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Clinical Study

Minimally invasive compared to open microdiscectomy for lumbar disc herniation

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ABSTRACT

Before the advent of minimally invasive surgery for microdiscectomy, an open microdiscectomy had been the standard surgical intervention. Minimally invasive techniques have recently become more popular based upon the premise that smaller, less traumatic incisions should afford better recovery times and outcomes. From 2005 to 2008 we analyzed the outcomes of 25 patients who received an open microdiscectomy compared to 20 patients who received a minimally invasive microdiscectomy by the senior author (DC) in the lumbar region for disc herniation. A retrospective analysis was performed by carefully reviewing medical records for perioperative and immediate postoperative outcomes, and clinical follow-up was obtained either in the clinic or by telephone. There were no statistically significant differences between the minimally invasive and open groups in terms of operative time, length of stay, neurological outcome, complication rate, or change in pain score (pain improvement).

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1. Introduction

The standard surgical treatment of lumbar disc herniation has been open microdiscectomy,¹ but there has been a trend towards minimally invasive procedures. The open microdiscectomy is traditionally done by mobilizing the muscles laterally off the spinous process and lamina using a unilateral retractor. A minimally invasive microdiscectomy involves dilating the paraspinous muscles and using tubular retractors without stripping the muscles off the spinous processes.^{2–6} It is thought that dilating the muscles rather than stripping the muscles decreases surgical morbidity.^{7–9} The purported benefit of the minimally invasive approach is that it would allow patients to recover more quickly because of less tissue trauma.¹⁰

While a minimally invasive approach may seem ideal, there is a learning curve associated with execution of the procedure, patient safety, and outcome.¹¹ In this study, we retrospectively analyzed whether minimally invasive microdiscectomy offers less morbidity and better outcome compared to open microdiscectomy in treating lumbar disc herniations.

2. Materials and methods

Forty-five consecutive patients who underwent a microdiscectomy for a lumbar disc herniation from 2005 to 2008 by the senior

author (DC) were included in this study. Indications for surgery were neurological deficit or pain refractory to conservative, non-surgical interventions such as activity modification, non-steroid anti-inflammatory medication, physical therapy, time, and epidural steroid injections. The patients were retrospectively separated into one of two groups: (i) those who underwent a minimally invasive microdiscectomy (Fig. 1); and (ii) those who underwent an open microdiscectomy. Procedure assignments were based upon the patient's request: patients who underwent open microdiscectomy were indifferent to the approach, and patients who underwent minimally invasive microdiscectomy specifically requested the procedure.

Retrospectively, we statistically analyzed all 45 patients and compared the two groups: 20 patients with minimally invasive surgery and 25 patients with open surgery. The analysis included the following factors: age, weight, sex, level operated on, complications, operative time, blood loss, length of stay, pain scores, and neurological outcome (American Spinal Injury Association scale). Clinic follow-up was reviewed for outcome. For patients who did not have recent clinic visits, follow-up was obtained through telephone questions by the attending neurosurgeon (DC). All patients in the follow-up were asked a series of standard questions regarding pain (worse, same, better), postoperative infections requiring antibiotics or re-operation, or disc re-herniation manifesting as symptoms or requiring surgery (in the clinic and over the phone). Statistical calculations were performed using the Students' *t*-test or Fisher's exact test when appropriate. The *p* values were calculated for statistical significance, and a threshold of *p* < 0.05 was used to determine statistical significance.

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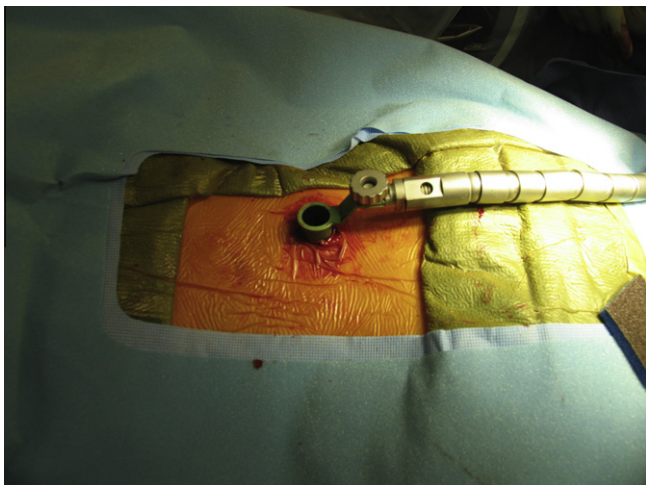


Fig. 1. Intraoperative photograph of minimally invasive microdiscectomy. (This figure is available in colour at www.sciencedirect.com).

3. Results

3.1. Demographics, baselines and clinical data

For the 20 patients who underwent a minimally invasive microdiscectomy, the mean age was 45 years and 50% were male (Table 1). For the 25 patients who had undergone open microdiscectomy, the mean age was 42 years and 48% were male. There was no difference in age ($p = 0.63$, Student's *t*-test) or gender ($p = 0.99$, Fisher's exact test) among the two groups. The mean weight of patients with minimally invasive microdiscectomy was 80 kg, and the patients with open microdiscectomy had a mean weight of 81 kg ($p = 0.86$, Student's *t*-test). The mean follow-up obtained for the minimally invasive group was 8.2 months, and the open group also had a follow-up of 8.2 months ($p = 0.97$, Student's *t*-test).

Of the 20 patients who underwent minimally invasive microdiscectomies, 13 patients had surgery at vertebral levels of L5–S1, six had surgery at L4–L5, and one had surgery at L2–L3 (Table 1). None of the minimally invasive microdiscectomies was converted to an open microdiscectomy. Out of the 25 patients who underwent open microdiscectomies, 14 had surgery at the L5–S1 level, nine had surgery at L4–L5, one had surgery at L3–L4, and one had surgery at L2–L3. The disc levels operated on were stratified using Fisher's exact test to see if there was a significant difference between the two groups. There was no significant difference in the number of surgeries performed at each vertebral level be-

Table 1
Baseline demographics of patients who underwent either a minimally invasive microdiscectomy or an open microdiscectomy for lumbar disc herniation

Characteristics	MI (20 patients)	Open (25 patients)	<i>p</i> value
Age (years; mean \pm SD)	44.55 \pm 3.60	42.24 \pm 3.18	0.63
Male sex (%)	50	48	0.99
Weight (kg)	80.20 \pm 4.03	81.10 \pm 3.25	0.86
Discectomy side (no. patients):			
Right	10	13	0.99
Left	10	11	0.77
Bilateral	0	1	0.99
Discectomy level (no. patients):			
L2–L3	1	1	0.99
L3–L4	0	1	0.99
L4–L5	6	9	0.76
L5–S1	13	14	0.76

L = lumbar, MI = minimally invasive, S = sacral, SD = standard deviation, yrs = years.

tween the groups (Table 1). Also, using Fisher's exact test, we found no significant difference in whether the procedure was performed on the left or right side of the spine between the two groups (Table 1).

3.2. Perioperative factors

The mean operative time (defined as anesthesia start to anesthesia end) for the group who underwent minimally invasive microdiscectomies was 122.65 minutes compared to 122.12 minutes for the group who underwent an open microdiscectomy (Table 2, $p = 0.48$, Student's *t*-test). The mean blood loss for the minimally invasive group was 19 mL compared to 42 mL for the open group (Table 2; $p = 0.02$, Student's *t*-test).

3.3. Length of stay, recurrent disc herniations, complications, pain, and neurological outcomes

Complications were counted as any postoperative or intraoperative event that required medical or surgical intervention, including superficial wound infection. There were a total of four complications among the 20 patients (20%) who underwent a minimally invasive microdiscectomy: two disc re-herniations and two incidental durotomies (Table 2). Of the 25 patients who underwent open microdiscectomy, six had complications (24%): four incidental durotomies, one infection, and one disc re-herniation. In terms of complication rate, there was no significant difference between the two groups ($p = 0.52$). There were no deaths among all studied patients.

There was no difference in mean hospital stay between patients in the minimally invasive group (2.9 days) and for those in the open surgery group (3.0 days) (Table 2; $p = 0.39$, Student's *t*-test).

The mean motor score in the affected muscle group in patients who underwent minimally invasive surgery was: 4.35 out of 5 preoperatively, and 4.88 out of 5 postoperatively. For patients in the open surgery group, the mean motor score in the affected muscle group was: 4.52 out of 5 preoperatively, and 4.72 out of 5 postoperatively. There was no difference in neurologic improvement between the groups (Table 2; $p = 0.064$, Student's *t*-test).

Preoperative and postoperative pain scores were categorized as the patient being worse than, same as, or better than before the microdiscectomy. In the minimally invasive group, 0% had worse pain, 30% of the patients had the same amount of pain, and 70% were better. In the open surgery group, 4% had worse pain, 20% were the same, and 76% were better (Table 3). There was no statis-

Table 2
Factors in minimally invasive (MI) microdiscectomy and open microdiscectomy for lumbar disc herniation

Parameter	MI (20 patients)	Open (25 patients)	<i>p</i> value
Operative time (min) ^a	122.65 \pm 8.61	122.12 \pm 7.22	0.48
Blood loss (mL) ^a	19.00 \pm 4.49	42.25 \pm 10.15	0.02*
Transfusions (mL)	0	0	NA
Length of stay (days) ^a	2.889 \pm 0.30	3.000 \pm 0.26	0.39
Neurological improvement (ASIA score) ^a	0.5556 \pm 0.2455	0.2000 \pm 0.08165	0.06
Complications:	4 total (20%): 2 durotomies; 2 disc re-herniation	6 total (24%): 4 durotomies; 1 disc re-herniation; 1 infection	0.52

ASIA = American Spinal Injury Association; NA = not applicable.

* Statistically significant.

^a Mean (\pm standard deviation).

Table 3

Pain scores comparing preoperative and postoperative outcomes for minimally invasive (MI) microdiscectomy and open microdiscectomy for lumbar disc herniation

Procedure	Worse	Same	Better
MI	0	6	14
Open	1	5	19
<i>p</i> value	0.55 (NS)	0.33 (NS)	0.45 (NS)

NS = not statistically significant.

tically significant difference between the minimally invasive and open microdiscectomy groups in all categories: worse than ($p = 0.55$, Fisher's exact test); same as ($p = 0.33$, Fisher's exact test), and better than ($p = 0.45$, Fisher's exact test).

4. Discussion

Although minimally invasive microdiscectomies are appealing to many patients, its superiority over standard open microdiscectomy has not been conclusively demonstrated. Wu et al. concluded in their retrospective study that minimally invasive microdiscectomy affords optimal post-operative outcomes and is superior when compared to open microdiscectomy.¹² Harrington and French found that perioperative parameters were similar. In their study, the minimally invasive group had less narcotic usage and shorter length of stay, but they did not conclude that one technique was better than the other.¹³ Cole and Jackson showed that obese individuals undergoing minimally invasive microdiscectomies had decreased incision lengths and may have a reduced infection rates.¹⁴ However, German et al.⁷ and Porchet et al.¹⁵ show that there is no significant difference between minimally invasive and open microdiscectomies.

From our data, we did not find a significant difference in length of surgery between patients who underwent a minimally invasive microdiscectomy compared to an open microdiscectomy. The calculated *p* value of 0.48, and mean number of minutes (min) (122.65 min *versus* [vs.] 122.12 min, respectively) show that both microdiscectomy approaches took the same amount of time. Ryang et al. found, similar to our results, that operating times with either minimally invasive or open microdiscectomies were not significantly different.¹⁶

In our study, the open microdiscectomy (42 mL) appeared to incur more blood loss compared to the minimally invasive technique (19 mL) ($p = 0.02$). However, because blood loss was estimated, it is highly unlikely that a 23 mL difference could be discerned intraoperatively by our means (that is, sponge saturation estimation, blood loss in suction canister potentially confounded by irrigation fluid, surgeon's perception). Thus, we believe that this 23 mL difference is still within error of our ability to estimate intraoperative blood loss. Thus, until blood loss can be calculated more accurately and with larger numbers of patients, and strict blood loss is measured rather than estimated, the blood loss difference is noted but remains beyond the accuracy of our measurement means.

With regards to length of stay, unlike in the present study, German et al. showed that patients who underwent minimally invasive microdiscectomies had about half the length of stay compared to patients who underwent open microdiscectomies (0.84 days vs. 1.43 days).⁷ This may be due to our length of stay being relatively long (approximately 3 days). One main reason for this is that at our hospital, many patients travel a long distance to have surgery (up to a 5-hour drive), and many other patients are emergent transfers from other community hospitals. Such patients insist on staying longer in the hospital before undergoing such arduous drives home. It is also a challenge for transferred patients to return home since they were brought in by ambulance and do

not have the ready means to return to their homes. Nonetheless, we did not find a significant difference in the length of stay between the two groups. Although shorter hospital stays may lead to lower medical costs,¹⁷ it is not conclusive that minimally invasive microdiscectomies will decrease hospital stay.

Using the manual motor score, we analyzed the status of neurological function and muscle strength before and after an open or minimally invasive microdiscectomy. Both groups of patients had comparable preoperative neurological scores: minimally invasive, 4.35/5; and open, 4.52/5. Minimally invasive microdiscectomy patients tended toward having a larger improvement in score. The minimally invasive group had a 0.53 mean improvement while the open group had a 0.20 mean improvement ($p = 0.06$).

In terms of preoperative and postoperative pain scores, there was no significant difference between the open and minimally invasive groups (Table 3). Both groups have similar outcomes with most patients receiving pain relief from surgery (70% for minimally invasive and 76% for open).

McLoughlin and Fourney analyzed the depth of the learning curve involved in minimally invasive lumbar microdiscectomies and found that it took about 15 cases for spine surgeons to be comfortable with, and proficient at, the technique. Operative times and complications for minimally invasive microdiscectomy were reduced as the surgeon became more experienced with the technique.¹⁸ With regards to this study, the patients in the senior author's learning curve were included. The complication rates did not appear to be different, even with the minimally invasive "learning" surgeries included in the analysis. However, even with including the learning cases, there did not appear to be a significant difference between the two techniques.

An advantage that minimally invasive surgery may offer is the psychological effect that newer and more advanced technology is being used.⁷ This may allow patients to believe that minimally invasive microdiscectomy is superior. Many patients specifically request – and want only – minimally invasive surgery. Although there is no conclusive evidence that minimally invasive microdiscectomy is superior to open microdiscectomy, the perception of superiority may be so powerful that it motivates the patient to request only minimally invasive microdiscectomy.

5. Conclusions

We did not find a significant difference between minimally invasive microdiscectomy and open microdiscectomy for lumbar disc herniation in perioperative factors and outcomes with regards to blood loss, neurological function, complication rate, length of surgery, length of stay in hospital or pain improvement.

References

- Osterman H, Seitsalo S, Karppinen J, et al. Effectiveness of microdiscectomy for lumbar disc herniation: a randomized controlled trial with 2 years of follow-up. *Spine (Phila Pa 1976)* 2006;**31**:2409–14.
- Beldziński P, Dzierzanowski J, Słoniewski P. Lumbar disc surgery in historical perspective. *Ortop Traumatol Rehabil* 2004;**6**:382–4.
- Casper W. A new surgical procedure for lumbar disc herniation causing less tissue damage through microsurgical approach. *Adv Neurosurg* 1977;**4**:74–80.
- Foley KT, Lefkowitz MA. Advances in minimally invasive spine surgery. *Clin Neurosurg* 2002;**49**:499–517.
- Casper W, Campbell B, Barbier DD, et al. The Casper microsurgical discectomy and comparison with a conventional standard lumbar disc procedure. *Neurosurgery* 1991;**28**:78–87.
- Palmer S. Use of a tubular retractor system in microscopic lumbar discectomy: 1 year prospective results in 135 patients. *Neurosurg Focus* 2002;**13**:E5.
- German JW, Adamo MA, Hoppenot RG, et al. Perioperative results following lumbar discectomy: comparison of minimally invasive discectomy and standard microdiscectomy. *Neurosurg Focus* 2008;**25**:E20.
- Tullberg T, Isacson J, Weidenhielm L. Does microscopic removal of lumbar disc herniation lead to better results than the standard procedure? Results of a one-year randomized study. *Spine* 1993;**18**:24–7.

9. Chi JH, Dhall SS, Kanter AS, et al. The mini-open transpedicular thoracic discectomy: surgical technique and assessment. *Neurosurg Focus* 2008;**25**:E5.
10. Righesso O, Falavigna A, Avanzi O. Comparison of open discectomy with microendoscopic discectomy in lumbar disc herniations: results of a randomized controlled trial. *Neurosurgery* 2007;**61**:545–9.
11. Nowitzke AM. Assessment of the learning curve for lumbar microendoscopic discectomy. *Neurosurgery* 2005;**56**:755–62.
12. Wu X, Zhuang S, Mao Z, et al. Microendoscopic discectomy for lumbar disc herniation: surgical technique and outcome in 873 consecutive cases. *Spine (Phila Pa 1976)* 2006;**31**:2689–94.
13. Harrington JF, French P. Open versus minimally invasive lumbar microdiscectomy: comparison of operative times, length of hospital stay, narcotic use and complications. *Minim Invasive Neurosurg* 2008;**51**:30–5.
14. Cole 4th JS, Jackson TR. Minimally invasive lumbar discectomy in obese patients. *Neurosurgery* 2007;**61**:539–44 [discussion 544].
15. Porchet F, Bartanusz V, Kleinstueck FS, et al. Microdiscectomy compared with standard discectomy: an old problem revisited with new outcome measures within the framework of a spine surgical registry. *Eur Spine J* 2009;**3**:360–6.
16. Ryang YM, Oertel MF, Mayfrank L, et al. Standard open microdiscectomy versus minimal access trocar microdiscectomy: results of a prospective randomized study. *Neurosurgery* 2008;**61**:174–82.
17. Arts MP, Peul WC, Brand R, et al. Cost-effectiveness of microendoscopic discectomy versus conventional open discectomy in the treatment of lumbar disc herniation: a prospective randomized controlled trial [ISRCTN51857546]. *BMC Musculoskelet Disord* 2006;**7**:42.
18. McLoughlin GS, Fourney DR. The learning curve of minimally-invasive lumbar microdiscectomy. *Can J Neurol Sci* 2008;**35**:75–8.