Surgical treatment of thoracic disc herniations via tailored posterior approaches

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Abstract We present clinical findings, radiological characteristics and surgical modalities of various posterior approaches to thoracic disc herniations and report the clinical results in 27 consecutive patients. Within an 8-year period 27 consecutive patients (17 female, 10 male) aged 30–83 years (mean 53 years.) were surgically treated for 28 symptomatic herniated thoracic discs in our department. Six of these lesions (21%) were calcified. In all cases surgery was performed via individually tailored posterior approaches. We evaluated the pre- and postoperative clinical status and the complication rate in a retrospective study. Nearly one half of the lesions (46.4%) were located at the three lowest thoracic segments. Clinical symptoms included back pain or radicular pain (77.8%), altered sensitivity (77.8%), weakness (40.7%), impaired gait (51.9%) or bladder dysfunction (22%). Costotransversectomy was performed in 8 patients, 1 lateral extracavitary approach, 2 foraminotomies, 15 transfacet and/or transpedicular approaches and 2 interlaminar approaches were used for removing the pathologies. After a mean follow-up of 38.6 months (3–100 months), complete normalization or reduction of local pain was

recorded in 87% of the patients and of radicular pain in 70% of the cases, increased motor strength could be achieved in 55%, sensitivity improved in 76.2% and improvement of myelopathy was noted in 71.4%. Two patients suffered from postoperative impairment of sensory deficits, which in one case was discrete. The overall recovery rate within the modified JOA score was 39.5%. In 1 patient, two revisions were required because of instability and a persisting osteophyte, respectively. The rate of major complications was 7.1% (2/28). Surgical treatment of thoracic disc herniations via posterior approaches tailored to the individual patient produces satisfying results referring to clinical outcome. Posterior approaches remain a viable alternative for a large proportion of patients with symptomatic thoracic disc herniations.

Keywords Thoracic disc herniation · Posterolateral approach · Transthoracic approach · Thoracoscopic discectomy · Costotransversectomy

Introduction

Thoracic disc herniations (TDH) are rare in comparison with those originating from either cervical or lumbar discs. The incidence is estimated to be between 0.25 and 1% of all such lesions, and population studies indicate that the overall incidence of thoracic disc herniations is approximately 1 per million patient-years [1, 2]. Thoracic disc herniations typically present with a variety of nonspecific symptoms, frequently leading to a wrong or delayed diagnosis [2–4]. A variety of surgical approaches have been described to reach these anatomically challenging lesions including open transthoracic, costotransversectomy or lateral extracavitary approach, transpedicular or transfacet approaches, as well as

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thoroscopic microdiscectomy [2, 3, 5–7]. According to Fessler and Sturgill [8], the mortality and morbidity associated with the transpedicular, costotransversectomy, lateral extracavitary, and transthoracic approaches to thoracic disc disease are virtually identical. The authors concluded that the key determinants for approach selection from these alternatives should be the anatomic location of the herniated material, the general health of the patient, and also the surgeon's experience.

For central TDH, particularly when associated with dense calcification, posterolateral approaches have been considered inferior to transthoracic approaches because of a more limited field of view of the anterior canal and ventral aspect of the dura [9].

On the other hand, as even the busy spinal expert is possibly only exposed to very few cases annually, and the transthoracic approach to disc herniations appears technically demanding to some, it might then be reasonable to choose a well beaten path in form of the dorsolateral approach. Even more so, if there is little or no experience with anterior techniques. This might not apply to any form of thoracic disc herniation, so that in particular cases a transthoracic approach simply represents the best choice of treatment. The authors want to point out that they do not favor the posterolateral approaches to thoracic disc herniations, in contrast, they strongly believe that surgical treatment of thoracic disc herniations should not focus on one technique alone but that spine surgeons should use a wide scale of techniques to deal with these complex lesions. Based on our own experience, anterolateral transthoracic surgery, at least the open microsurgical approach via a mini thoracotomy is relatively easy to learn with a considerable learning curve [10–13]. Those surgeons who have not yet adopted these techniques are to be forced to do so. However, as the literature is scarce concerning reports on the results of posterolateral approaches to thoracic disc herniations, the authors felt it appropriate to present this study to add more specific information to the ongoing discussion about the different routes to thoracic disc herniations.

In this retrospective study, the authors analyze their series of 27 consecutive patients with 28 symptomatic thoracic disc herniations which were treated via an individually tailored dorsal- or dorsolateral approach. The aim of this study is to determine the viability of posterior approaches for safe and successful removal of thoracic disc herniations in the light of progressive use of transthoracic routes.

Patients and methods

There were 27 consecutive patients suffering from 28 symptomatic thoracic disc herniations presenting at our institution between 1993 and 2001.

The study group consisted of 17 women and 10 men. Age ranged from 30 to 83 years (mean age 53 years).

We performed 30 surgeries in these 27 patients (one patient with two herniations at different levels, two revisions), which corresponds to 0.4% of all spine surgeries at our institution within this time frame. MEP or SEP monitoring was not performed.

Diagnosis of thoracic disc herniation was secured with MRI imaging in 27/28 cases, additional CT scans were performed in 19/28 cases. CT scans and intraoperative findings confirmed calcifications in 6/28 (21.4%) of the cases. There were 20 patients harboring 21 paramedian disc herniations and 2 patients suffering from centrally located herniations while 5 patients had 5 lateral disc herniations.

13/28 (46.4%) disc herniations were found at the three lowest thoracic levels. Locations of the disc herniations are depicted in Fig. 1.

Pain, either local and/or radicular, was the major complaint in this patient group (55.6 and 74%, respectively). Neurological deficits varied with sensory disturbances predominating (78%) and motor deficits, myelopathic symptoms or bladder dysfunction were present to a lesser degree (see Table 1).

The patient's conditions were evaluated pre- and post-operatively, follow-up was performed on an ambulatory setting, if not applicable, patients were interviewed by telephone using a standardized evaluation sheet.

Each patient's neurological condition was documented using the Frankel neurological scale and a JOA scale system modified according to Benzel et al. [14], a 13-point scale measuring lower-extremity motor function, lower-extremity and trunk sensory function, and bladder function. In the present study a JOA score of 5 or less was regarded

Fig. 1 Number of disc herniations according to the respective thoracic disc levels, with characterization of localization. Nearly one half of the lesions (46.4%) were located in the three lowest thoracic segments

Table 1 Distribution of clinical symptoms among 27 patients with symptomatic thoracic disc herniations

Clinical finding	Number of patients (%)
Motor deficit	11 (40.7)
Sensory deficit	21 (77.8)
Bladder dysfunction	6 (22.2)
Myelopathy	14 (51.9)
Radicular pain	20 (74)
Local pain	15 (55.6)

Fig. 2 Distribution of various posterior approaches for resection of thoracic disc herniations, Costotransversectomy was performed in 8 patients, 1 lateral extracavitary approach, 2 foraminotomies, 15 transfacet and/or transpedicle approaches and 2 interlaminar approaches were used for removing the pathologies

as indicating severe neurological impairment, 6–8 as moderate, and 9 or greater as mild neurological impairment.

Percentage of recovery for each patient was calculated using the following formula:

$$\frac{[\text{postoperative mJOA score} - \text{preoperative mJOA score}]/[13 - \text{preoperative mJOA score}]}{\times 100}.$$

Due to their radiological appearance, disc herniations were characterized and divided into three groups regarding their location with respect to the spinal cord ventrally: central, paramedian and lateral.

Modes of surgical treatment were collected by analyzing the operation reports which in all cases also contained particular neuroradiological information concerning the thoracic disc pathology. Complications of surgery were noted and evaluated. Postoperative imaging was only performed when there was no clinical improvement or worsening, or when the surgeon felt not confident to have

performed sufficient decompression of the spinal cord and nerve roots.

Statistical analysis was performed with commercially available standard software (Winstat for Excel, version 2.0). Differences in pre- and postoperative neurological status were examined using Student's *t* test. A probability value of <0.05 was considered significant.

Results

Mean follow-up time for the study group was 38.6 months (3–100 months).

Numbers of approaches applied were costotransversectomy in 8 (for illustration see Fig. 3); lateral extracavitary in 1, foraminotomy in 2, transfacet and/or transpedicular in 15- and interlaminar in 2 patients. The various approaches related to the site of pathology are demonstrated in Fig. 2.

Complete normalization or reduction of local pain was recorded in 87% of the patients and of radicular pain in 70% of the cases, increased motor strength could be achieved in 55%, sensitivity improved in 76.2% and improvement of myelopathy was noted in 71.4%. Two patients suffered from permanent postoperative impairment of sensory deficits, which in one case was discrete. The postoperative neurological changes are depicted in Fig. 4, and the pre- and postoperative Frankel grades of this study group are shown in Fig. 5.

The mean modified JOA score rose from 10.1 preoperatively (range 4–13) to 11.2 (range 5–13) after surgery.

The overall recovery rate within the modified JOA score as detailed above was 39.5%.

There was a significant difference between pre- and postoperative modified JOA score in this series ($p < 0.0001$, Student's *t* test).

Analyzing the recovery rates of different preoperative neurological conditions, we found that the recovery rate was higher when the preoperative condition was better. The recovery rate in the only patient with severe preoperative neurological impairment was 11%, whereas the rates for moderate and mild preoperative neurological impairment were 31.3 and 43.4%, respectively. The changes in the modified JOA score and the different recovery rates are shown in Fig. 6a, b.

Subanalysis of the patients with calcified “hard” discs (6 patients, 6 discs) in comparison to those patients without calcified discs (21 patients, 22 discs) revealed no statistically significant difference concerning outcome data (see Table 2).

Seven complications occurred in six patients. One woman developed an attenuation of preoperative motor deficits after surgery for a Th 11/12 paramedian soft, non-calcified disc herniation treated through a combined

Fig. 3 Illustration of pre-, intra- and postoperative imaging of a densely calcified right sided paramedian thoracic disc herniation at Th 6/7 excised through a costotransversectomy approach

Fig. 4 Postoperative changes classified as better, same or worse in the study group of 27 patients with thoracic disc herniation treated surgically

Fig. 5 Pre- and postoperative Frankel scores of 27 patients treated for 28 thoracic disc herniations

transfacet/transpedicular approach. These deficits were regressive in the further follow-up, resulting in an improvement of the modified JOA score from 7 to 9 at last follow-up. Another male patient developed macroinstability of the operated segment after surgery for a Th12/L1 paramedian disc herniation via a combined transfacet/transpedicular approach. In addition, this patient had a residual osteophyte at the operated segment causing impaired sensory deficits that needed reoperation for sufficient decompression resulting in two revision surgeries. The rate of postoperative instability in this series is therefore 1/28 or 3.5%.

Another woman had local sensory disturbances following costotransversectomy approach for a herniated disc at

Fig. 6 **a** Pre- and postoperative mean JOA score of the study group. **b** Different recovery rates estimated with the modified JOA score changes stratified for preoperative grade of neurological impairment (see text)

Th 7/8 which were only of minor quality and without functional restrictions.

In addition, there were one postoperative wound seroma that was treated with puncture, one injury to the pleura that was sewed intraoperatively, and one postoperative urinary tract infection. No patient required a chest tube, there were no bleeding complications.

Overall, the rate of major complications was 2/28 or 7.1%, while the rate of minor complications was 5/28 or 17.8%.

Discussion

Our study reveals that for a large proportion of symptomatic thoracic disc herniations surgical excision is feasible and successful when using tailored posterolateral approaches. This is meaningful because there are still many spine surgeons who are not familiar enough with thoracoscopic or open transthoracic approaches to the spine. In spine centers where the case load is high enough (e.g. because of trauma patients needing anterior reconstructions), the situation might be different and surgical experience with anterior approaches is excellent.

Table 2 Comparison of outcome between calcified and non-calcified thoracic disc herniations revealing no significant difference

Comparison calcified versus non-calcified disc herniations	Calcified disc herniations (<i>n</i> = 6)	Non-calcified disc herniations (<i>N</i> = 22)	Statistical result
Mean age (years)	54.7	52.5	
Preop mJOA score	10	10.1	
Postop mJOA score	10.83	11.3	
Mean mJOA recovery rate (%)	35.17	40.7	<i>p</i> = 0.7554

Under these circumstances a significant number of our cases should have been operated by an anterior route. However, reviewing the literature shows that outcome and complication rates in these cases are comparable.

Excluding the disappointing results of laminectomy, which first were reported first by Logue [15], numerous posterolateral approach variations were published, that predominantly resulted in acceptable outcomes [2, 3, 5–7, 16–19].

The percentage of normalization or improvement from pain and motor deficits varies between 70–80% and 60–80%, respectively, in current reports, depending on the different populations that have been studied. These numbers correspond well with our results, especially concerning pain reduction and recovery from myelopathic symptoms.

Stillerman et al. reported their experience with treating 71 patients harboring 82 symptomatic thoracic disc herniations, using four different approaches, including trans-thoracic removal in 60% of their cases and different posterolateral routes in the others. They found that there was no statistically significant difference in neurological outcome and pain improvement between the four groups. The overall complication rate was 14.6% in their series. They reviewed the literature and found an overall complication rate of 14.8% in 263 reviewed cases. The rates of major complications were 3.6 and 6.1%, respectively [2]. In our study group, we had major complications in 7.1% and minor, transient complications in 17.8%. Adverse events, however, have been very painstakingly recorded.

Mulier and Dubois reported seven own patients and reviewed the literature reporting on additional 324 patients with thoracic disc herniations analyzing outcome differences between anterior, posterolateral and lateral approaches. They found that outcome using anterior approaches was significantly better compared to the others [9]. However, in their analysis the authors tested the results of anterior surgery against posterolateral and lateral approaches together. If one tested the posterolateral approaches solely against anterior surgeries there were no statistically significant difference. Differences in the preoperative status of the patient groups (with a very high proportion of patients having paresis in the “lateral” group) make clear conclusions somewhat difficult. This is a distinct problem

with comparing all the series reporting the treatment outcomes for thoracic disc herniations, and Chen [4] concluded in his outcome review in 2000 that enhanced uniformity is a prerequisite for future studies in this particular field.

It have been Fessler and Sturgill [8] who first reviewed complication rates extensively in the literature using a uniform bundle of clinical data to make a more reliable comparison between surgical techniques. They clearly stated that, according to their analysis, laminectomy has to be abandoned as a surgical option in thoracic disc disease, and furthermore, morbidity and mortality are virtually identical between the other techniques. They concluded that the decision for a particular technique should include consideration of “(1) the anatomic location of the herniated material, (2) the general health of the patient, and (3) the surgeon’s experience”.

Nevertheless, at that time, experience with the thoracoscopic approach was low, and therefore outcome with this technique was underreported. One of the largest contemporary series of thoracic disc herniations treated with a thoracoscopic approach is that of Rosenthal [20, 21], who introduced thoracoscopic disc excision in the mid 90s. An analysis of his 167 cases treated between 1995 and 2004 revealed 78% of patients having a good or excellent result, 19% achieving a regular result and 3% having a poor result. The overall complication rate was 14% [22]. The rate of secondary fusion procedures was 3/167 or 1.8%, which compares favorably to our 3.5% rate.

Considering these data, it appears not appropriate to perform primary fusion procedures in patients with thoracic disc herniations, as some authors prefer [1]. In cases where a more extensive bone removal is done to better visualize the pathology, fusion can be a reasonable adjunct to prevent late deterioration because of instability and pain, but this will occur in a low number of cases, probably because the thoracic spine is more stable due to the effect of the rib cage.

We are, to the best of our knowledge, the first to use a modified JOA score to compare pre- and postoperative results after posterolateral thoracic disc surgery. We found a significant difference between the pre- and postoperative JOA scores in our patients. Outcome analysis is, in our opinion, more accurate using such scores than reporting

neurological outcome with the Frankel scale, as we have done simultaneously in this case series for better comparison. Additionally, we analyzed the recovery rates in our patients stratified to different preoperative neurological conditions. The most interesting finding is that poorer preoperative neurological status correlates with poorer outcome. This points out that prognosis of thoracic disc disease is correlated with preoperative neurological status, as in many other diseases around the spinal cord. It may be possible that preoperative status is a more important predictor of outcome than the choice of approach; this must be further evaluated in future studies.

The subanalysis of the patients with calcified discs, although there was only a low number, further revealed that there was no difference in outcome compared to patients with non-calcified discs indicating that the use of posterolateral approaches is feasible even for these more complex pathologies, although surely not in all cases.

To us, it is evident that individually tailored posterior approaches to thoracic disc herniations still are valuable tools for spine surgeons. Nevertheless, if applicable, spine surgeons should gain training and experience in anterior, especially minimally invasive anterior approaches to the thoracic spine to further improve the possibilities of treatment of such delicate lesions. There remain certain cases that are better treated by an anterior route a priori because of improved visualization and reduced invasivity. However, for a large proportion of patients harboring thoracic disc herniations, those spine surgeons lacking sufficient experience with anterior surgery can still offer safe and effective thoracic disc herniation removal via posterolateral approaches.

Conclusion

In this retrospective study, the authors analyze their series of 27 consecutive patients with 28 symptomatic thoracic disc herniations who were treated via an individually tailored dorsal or dorsolateral approach.

Results were comparable with the majority of results reported in the literature, also concerning complication rates.

Using the modified JOA score and calculating recovery rates for subgroups, it was found that preoperative neurological status correlates positively with the recovery rate, which is a new finding.

Posterolateral approaches remain a viable alternative for a large proportion of symptomatic thoracic disc herniations.

Conflict of interest None.

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