Minimally invasive tubular microdiscectomy for recurrent lumbar disc herniation

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OBJECTIVE The aim of the study was to investigate the safety and efficacy of minimally invasive tubular microdiscectomy for the treatment of recurrent lumbar disc herniation (LDH). As opposed to endoscopic techniques, namely microendoscopic and endoscopic transforaminal discectomy, this microscopically assisted technique has never been used for the treatment of recurrent LDH.

METHODS Thirty consecutive patients who underwent minimally invasive tubular microdiscectomy for recurrent LDH were included in the study. The preoperative and postoperative visual analog scale (VAS) scores for pain, the clinical outcome according to modified Macnab criteria, and complications were analyzed retrospectively. The minimum follow-up was 1.5 years. Student t-test with paired samples was used for the statistical comparison of pre- and postoperative VAS scores. A p value < 0.05 was considered to be statistically significant.

RESULTS The mean operating time was 90 ± 35 minutes. The VAS score for leg pain was significantly reduced from 5.9 ± 2.1 preoperatively to 1.7 ± 1.3 postoperatively (p < 0.001). The overall success rate (excellent or good outcome according to Macnab criteria) was 90%. Incidental durotomy occurred in 5 patients (16.7%) without neurological consequences, CSF fistula, or negative influence to the clinical outcome. Instability occurred in 2 patients (6.7%).

CONCLUSIONS The clinical outcome of minimally invasive tubular microdiscectomy is comparable to the reported success rates of other minimally invasive techniques. The dural tear rate is not associated to higher morbidity or worse outcome. The technique is an equally effective and safe treatment option for recurrent LDH.

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KEY WORDS recurrent; lumbar disc herniation; minimally invasive; microdiscectomy; complication
visualization device. The aim of the study was to investigate the efficacy and safety of the minimally invasive tubular microdiscectomy technique for recurrent LDH and to compare these findings with reported results of other minimally invasive approaches (MED and ETD).

Methods

Patient Population

The study was approved by the local ethics committee. Between January 2011 and December 2012, 32 consecutive patients (15 males, 17 females; mean age 49.5 ± 13.4 years) with recurrent LDH were treated with minimally invasive tubular microdiscectomy in our neurosurgical department. Patients with clinical symptoms and signs of instability on dynamic radiographs were treated with fusion and had been primarily excluded from this study. Two patients with early recurrent LDH (< 12 weeks after primary surgery) were excluded from this retrospective study. Early recurrent LDH does not present a particular challenge in spine surgery because scar tissue has not yet developed, and revision surgery is unproblematic. We finally included 30 patients in our study (15 males, 15 females; mean age 49.4 ± 13.6 years). Various surgeons at different stages of neurosurgical training (e.g., neurosurgical residents, attending neurosurgeons, or neurosurgeons with subspecialization in spine surgery) performed the operations.

Surgical Technique

The operations were performed under general anesthesia, with the patient in prone position. The affected level was detected fluoroscopically in lateral projection. Then the skin incision is made along the initial scar, which is used partially or completely, depending on the initial length. A 2-cm incision is fully adequate for the transmuscular tubular approach. To insert the muscle dilators via a slightly more lateral trajectory through virgin tissue, the skin is mobilized laterally to the affected side. The muscle dilators are then inserted, aiming at the facet joint.

A 16–20-mm tubular retractor (METRx MD, Medtronic Sofamor Danek, Inc.) is then inserted. The retractor is always initially docked on the facet joint since this is a safe bony landmark for the muscle dilation process. Lateral and anteroposterior radiographs are then taken to ensure the optimal final position of the working channel along the craniocaudal axis as well as its position with respect to the facet joint, the pedicle, and midline (Fig. 1). The optimal position is pre- and intraoperatively determined after careful examination of the preoperative MR image for the remaining facet and localization of the recurrent LDH. The tube should be aimed at the causative pathology, but it should also keep bone structures within view as these offer safe planes for preparation. Generally, this bony structure is the facet joint. The operating microscope is used for visualization. The remaining muscle fibers within the operation field are cauterized and removed. A diamond drill is then used to remove part of the bone on the medial aspect of the facet joint. The drilling direction is along a plane between the facet joint and the lateral dural sac, which is usually affected by scar tissue. Thus, the lateral recess is decompressed, and the nerve root and the disc fragment can be identified. Using this technique the recurrent LDH can be removed, the coexisting lateral recess stenosis can be decompressed, and the segmental stability should be maintained. Bone removal is minimal. Occasionally, when the disc fragment has migrated cranially, a more cranial approach is performed. The remaining lamina is drilled cranially until virgin dural sac, unaffected from scar tissue, is reached. Then, depending on the underlying pathology, mobilization of the dural sac, adhesiolysis, removal of the recurrent LDH, and foraminotomy through drilling or removal of bone using Kerrison rongeurs at the pars interarticularis and foraminral roof is performed. All of the surgical maneuvers used in a standard open microdiscectomy can be performed through the tubular retractor under microscopic view. Moving the tubular retractor at various angles allows the surgeon to reach various areas of the spine, a process known as wanding.33 When the goals of the operation are fulfilled and adequate hemostasis within the spinal canal and the entire operating field is obtained, the tube is smoothly withdrawn and microbleeding of muscle fibers in the different layers of the paravertebral musculature should be microscopically identified and cauterized. This procedure is a mandatory precaution to be taken to avoid rehemorrhage. Subfascial drainage is not necessary. The 2-cm skin incision is then closed with subcutaneous sutures and skin glue.

Data Collection

The medical records, visual analog scale (VAS) scores for pain, complications, and clinical outcome according to modified Macnab criteria (Table 2) were analyzed retrospectively. The VAS data for pain pre- and postoperatively had been collected prospectively. The postoperative VAS scores were assessed during hospital stay. All patients were interviewed and examined at 6–12 weeks as well as 12 months after the operation. The outcome according to Macnab criteria was also assessed at these times. In addition to the 12-month follow-up, we performed follow-up telephone interviews to exclude deterioration of symptoms.

## Table 1. Studies on recurrent LDH treated with minimally invasive surgery

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Study Type</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nomura et al., 2013</td>
<td>Retro control</td>
<td>30 TD (MED) vs 27 MED</td>
</tr>
<tr>
<td>Eloqayli &amp; Al-omari, 2012</td>
<td>Obsv retro</td>
<td>6 ETD</td>
</tr>
<tr>
<td>Smith et al., 2010</td>
<td>Obsv retro</td>
<td>16 MED</td>
</tr>
<tr>
<td>Ruetten et al., 2009</td>
<td>Prosp RCT</td>
<td>50 open vs 21 ETD vs 29 IL</td>
</tr>
<tr>
<td>Lee et al., 2009</td>
<td>Retro control</td>
<td>24 ETD vs 29 open</td>
</tr>
<tr>
<td>Hoogland et al., 2008</td>
<td>Prosp cohort</td>
<td>262 ETD</td>
</tr>
<tr>
<td>Ahn et al., 2004</td>
<td>Obsv retro</td>
<td>43 ETD</td>
</tr>
<tr>
<td>Isaacs et al., 2003</td>
<td>Obsv retro</td>
<td>10 MED</td>
</tr>
<tr>
<td>Le et al., 2003</td>
<td>Obsv retro</td>
<td>10 MED</td>
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</table>

IL = interlaminar endoscopic discectomy; obsv = observational; open = open microdiscectomy; prosp = prospective; RCT = randomized control trial; retro = retrospective; TD = transosseous discectomy.
or occurrence of delayed complications like re-recurrence or instability. Thus, the minimum follow-up was 1.5 years.

Statistical Analysis

For the statistical comparison of the pre- and postoperative VAS scores for pain, the Student t-test with paired samples was used. Prism 6 statistical software for Mac (GraphPad Software Inc.) was used for data processing. A p value < 0.05 was considered to be statistically significant.

Results

The mean operating time was 90 ± 35 minutes. The segments operated on were: L4–5 (16 of 30), L5–S1 (12 of 30), L2–3 (1 of 30), and L3–4 (1 of 30) levels. The VAS score for leg pain (Fig. 2) was significantly reduced from 5.9 ± 2.1 preoperatively to 1.7 ± 1.3 postoperatively (p < 0.001). The clinical outcome was assessed as excellent for 18 patients (60%), good for 9 patients (30%), fair for 1 patient (3.3%), and poor for 2 patients (6.7%).

In 21 patients no complication was reported. Recurrence rate was nil. Incidental durotomy occurred in 5 patients (16.7%) and was repaired with only a fibrin sealant patch (FSP) in 4 patients and by primary closure with an additional FSP in 1 patient. These 5 patients suffered no additional neurological deficits, and the outcome was excellent for 4 of them and good for 1. A postoperative CSF fistula did not occur.

Two patients (6.7%) with postoperative instability required fusion. The affected segment was L4–5. These patients had poor outcomes according to Macnab criteria; as an additional intervention was needed. We studied these cases carefully to identify potential risk factors for the instability. One patient underwent a bilateral partial laminectomy during revision surgery because of bilateral symptoms; the other patient underwent revision surgery for rebleeding and early recurrence only 2 days after the primary surgery. The extension of the partial laminectomy and facetectomy, as well as rediscectomy, were clear risk factors for developing instability in this patient.

Lastly, 2 patients had a facet joint syndrome that could easily be treated with a facet joint block. The overall success rate (excellent or good outcome according to Macnab criteria) was 90%. The mean length of hospital stay was 5 ± 1.8 days.

Discussion

Our technique with the use of a minimally invasive transmuscular approach in combination with the operating microscope has a relatively short learning curve. The familiarity of neurosurgeons with the operating microscope is a decisive factor. The operations in our study were successfully performed by several surgeons at different stages of their neurosurgical career. Thus, ease in mastering this procedure is a major advantage compared with the long learning curve of the ETD and MED techniques, where familiarity with the endoscope must be acquired. ETD and MED are also more demanding to perform due to the absence of 3D visualization. Our technique requires

| TABLE 2. Modified Macnab criteria for assessment of clinical outcome after minimally invasive tubular microdiscectomy |
|---|---|
| **Outcome** | **Characteristic** |
| Excellent | No pain; no restriction of mobility; return to normal work and level of activity |
| Good | Occasional nonradicular pain; relief of presenting symptoms; able to return to modified work |
| Fair | Some improved functional capacity; still handicapped and/or unemployed |
| Poor | Continued objective symptoms of root involvement; additional operative intervention needed at index level irrespective of length of postoperative follow-up |
no special training in endoscope use. This factor could be
decisive and enable the wide applicability of the technique
among neurosurgeons, who are more familiar with the mi-
croscope than with the endoscope.\textsuperscript{33}

The overall success rate of 90\% in our series is com-
parable to reported success rates of MED and ETD in the
literature\textsuperscript{1,7,14,15,24,25,32,39,43} The mean operative time of 90 ± 35 minutes is comparable to other series using MED
(98–102 minutes).\textsuperscript{15,24,25}

The instability/fusion rate in our series was 6.7\%.
In another series of 16 patients\textsuperscript{43} and in two 10-patient series
described by Le et al.\textsuperscript{24} and Isaacs et al.\textsuperscript{15} in 2003, no case of
instability and fusion was reported. In our series, we re-
port an incidental durotomy rate of 16.7\%.
This incidence is in the midrange of values (13\%–27\%)
reported in the liter-
ature concerning revision microdiscectomy via open or
endoscopic approach.\textsuperscript{6,8,43,48} Our reported incidence is clearly
higher than in the ETD (nil)\textsuperscript{1,14,39} and slightly higher than in
MED (7.4\%–12.5\%).\textsuperscript{15,24,32,43} Compared with a series of
patients that were treated with open revision microdis-
cectomy in our clinic (data not shown), the durotomy inci-
dence rate is not significantly higher. Thus, we do not re-
gard working through the minimally invasive access tube
and the use of longer instruments as limiting factors that
may increase the durotomy incidence rate. In our opin-
ion, the bottom line is that durotomy was not associated to
additional morbidity. Neurological deficits did not occur,
and no CSF fistula was reported. The outcome of these
patients according to Macnab criteria was excellent (n =
4) or good (n = 1). Our results were in general comparable
to the reported MED series in terms of clinical outcome.

Compared with ETD, our technique has a higher rate of
dural tear. Dural tear rate in ETD is reported to be nil.\textsuperscript{1,14,39,43}
However, the continuous saline flow in the operating field
deroscopy could account for underdiagnosed in-
trooperative dural tears. Postoperative CSF fistulas after
small dural tears in minimal access surgery are rare,\textsuperscript{33,49,52}
therefore, in these cases small dural tears can be easily
missed. The reported success rates of ETD are not bet-
ter compared with our series (80\%–85\% vs 90\%, respec-
tively).\textsuperscript{1,7,14,15,24,25,32,39,43} Additionally, the ETD technique
has a markedly long learning curve, is inadequate for
use in cases with a coexisting lateral recess stenosis, and
may be difficult or even impossible to use for the resec-
tion of a dislocated herniated fragment within the spinal
ca
\textsuperscript{r},\textsuperscript{16,27,36,37,39,40} Difficulties in recognizing and remov-
ing small dislocated fragments also sometimes occur in
MED.\textsuperscript{52}

In our technique, as in MED, wanding of the tubular
retractor allows the surgeon to move to various areas, cru-
nially, caudally, laterally, or contralaterally, to reach and
remove dislocated disc fragments.\textsuperscript{33} With our technique,
every recurrent LDH can be treated. In this respect, we
believe that a slightly smaller working channel (e.g., 16
mm vs 20 mm) could be advantageous, since it allows for
more effective wanding. The slightly more limited view is
overcome by this means.

Bone removal is not effective in ETD. This is the rea-
son why in the series reported by Ahn et al.\textsuperscript{1} the coex-
istence of lateral recess stenosis was identified as a negative
prognostic factor affecting the outcome. The same reason
accounts for the nil rates of instability and fusion in this
series,\textsuperscript{1} and the very low rate of 1 patient out of 238 in the
series presented by Hoogland et al.\textsuperscript{14} In this prospective
cohort study with a 2-year follow-up, the re-recurrence
rate is reported to be 4.62\%.\textsuperscript{14}

In minimally invasive tubular microdiscectomy, the co-
existence of lateral recess stenosis does not affect the out-
come, because bone decompression is very effective with
this technique. Also, bone decompression does not seem to
correlate to a significantly higher fusion rate, whereas the
re-recurrence rate in our series is nil.

Limitations of the Study
We acknowledge the retrospective nature and the small
cohort of 30 patients of the study as methodological draw-
backs.

Conclusions
Minimally invasive tubular microdiscectomy is a safe
treatment option for recurrent LDH and is equally effec-
tive compared with the other available minimally invasive
techniques (MED, ETD).

References

1. Ahn Y, Lee SH, Park WM, Lee HY, Shin SW, Kang HY:
Percutaneous endoscopic lumbar discectomy for recurrent
disc herniation: surgical technique, outcome, and prognos-
tic factors of 43 consecutive cases. \textit{Spine (Phila Pa 1976)}
29(3):E326–E332, 2004

2. Casal-Moro R, Castro-Menéndez M, Hernández-Blanco M,
Bravo-Rico JA, Jorge-Barreiro FJ: Long-term outcome after
microendoscopic discectomy for lumbar disk herniation: a
prospective clinical study with a 5-year follow-up. \textit{Neuro-
surgery} 68(5):1568–1575, 2011

3. Chang SS, Fu TS, Liang YC, Lia PL, Niu CC, Chen LH, et al:
Results of microendoscopic discectomy performed in the
26 cases with a minimum 3 years follow-up. \textit{Chang Gung
Med J} 32:89–97, 2009

4. Chotigavanichaya C, Korwuthikulrungsri E, Surat-
karndawadee S, Ruangchaisutikom M, Watthanaapisit T,
Tanapipatsri S, et al: Minimally invasive lumbar dissec-
tomy with the tubular retractor system: 4–7 years follow-

5. Dai LY, Zhou Q, Yao WF, Shen L: Recurrent lumbar disk
herniation after discectomy: outcome of repeat discectomy.
\textit{Surg Neurol} 64:226–231, 2005

lumbar disk herniation: A prospective comparative study of
three surgical management procedures. \textit{Asian J Neurosurg}
8:139–146, 2013

7. Eloqayli H, Al-omari M: Percutaneous discectomy: mini-
\textsuperscript{m}mally invasive method for treatment of recurrent lumbar disk


approach to far-lateral lumbar disc herniation. \textit{Neurosurg
Focus} 7(5):e5, 1999

10. Garg B, Nagaraja UB, Jayaswal A: Microendoscopic versus
open discectomy for lumbar disc herniation: a prospective
randomised study. \textit{J Orthop Surg (Hong Kong)} 19:30–34,
2011

11. German JW, Adamo MA, Hoppenot RG, Blossom JH, Nagle
HA: Perioperative results following lumbar discectomy:


minimal access lumbar microdiscectomy for recurrent herniations


Disclosure
Dr. Hubbe reports being a consultant for Medtronic.

Author Contributions
Conception and design: Kogias, Hubbe. Acquisition of data: Vasilikos, Scholz. Analysis and interpretation of data: Kogias, Klingler. Critically revising the article: Hubbe, Franco-Jimenez, Klingler. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Kogias. Statistical analysis: Klingler. Administrative/technical/material support: Franco-Jimenez.

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