are no clear-cut definitions of these criteria. The required extent of decompression and the circumstances in which additional fusion is necessary continue to remain unclear.

Scarring of the epidural space is one operative consequence of conventional surgery.[19-22] This may become clinically symptomatic and makes revision surgery more difficult. Access may influence the stability and coordination system in the innervation area of the dorsal nerve roots of the spinal nerves.[23-25] The use of microsurgical techniques has reduced tissue damage and its consequences.[26-28]

The goal of new procedures must be to achieve results commensurate with those of standard techniques while minimizing traumatization and its long-term consequences. A focal point of technical developments in spinal surgery has been optimization of the intraoperative visualization and light conditions and this continues to remain the objective. This development has meant that endoscopic operations have become standard in various areas, such as laparoscopy or arthroscopy. Today, herniated disks and stenosis of the lumbar and cervical spine can also be operated full-endoscopically using various accesses and techniques.[29-35]

The goal of this prospective study was to examine the technical possibilities of full-endoscopic resection of z-joint cysts using an interlaminar or transforaminal access. The focus of the study was on the issue of adequate decompression, possible effects of reduced traumatization, potential specific complications and the technical performance of the accesses depending on the pathological and anatomical correlates.

Materials and Methods

Patients' Characteristics

Ninety-four patients were enrolled in the prospective study. All the patients had undergone surgery between January 2009 and September 2010 using the full-endoscopic interlaminar and transforaminal technique due to lumbar z-joint cyst. 62 patients were women, 32 were men. The age range was between 31 and 78 years (mean 52 years). The stress profile of occupation and sports was evenly distributed. None of the patients had retired because of the reported complaints. In all, 11 patients were unemployed, 64 were on sick leave. Height and weight were evenly distributed.

All the patients presented with clinically-symptomatic sciatica or neurogenic claudication. 83 underwent MRI and 11 had CT examination because of indwelling implants or claustrophobia. The duration of pain ranged from 10 days to 15 months (mean 62 days). 57 patients presented with neurological deficits. 7 patients had undergone previous microscope-assisted surgery at a different level. Seventy-two patients had received a mean of 6 weeks conservative treatment, 22 patients with uncontrollable pain symptoms or pronounced acute paralysis were operated immediately. A total of 85 patients (90%) were operated interlaminar (IN) and 9 (10%) transforaminal (TR). Twenty-one interventions were performed at level L5/S1 (17 × IN, 4 × TR), 52 at L4/5 (48 × IN, 4 × TR), 5

at L3/4 (4 × IN, 1 × TR), 4 at L2/3 (4 × IN, 0 × TR), and 2 at L1/2 (2 × IN, 0 × TR), whereby the designation L4/5 is taken as the definition of the penultimate free level. Surgery was performed on one side in all cases. General anesthesia was administered in all cases.

Inclusion Criteria

All localizations of single level unilateral z-joint cysts (85 × located inside the spinal canal, 9 located intraforaminally and extraforaminally) were included.

The inclusion criteria for interlaminar access were all z-joint cyst located inside the spinal canal. No limits were set for the extent of the cysts or the location inside the spinal canal due to the technical possibility of bone resection. The inclusion criteria for the transforaminal approach were z-joint cysts located inside or outside the neuroforamen affecting the exiting nerve root of this level.

Exclusion criteria were predominantly back pain, spondylolisthesis more than Meyerding grade I, spinal stenosis, or disk herniations at higher levels on the same side. Apart from general surgical contraindications, there were no exclusion criteria relating to general illness.

Optics and Instruments

The rod lenses have a diameter of 6.9 mm, a viewing direction of 25° and include an eccentrically located, intraendoscopic working channel measuring 4.1 mm in diameter (Figures 1 and 2). The eccentric positioning of the working channel permits additional mobility of the instruments by rotation of the endoscope. Furthermore, fiber-optic cable, the liquid-stream system, and the lens system are included in the optical system. The length of the lens is 207 mm for the transforaminal approach and 165 mm for the interlaminar approach.

The optical system also includes the ports for the fiber-optic cable and camera, and a 360° rotatable connection for the irrigation liquid. The returning liquid flows through the working channel, and between the lens system and operation sheath. A membrane to be placed at the top of the scope is supplied to provide temporary interruption of the water flow through the working channel and hence enable the irrigation pressure to be increased. The scope is freely guided through the operation sheaths which have an outer diameter of 7.9 mm and are adjusted to the length of the scope. The sheaths are introduced through a dilator with an outer diameter of 6.9 mm. A spinal needle and a guide wire are also required for the transforaminal approach.

A range of different instruments is available with outside diameters from 2 to 4 mm. The surgeon can work with all the instruments introduced under continuous visualization. The main instruments are rongeurs, punches, dissectors, and angled retractors.

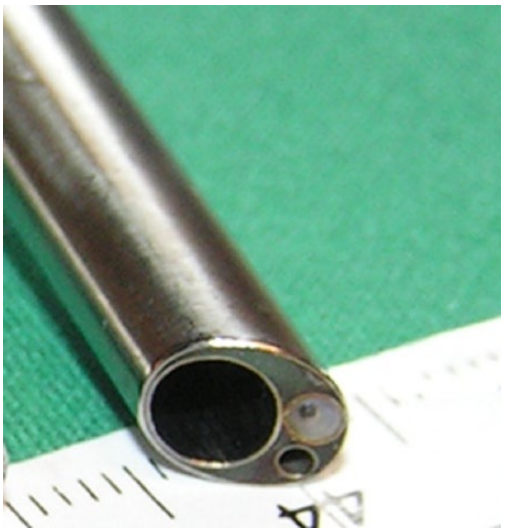

Figure 1. Endoscope including working channel, optical and light system, and irrigation canal.

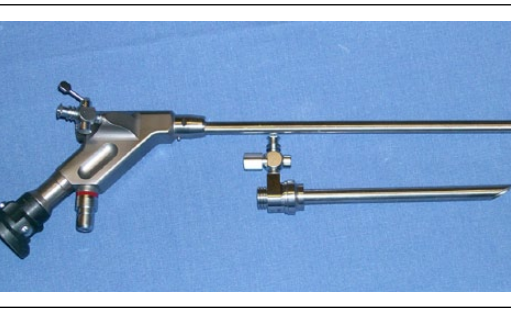

Figure 2. Endoscope with operation sleeve.

A radiofrequency articulating ball electrode is available for dissection, coagulation, and probing. Shaver and cutter heads have a diameter up to 4 mm and are comparable to those used in arthroscopy (Figure 3). Additional accessories generally used in endoscopic or arthroscopic operations are also required: monitor, light source, camera unit, shaver motor, pump for irrigation fluid, radio frequency unit, and a documentation system.

All of the operating instruments and optics products have worldwide certification and are supplied by WOLF (instrument manufacturer Richard Wolf, Knittlingen, Germany).

Operative Technique Lateral Transforaminal Approach

The z-joint cyst located in the neuroforamen is shown in Figure 4.

Figure 3. Endoscope with introduced 4-mm bone resector.

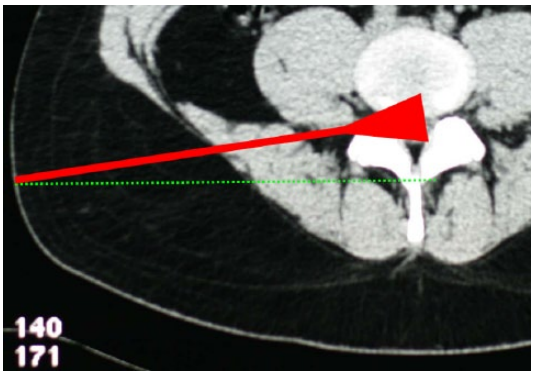

Figure 5. Working area of the lateral transforaminal approach.

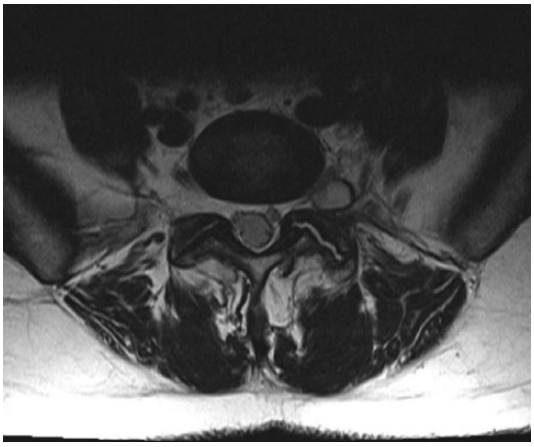

Figure 4. Zygoapophyseal joint cyst located in the neuroforamen.

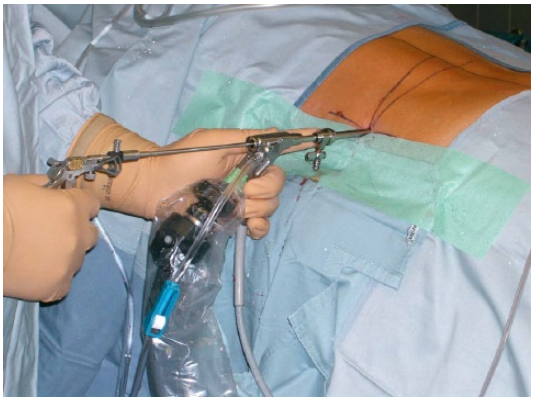

Figure 6. Lateral transforaminal approach with inserted endoscope and instruments.

The surgical access is created with the patient in the prone position under orthograde radiological control in 2 planes. First, the localization of the skin incision is marked. The aim is to achieve tangential access to the spinal canal (Figure 5). The dorsal edge of the inferior articular process normally limits the area of entry ventrally in lateral radiation for levels L3/4 and L4/5. Safety must take precedence particularly at the higher levels as a result of the need to prevent complications involving injury to abdominal or thoracic structures. In such cases, a preoperative selective single CT scan with broad window should be performed as a minimum to define the safe access pathway. This applies especially to patients where retroperitoneal operations have been performed at an earlier stage. In these cases, a more individual, less lateral access has to be selected. At level L5/S1 the iliac crest precludes a lateral approach in most cases. A more posterior entry point is then recommended.

A 1.5-mm atraumatic spinal cannula is inserted through the skin incision directly into the target area. After insertion of a 0.8-mm guide wire, the cannulated dilator with an outer diameter of 6.9 mm is pushed in. At this point, the target wire may be removed so that further positional correction can be made safely using the blunt dilator. A surgical sheath with beveled opening and an outer diameter of 7.9 mm is then placed over the dilator. Subsequent decompression is then carried out under visual control and continuous irrigation (Figure 6). If further penetration into the epidural space is required, this is performed under visual control to protect neural structures. If the anatomical bony diameter of the intervertebral foramen does not permit direct entry into the spinal canal, burrs are used to carry out bone resection and expand the openings. If the position of the exiting nerve is not clear, which is frequently the case in cysts located intraforaminally or extraforaminally, access is made on

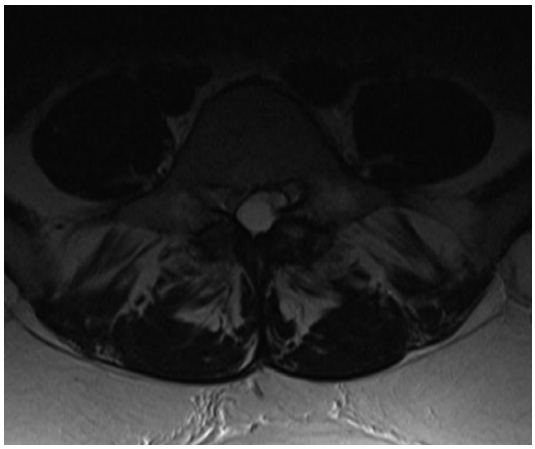

Figure 7. Zygoapophyseal joint cyst located in the spinal canal.

the caudal pedicle as a safe area and further dissection toward the cyst is carried out under visual control. The narrow anatomic conditions prevailing, especially at level L5/S1, means that particular care has to be exercised when positioning the needle to the caudal pedicle and the exposure of the complete foramen, including the exiting nerve root and the cyst should be carried out under continuous visualization.

Operative Technique for the Interlaminar Approach

The z-joint cyst located in the spinal canal is shown in Figure 7.

The surgical access is created with the patient in the prone position under orthograde radiological control in 2 planes. The skin incision is made as medially as possible in the craniocaudal center of the interlaminar window. A dilator with an outer diameter of 6.9 mm is inserted bluntly to the lateral edge of the interlaminar window. An operation sheath with an outer diameter of 7.9 mm and beveled opening is then directed toward the ligamentum flavum. The subsequent procedure is performed under visual control and with constant irrigation. A lateral incision to about 3 to 5 mm is made in the ligamentum flavum and further widening for penetration into the spinal canal is achieved through the elasticity of the ligament (Figure 8). The operating sheath with beveled opening can be turned and used as a nerve hook. Mobility within the spinal canal is controlled by manipulating the optics based on the joystick principle. If the anatomical bony diameter of the interlaminar window does not allow direct penetration into the spinal canal through the ligamentum flavum, a bone cutter is used to carry out bone resection and expand the opening.

Figure 8. Interlaminar approach with inserted endoscope and instruments.

The key element for both techniques is complete resection of the cyst. After the cyst has been identified, possible adhesions to neural structures are released. The cyst is then opened and completely resected. If necessary, the neighboring bony structures are also resected. The operation was finished when the complete cyst was resected and the neural structure was clearly decompressed under visual observation.

Follow-up and Statistical Analysis

Follow-up examinations were carried out on day 1 and then 3, 6, 12, and 24 months postoperatively. Apart from recording general parameters, the following measuring instruments were used: Visual analog scale (VAS) for back and leg pain, German version of the North American Spine Society Instrument (NASS),[38,39] and Oswestry Low-Back-Pain Disability Questionaire.[40] The Wilcoxon test and the Mann-Whitney *U* test were applied for comparison of preoperative and postoperative global results, and for comparison of results in the transforaminal versus the interlaminar group at different times. McNemar's test was used to compare characteristics of the 2 groups.

Depending on the group characteristics, the descriptive assessments and analytical statistics were performed with the SPSS Version 20 program package. A positive significance level was assumed at $P < .05$.

Results

Seventy-four (79%) patients were included in the follow-up. Exclusion of the remaining patients was for the following reasons: 2 patients underwent additional surgery in the same segment, 8 patients moved away and left no forwarding address, and 10 patients did not respond to letters or telephone calls.

None of the results showed any dependence on gender, age, height, weight, employment status, or concomitant diseases. The operating time ranged from 14 to 43 minutes (mean = 22 minutes). There was no measurable blood loss. A dural tear of less than 2 mm was observed in two cases and this was covered by a collagen flap after the procedure. No other complications, such as postoperative bleeding, injury to nerves, or temporary urinary retention were observed. 4 patients developed a transient postoperative dysesthesia (3 patients of the transforaminal group, 1 of the interlaminar group). Postoperative pain medication was not required. Mobilization was immediate, depending on narcosis. No rehabilitative measures were performed except for patients with paresis. The patient population was equal in the interlaminar and transforaminal group. No significant differences between the 2 groups were found in the assessment of results obtained for all the parameters.

Intraoperative Findings

Sixty-three (67%) out of 94 patients had a cyst filled with mucoid content, 18 (19%) with serous content and 13 (14%) with hemorrhage material. In 22 patients (24%), strong adhesions between the cyst and the dura had to be released. In 17 patients (18%), the lateral recess was additionally decompressed and a pure complete resection of the cyst was performed in the rest of the patients.

Recurrences

Two patients (2.1%) with a recurrent cyst at the operated level within the follow-up period after a period free of pain. One patient was operated on again using the same technique and remained free of pain. The other patient was fused in the affected level.

Clinical Outcome

Figures 9 and 10 show the data of the scales. There is constant and significant ($P < .001$) improvement in leg pain and daily activities. There was no influence on back pain. After a period of 2 years, 63 (85%) patients no longer had leg pain, 8 (11%) had pain occasionally or the pain was greatly reduced, and 3 (4%) experienced no essential improvement. There was no significant operation-related deterioration in leg or back pain. Neurological deficits were significantly ($P < .001$) better reduced with a history of less than 2 weeks. Sixty-nine patients (93%) reported subjective satisfaction and stated that they would undergo the procedure again. No patient underwent an additional operation due to persistent leg pain during the follow-up period. In all, 66 patients returned to their occupation or sports activities. Sick leave following hospitalization ranged from 3 to 37 days, with a mean of 12 days. No clinical symptoms were observed relating to growing instability.

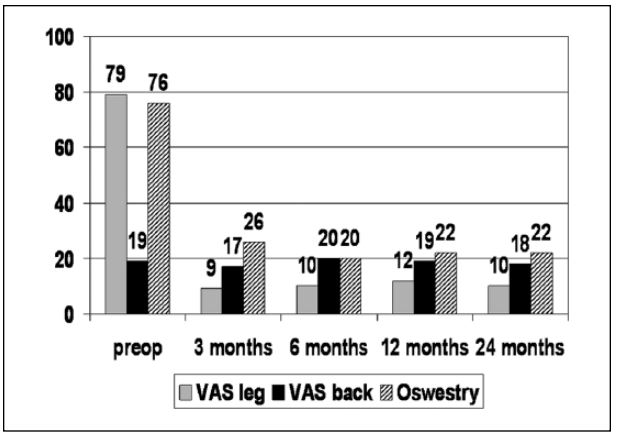

Figure 9. Visual analog scale and Oswestry Low-Back-Pain Disability Questionnaire: 24-month results.

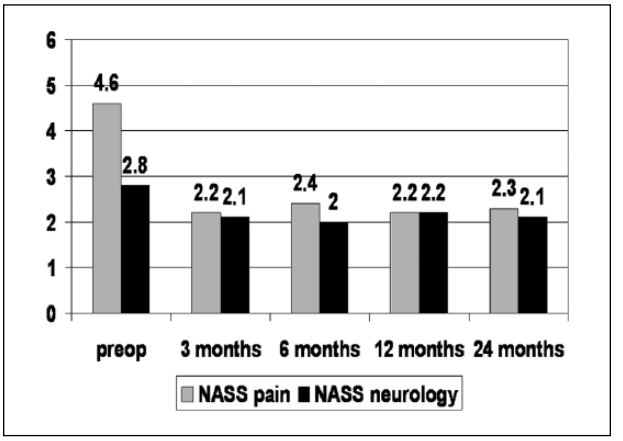

Figure 10. German version of the North American Spine Society Instrument (NASS) pain and NASS neurology: 24-month results.

Postoperative Changes

Routine performance of postoperative MRIs for purely study purposes without clinical symptoms was not possible in the authors' health system because of costs resulting from the number of patients involved. An MRI with administration of dye was carried out 21 times postoperatively after a period of at least 3 months. Assessment was made by radiologists who carried out the preoperative MRIs. Intraforaminal changes that could be rated as being due to operation were diagnosed in the transforaminal group. No intraformainal or extraforaminal changes in neural structures involving scar distortions were observed. Likewise, no scarring was observed in the access pathway.

The craniocaudal and dorsoventral expansion of changes in the lateral epidural space observed in the interlaminar group was a maximum of 5 mm. The expansion was regarded as being related to the operation and corresponded to the size of the flavum defect. There were no scars in the access area. This is confirmed macroscopically in the revision cases after decompression of recurrent disk herniation with interlaminar access.

No increasing segmental instability was observed during the follow-up period.

Operative Technique

Access-related bony resection was required in 63 cases (67%). In the interlaminar access, it was necessary to widen the interlaminar window 62 times, in order to gain access to the spinal canal. In the transforaminal group, bony segments had to be removed from the under surface of the superior articular process, or the cranial segment of the caudal pedicle in one case.

Total resection of the z-joint cyst was technically possible in all cases. The use of bipolar high-frequency probes was found to be necessary in all cases for dissection and cauterization.

Discussion

The goal of surgical treatment of z-joint cysts is sufficient decompression with minimization of operation-induced traumatization and its consecutive sequelae. The present study results show that the full-endoscopic transforaminal and interlaminar operation offers therapeutic alternatives to conventional procedures.

The procedure discussed achieves the results of microscope-assisted procedures at levels of between 80% and 100%.[41-44] The possibility of sufficient decompression with the endoscopic transforaminal and interlaminar technique equal to that of microscope-assisted procedures is also shown in prospective randomized studies in the field of lumbar disk herniation, lateral and central stenosis.[29-35] The avoidance or reduction of resection of spinal canal structures facilitated by this technique and the minimally traumatic cyst resection seem capable of reducing operation-induced segment instability,[45-48] operation time, tissue traumatization and complications that may occur in the course of conventional procedures.[49-53] The preoperative activity level is attained to a comparably high extent.[54] Operation-related rehabilitative measures are not necessary. There is no operation-related aggravation of existing symptoms that is consistent with the minimally-invasive procedure. Concomitant diseases do not lead to increased morbidity. The reduction of neurological deficits could not be predicted on the basis of known results.[58,59] Although all patients were operated under general anesthesia in the present study, operation under local anesthesia is also described especially for the transforaminal approach.[60]

Revisions due to recurrent cysts can be operated using the same technique. The appearance of z-joint cysts is often closely related to degeneration of the joint, especially when there are growing complaints of back pain, and a stabilizing operation therefore has to be discussed when a recurrent cyst appears.

Postoperative MRI scans show no scarring in the access area and only slight scarring in the spinal canal or foramen. The epidural fat as lubricant is largely preserved. This finding was confirmed in repeated procedures after microsurgically assisted operations which, unlike subsequent conventional techniques, were neither made significantly more difficult nor required longer operation time.[61] By contrast, epidural scarring, which may become clinically symptomatic in up to 10 % of cases, must be expected when using conventional techniques.[62,63] Reduced traumatization of the ligamentum flavum appears to bring advantages.[64] The opening of the ligament to insert the endoscope into the spinal canal can be limited to maximum 5 mm. However, it is important to remember that epidural scarring may be unremarkable in the MRI.[62,65] Overall, the combination of a lack of clinical symptoms, the MRI findings and the intraoperative revision findings demonstrate reduced scarring due to the procedure described.

The lens system with a 4.2-mm intraendoscopic working channel expands the indication spectrum with appropriate new instruments, shavers and burrs for providing adequate bone resection. Mobility is increased by the possibility of bone resection and surgery on every z-joint cyst is therefore technically feasible. Parameters like the bony diameter of the interlaminar window or the extent of craniocaudal extension of the cyst are no longer contraindications. Because of the fact that a definitive assessment of the necessity of bone resection is not always possible based on preoperative imaging, the new instruments offer considerable advantages in guaranteeing that intraoperative obstacles to access can be overcome.

In order to guarantee complete decompression, z-joint cysts have to be resected under visual control. Predictable decompression under visual control must be guaranteed as a basic prerequisite for comparison with conventional operations. The indications for transforaminal access in the resection of z-joint cysts is limited to intraforaminally and extraforaminally located cysts. This means that adequate operation of z-joint cysts located inside the spinal canal cannot be sufficiently addressed using a transforaminal approach because of the lack of mobility.

The authors therefore use the interlaminar approach in cysts located inside the spinal canal which the authors believe are technically inoperable using the transforminal technique.

Based on individual pathology and anatomy, the guide indication for the present techniques are radicular compression symptoms caused by z-joint cysts. Concomitant osteochondrosis and spinal canal stenosis are not contraindications. Bilateral and bisegmental procedures, such as those that may also be required in conventional techniques, are technically possible within the indication criteria.

Conclusions

The results of the present prospective study show that predictably sufficient decompression under visual control within a short operation time is guaranteed using the full-endoscopic transforaminal and interlaminar technique. The equivalence in effectiveness to conventional operations is taken as the minimum target for new techniques and this equivalence is attained. The endoscope with its 4.2-mm working channel and corresponding instruments have opened up the field of indication from disk herniations and stenosis to decompression of z-joint cysts. The authors believe that this approach offers the following advantages: facilitation for the surgeon thanks to excellent presentation of anatomical structures, good illumination and expanded field of vision with 25° optics, cost-effective procedure due to short operating time, rapid rehabilitation and low postoperative care costs, reduced traumatization, reduced bleeding, facilitated revision operations, image monitoring as a training platform for assistants, and high level of patient acceptance. The following disadvantages have to be considered: limited possibility of extending surgery in the event of unforeseen obstacles, steep learning curve, theoretically elevated risk of injury to exiting nerve, and narrow indication criteria in the transforaminal technique because of limited mobility resulting from the elimination of extensive bone resection. Furthermore, as yet there is no possibility of suturing a dural tear full-endoscopically.

In the authors' view, the techniques presented as adequate and safe supplements and alternatives to open, microscope or endoscopically assisted procedures. New endoscopes and instruments provide the possibility of selecting an interlaminar or transforaminal procedure, and z-joint cysts outside and inside the spinal canal can be appropriately operated using the full-endoscopic technique, taking the appropriate criteria into account.

Nevertheless, open and maximally invasive procedures are necessary in spinal surgery today and will remain so in future. These must be mastered by surgeons so that they are in a position to deal with the problems and complications that may arise in the course of full-endoscopic procedures. Despite the growing spectrum of indications for full-endoscopic techniques, these do not represent a replacement of existing operative standards but are rather a supplement and alternative within the overall concept of spinal surgery.

Declaration of Conflicting Interests

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