Is Sequestrectomy a Viable Alternative to Microdiscectomy? A Systematic Review of the Literature

Bahram Fakouri MD, Nitin R. Shetty MPhil, FRCS(Orth),
Thomas C. H. White MRCS

Published online: 3 September 2014
© The Association of Bone and Joint Surgeons® 2014

Abstract

Background Traditionally, lumbar discectomy involves removal of the free disc fragment followed by aggressive or conservative excision of the intervertebral disc. In selected patients, however, it is possible to remove only the free fragment or sequester without clearing the intervertebral disc space. However, there is some controversy about whether that approach is sufficient to prevent recurrent symptoms and to provide adequate pain relief.

Questions/purposes This systematic review was designed to pose two questions: (1) Does performing a sequestrectomy only without conventional microdiscectomy lead to an increased reherniation rate; and (2) is there a difference in the patient-reported levels of radicular pain?

Methods Systematic MEDLINE and EMBASE searches were carried out to identify all articles published in peer-reviewed journals reporting the outcomes of interest for conventional microdiscectomy versus sequestrectomy for lumbar disc herniation from L2 to the sacrum (Level III evidence and above); hand-searching of bibliographies was also performed. A minimum of Level II evidence was required with a followup rate of greater than 75%. Followup in all studies was from 18 to 86 months. Seven

studies met the inclusion criteria for this review. The studies were analyzed for operating time, hospital stay, pre- and postoperative visual analog scale, and reherniation rate.

Results Patients in both the microdiscectomy and sequestrectomy groups showed comparable improvement of visual analog scale (VAS) score for leg pain. VAS score improvement ranged from 5.6 to 6.5 points in the microdiscectomy groups and 5.5 to 6.6 in the sequestrectomy group. The reherniation rate in the microdiscectomy group ranged from 2.3% to 11.8% and in the sequestrectomy groups from 2% to 12.5%.

Conclusions This review of the available literature suggests that, compared with conventional microdiscectomy, microsurgical lumbar sequestrectomy can achieve comparable reherniation rates and reduction in radicular pain when a small breach in the posterior fibrous ring is found intraoperatively.

Introduction

Lumbar discectomy is the most common surgical procedure carried out in the United States for patients with back and leg symptoms [29]. The proportion of patients undergoing surgery to treat sciatica from lumbar disc herniation varies from 2% to 10% [12]. In 1934 Mixter and Barr [19] published their lumbar discectomy technique, which involved extensive removal of lamina and the offending ruptured disc through an intradural approach. In 1977 Casper [6] introduced the interlaminar approach with partial resection of bony structures, the facet joints, and the ligamentum flavum followed by the removal of the intervertebral disc material. Historically, some have advocated complete, radical, or subtotal lumbar discectomy, including

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research*® editors and board members are on file with the publication and can be viewed on request.

B. Fakouri (✉), N. R. Shetty, T. C. H. White
Guys and St Thomas' Hospital, Great Maze Pond,
London SE1 9RT, UK
e-mail: Dr.fakouri@googlemail.com; dr.fakouri@gmail.com

curettage of the disc space and removal of the adjacent endplates and, in doing so, removing some elements that could act as a source for reherniation [7]. Williams [31] proposed in 1978 a conservative microsurgical approach to virgin herniated lumbar discs by making only a blunt perforation in the fibrous annular ring without an incision or curettage of the disc space. This conventional microdiscectomy technique is considered to be the gold standard procedure for patients who require surgery for symptomatic lumbar disc herniation refractory to conservative measures [6, 22, 32]. Two of the main complications after lumbar discectomy are the recurrence of radicular pain and disc herniation. It has been demonstrated in previous studies that recurrence of radiculopathy and the reherniation rate after discectomy can be as high as 17% to 33% and 7% to 26%, respectively [2, 8, 9, 14, 17, 25, 27, 28]. Intervertebral disc space collapse has been observed after aggressive discectomy. This can lead to spondylosis, abnormal axial loading on the annulus and facet joints, and to refractory pain [16, 20, 30].

By contrast, Spengler et al. [25] demonstrated in 1990 a less invasive method, which involved removal of only extruded disc fragments and any loose pieces in the disc space with the use of only pituitary forceps for the removal of free fragments (sequester) or fragmentectomy (sequestrectomy). Carragee et al. [5] showed better clinical outcomes at 12-month followup and a higher overall satisfaction rate in patients who underwent limited lumbar discectomy compared with the patients who underwent subtotal discectomy, but the reherniation rate in the limited discectomy group was higher than in the subtotal discectomy group, 18% versus 9% [5]. Limited discectomy

causes less damage to the intervertebral disc and endplates and has been reported in other studies to have better short- and long-term outcomes with respect to back and leg pain [20, 30].

Many comparisons have been made between aggressive and conventional limited discectomy; however, there are few studies comparing conventional limited discectomy with sequestrectomy or fragmentectomy. A systematic review of the available literature for studies specifically comparing sequestrectomy with limited conventional discectomy rates therefore seems warranted.

This study was designed to (1) compare reherniation rates between sequestrectomy and conventional limited microdiscectomy; and (2) compare improvement of radicular pain between the two techniques.

Search Strategy and Criteria

A thorough and systematic literature search was carried out using MEDLINE and EMBASE databases for studies that were published in peer-reviewed journals on the comparison of outcomes of conventional microdiscectomy against fragmentectomy or sequestrectomy. A search was carried out using the following Boolean search criteria ([discectomy or microdiscectomy] and [sequestrectomy or sequesterectomy or fragmentectomy]). The resulting studies were then analyzed for inclusion or exclusion criteria by all three authors. Finally, the bibliographies of all selected studies were hand-searched for any study not picked up by the original search (Fig. 1).

Boolean search terms

1: Microdiscectomy or microdiskectomy or discectomy or diskectomy:

- MEDLINE: n = 5681
- EMBASE: n = 7464

2: Sequestrectomy or sequesterectomy or fragmentectomy:

- MEDLINE: n = 274
- EMBASE: n = 316

1 and 2:

- MEDLINE: n = 25
- EMBASE: n = 28
- Combined: n = 31 (all abstracts reviewed)

31 Abstracts vetted according to inclusion criteria (peer-reviewed comparative studies with clinical outcome data)

- n = 21 excluded

10 Papers reviewed and vetted according to inclusion and exclusion criteria

- N = 6 included

Hand-searching of bibliographies of 10 papers yielded one further result [11]

- N = 7 studies included in review

Fig. 1 The search strategy is shown (n = number of studies).

Inclusion criteria for the review were retrospective or prospective studies comparative studies, including randomized controlled trials, published in peer-reviewed journals, comparing groups of patients who underwent limited microdiscectomy or sequestrectomy at one level (Level III evidence) [21]. Papers were included that specified the following: (1) single-level disc herniation from L2 to S1; (2) correlating clinical signs and symptoms with radicular pain; (3) MRI findings corresponding with the clinical symptoms; (4) no previous operations on the spine; and (5) no emergency operations.

Only studies that described the technique of sequestrectomy including nonviolation of the disc space were included. Followup of at least 75% of the population to at least 18 months was required. Exclusion criteria were nonclinical or radiographic studies, the use of endoscopic or arthroscopic techniques, and failure to meet the inclusion criteria.

Thirty-one individual references were picked up with the original search strategy in EMBASE and MEDLINE. The abstracts were then analyzed by all three authors. On review of the abstracts, 15 studies were excluded according to the mentioned inclusion criteria (peer-reviewed comparative studies with clinical outcome data). Ten articles were then reviewed in full and the bibliographies of each article searched for any further studies that would fit the inclusion and exclusion criteria not picked up on the initial search. One further study was picked up in this way [11]. Three studies were excluded because they did not clearly define the operative technique of sequestrectomy, and one study was excluded as a result of a final followup of less than 50%. Seven studies were identified and included in this review (Table 1). Two were randomized controlled trials (Level II evidence); the remainder were retrospective studies (Level III) [21].

The selected studies were analyzed for the number of patients in each group, male-to-female ratio, mean age, pre- and postoperative visual analog scale, operating time, hospital stay, reherniation rate, and long-term outcomes with relation to back and leg pain. Most studies that met our inclusion criteria did not describe the disc level at which the reherniation occurred and so we did not evaluate this endpoint.

Heterogeneity in the studies' inclusion criteria and the fact that five of the seven studies were retrospective resulted in the need for us to perform a systematic review without data pooling rather than a statistical comparison (meta-analysis).

Results

Reherniation frequencies seemed comparable between the microdiscectomy and fragmentectomy groups. The individual studies showed a reherniation rate between 2.3%

Table 1. Results from each study

Study	Authors	Level of evidence	Number of patients; M/S	Mean age (years); M/S	Male: female; M/S	Mean followup (months); M/S	Final followup rate	Preoperative VAS leg; M/S	Operative time (minutes); M/S	Hospital stay (days); M/S	Complication rate; M/S	Postoperative VAS leg; M/S	Reherniation rate; M/S
A	Baek et al., 2012 [1]	2+	101/74	42.9/48.3	60:41/40:34	23.8/22.3	94%	7.5/7.43	70/90	1.17/1.1	6.4%/4.1%	1.07/1.08	6.93%/4.05%
B	Fakouri et al., 2011 [11]	2+	72/24	38.4/37.2	46:26/15:9	32.4/33.4	95%	7.5/7.8	32/24	1.17/1.1	6.4%/4.1%	1.6/1.2	5.56%/4.17%
C	Barth et al., 2008 [3]	1+	35/38	41.3/40.8	19:16/20:18	24/24	93%		62/49			2.9/1.8	10.5%/12.5%
D	Kast et al., 2008 [17]	2++	88/80	41.9/45.4	47:33/51:37	24/24	88%		38.3/32.6			2.8/3.1	2.3%/1.2%
E	Thome et al., 2008 [28]	1+	42/42	40/42	23:19/24:18	18/18	87%					76%/92%	10%/5%
G	Faulhauer and Manicke, 1995 [12]	2-	100/100		57:43/66:34	42.7	78%						7%/2%
H	Soliman et al., 2013 [26]	2-	34/20			86.2	89%						11.8%/10%

M = microdiscectomy; S = sequestrectomy; VAS = visual analog scale.

and 11.8% in the microdiscectomy group and between 1.2% and 12.5% in the sequestrectomy group (Table 1). The number of patients with recurrence of symptomatic lumbar disc herniation was the only parameter that was reported in all studies.

Of the four studies that reported visual analog scale (VAS), only two [1, 10] recorded preoperative VAS for comparison. Postoperative VAS scores for radicular pain in the four studies that reported it was comparable in the two groups (microdiscectomy and sequestrectomy). The postoperative VAS ranged from 1.07 to 2.9 in the microdiscectomy groups and from 1.08 to 3.1 in the sequestrectomy groups. In the two studies [1, 10] that reported it, the mean improvement of VAS from pre- to postoperative was 6.4 and 5.9 points in the microdiscectomy group and 6.4 and 6.6 points in the sequestrectomy group. Postoperative radicular pain or function was reported in all studies but a variety of outcome measures were used. The VAS score was the most frequently reported outcome measure with four studies reporting it [1, 3, 10, 15]. Other outcome measures used were the Prolo scale [4, 26], Oswestry Disability Index [24], SF-36 [4], Patient Satisfaction Index [4], and FFbH (Funktionsfragebogen Hannover) [15]. One study used a nonstandardized questionnaire [11]. It was therefore not possible to compare outcomes in all studies, but because the majority used the VAS, this is reported here.

Discussion

There are many studies comparing aggressive subtotal discectomy with conventional limited discectomy; however, there are few articles that provide a comparison between microsurgical sequestrectomy and conventional limited microdiscectomy. Sequestrectomy provides the spinal surgeon with a more conservative option, but questions regarding differences in reherniation and pain (both back and leg pain) remain. This study was designed to evaluate the available literature to answer these two important questions: (1) Is there a difference in reherniation rate between the two techniques? (2) Is there a difference in the outcome of back and leg pain?

Of the studies, only two were randomized [4, 26], and the remainder were retrospective studies. Another limitation was varying criteria for inclusion. The decision between conventional discectomy and sequestrectomy is usually made intraoperatively by the spinal surgeon by assessing the competence of the annulus with some studies defining an incompetent annulus as a contraindication to sequestrectomy [10, 15, 26]. Because there is some subjectivity to these findings, there could well be some selection bias in these studies that could influence the

results. In particular, this might have resulted in less challenging kinds of pathology being managed by sequestrectomy, perhaps resulting in inflation of the apparent benefits of treatment using that approach. Some studies emphasized the competence of the annulus to determine suitability for sequestrectomy, whereas others did not follow this principle and this imposed a selection bias because those patients with a competent annular ring and smaller annular defect might have a lesser rate of reherniations. The followup was relatively short in all but one of the studies to effectively evaluate the outcome of back pain with most being approximately 2 years. Although a number of parameters were evaluated, there was little consistency among the studies in their outcome measures. The only outcome that was consistently reported was reherniation rate. The hospital stay and complication rate were only documented by one study [10].

The risk of reherniation does not appear to be greater in sequestrectomy versus conventional microdiscectomy. All but one of the studies examined demonstrated a lower recurrence rate of disc herniation in the sequestrectomy group than in the microdiscectomy group. Barth et al. [4] demonstrated the highest reherniation rate of 12.5% and Kast et al. [15] the lowest (1.2%) in the sequestrectomy group. Considering all the studies, reherniation rates for the sequestrectomy group are favorably comparable to that of the conventional microdiscectomy group. Soliman et al. [24] had a relatively high rate of reherniation of 11.1% in their study group; however, it should be noted that their study had a mean followup of 7.2 years. Their reherniation rate at 2 years was similar to the other studies [24]. This highlights the importance of longer followup studies to evaluate reherniation rates. Some of the authors emphasize the competence of the fibrous ring as a key factor in determining the reherniation rate after fragmentectomy [10, 11, 15]. Carragee et al. [5] reported that a large annular defect measuring more than 6 mm resulted in a recurrence rate of 27.3%. However, Barth et al. [4] in their randomized study performed sequestrectomy for all types of disc herniations including transannular herniations and did not demonstrate a significant difference in the herniation rates between the two groups.

Both surgical groups showed a comparable improvement in the VAS scores for radicular leg pain in the short term. Patients with fragmentectomy reported back pain less frequently the day after the operation and ambulated more comfortably [1]. However, there was no difference in VAS scores after surgery between the fragmentectomy and conventional microdiscectomy groups. There have been concerns about long-term segmental degeneration after discectomy. The amount of disc material removed may play a role in early segmental degeneration; however, to evaluate these would require longer-term randomized

studies comparing the clinical outcomes after these procedures. Furthermore, it has been shown that sequestrectomy caused substantially less postoperative disc degeneration—loss of disc height and endplate changes (Modic type)—than conventional microdiscectomy and were correlated with an unfavourable clinical outcome [3]. In cumulative comparisons, McGirt et al. [18] found an increase in the incidence of long-term recurrent back pain and leg pain reported with aggressive discectomy versus limited discectomy (Level IV evidence). Soliman et al. [24] in their study recommend, based on their long-term followup outcome, to use fragmentectomy with all herniations because this may help prevent postoperative degeneration by maintaining the normal integrity of the anterior and middle columns. This approach could prevent or minimize future problems related to degeneration and may help decrease the occurrence of failed back syndrome [13, 23].

This systematic review found a comparable frequency of reherniation and similar outcomes of leg pain after sequestrectomy as compared with conventional limited discectomy in the short term. The presumption of an increased reherniation rate after sequestrectomy is not borne out by this review. Patients with a competent fibrous ring with defects less than 6 mm might be candidates for sequestrectomy. However, the literature remains deficient in long-term comparative prospective randomized studies and more long-term randomized studies focusing on reherniation rates and long-term clinical outcomes including back and leg pain are awaited before making a recommendation of sequestrectomy in all cases of lumbar disc herniation.

References

1. Baek GS, Kim YS, Lee MC, Song JW, Kim SK, Kim IH. Fragmentectomy versus Conventional microdiscectomy in single-level lumbar disc herniations : comparison of clinical results and recurrence rates. *J Korean Neurosurg Soc.* 2012;52:210–214.
2. Barrios C, Ahmed M, Arroategui J, Bjornsson A, Gillstrom P. Microsurgery versus standard removal of the herniated lumbar disc. A 3-year comparison in 150 cases. *Acta Orthop Scand.* 1990;61:399–403.
3. Barth M, Diepers M, Weiss C, Thome C. Two-year outcome after lumbar microdiscectomy versus microscopic sequestrectomy: part 2: radiographic evaluation and correlation with clinical outcome. *Spine (Phila Pa 1976).* 2008;33:273–279.
4. Barth M, Weiss C, Thome C. Two-year outcome after lumbar microdiscectomy versus microscopic sequestrectomy: part 1: evaluation of clinical outcome. *Spine (Phila Pa 1976).* 2008;33:265–272.
5. Carragee EJ, Spinnickie AO, Alamin TF, Paragioudakis S. A prospective controlled study of limited versus subtotal posterior discectomy: short-term outcomes in patients with herniated lumbar intervertebral discs and large posterior anular defect. *Spine (Phila Pa 1976).* 2006;31:653–657.
6. Casper W. A new surgical procedure for lumbar disk herniation causing less tissue damage through a microsurgical approach. *Adv Neurol.* 1977;4:74–80.
7. Cauchoix J, Ficat C, Girard B. Repeat surgery after disc excision. *Spine (Phila Pa 1976).* 1978;3:256–259.
8. Connolly ES. Surgery for recurrent lumbar disc herniation. *Clin Neurosurg.* 1992;39:211–216.
9. Eismont FJ, Currier B. Surgical management of lumbar intervertebral-disc disease. *J Bone Joint Surg Am.* 1989;71:1266–1271.
10. Fakouri B, Patel V, Bayley E, Srinivas S. Lumbar microdiscectomy versus sequestrectomy/free fragmentectomy: a long-term (> 2 y) retrospective study of the clinical outcome. *J Spinal Disord Tech.* 2011;24:6–10.
11. Faulhauer K, Manicke C. Fragment excision versus conventional disc removal in the microsurgical treatment of herniated lumbar disc. *Acta Neurochir (Wien).* 1995;133:107–111.
12. Frymoyer JW, Pope MH, Clements JH, Wilder DG, MacPherson B, Ashikaga T. Risk factors in low-back pain. An epidemiological survey. *J Bone Joint Surg Am.* 1983;65:213–218.
13. Jaikumar S, Kim DH, Kam AC. History of minimally invasive spine surgery. *Neurosurgery.* 2002;51:S1–14.
14. Kahanovitz N, Viola K, Muculloch J. Limited surgical discectomy and microdiscectomy. A clinical comparison. *Spine (Phila Pa 1976).* 1989;14:79–81.
15. Kast E, Oberle J, Richter HP, Borm W. Success of simple sequestrectomy in lumbar spine surgery depends on the competence of the fibrous ring: a prospective controlled study of 168 patients. *Spine (Phila Pa 1976).* 2008;33:1567–1571.
16. Kirkaldy-Willis WH, Wedge JH, Yong-Hing K, Reilly J. Pathology and pathogenesis of lumbar spondylosis and stenosis. *Spine (Phila Pa 1976).* 1978;3:319–328.
17. Kotilainen E, Valtonen S. Clinical instability of the lumbar spine after microdiscectomy. *Acta Neurochir (Wien).* 1993;125:120–126.
18. McGirt MJ, Ambrossi GL, Dato G, Sciubba DM, Witham TF, Wolinsky JP, Gokaslan ZL, Bydon A. Recurrent disc herniation and long-term back pain after primary lumbar discectomy: review of outcomes reported for limited versus aggressive disc removal. *Neurosurgery.* 2009;64:338–344; discussion 344–345.
19. Mixter WJ, Barr JS. Rupture of the intervertebral disc with involvement of the spinal canal. *N Engl J Med.* 1934;211:210–215.
20. Mochida J, Nishimura K, Nomura T, Toh E, Chiba M. The importance of preserving disc structure in surgical approaches to lumbar disc herniation. *Spine (Phila Pa 1976).* 1996;21:1556–1563; discussion 1563–1564.
21. Oxford Centre of Evidence Based Medicine. *The Oxford Levels of Evidence 2.* Oxford, UK: Oxford Centre of Evidence Based Medicine; 2009.
22. Riesenburger RI, David CA. Lumbar microdiscectomy and microendoscopic discectomy. *Minim Invasive Ther Allied Technol.* 2006;15:267–270.
23. Sadhasivam S, Kaynar AM. Iatrogenic arteriovenous fistula during lumbar microdiscectomy. *Anesth Analg.* 2004;99:1815–1817, table of contents.
24. Soliman J, Harvey A, Howes G, Seibly J, Dossey J, Nardone E. Limited microdiscectomy for lumbar disc herniation: a retrospective long-term outcome analysis. *J Spinal Disord Tech.* 2014;27:E8–E13.
25. Spengler DM, Ouellette EA, Battie M, Zeh J. Elective discectomy for herniation of a lumbar disc. Additional experience with an objective method. *J Bone Joint Surg Am.* 1990;72:230–237.
26. Thome C, Borm W, Meyer F. Degenerative lumbar spinal stenosis: current strategies in diagnosis and treatment. *Dtsch Arztebl Int.* 2008;105:373–379.
27. Vaughan PA, Malcolm BW, Maistrelli GL. Results of L4-L5 disc excision alone versus disc excision and fusion. *Spine (Phila Pa 1976).* 1988;13:690–695.

28. Weber H. Lumbar disc herniation. A controlled, prospective study with ten years of observation. *Spine (Phila Pa 1976)*. 1983;8:131–140.
29. Weinstein JN, Lurie JD, Tosteson TD, Tosteson AN, Blood EA, Abdu WA, Herkowitz H, Hilibrand A, Albert T, Fischgrund J. Surgical versus nonoperative treatment for lumbar disc herniation: four-year results for the Spine Patient Outcomes Research Trial (SPORT). *Spine (Phila Pa 1976)*. 2008;33:2789–2800.
30. Wenger M, Mariani L, Kalbarczyk A, Groger U. Long-term outcome of 104 patients after lumbar sequestrectomy according to Williams. *Neurosurgery*. 2001;49:329–334; discussion 334–335.
31. Williams RW. Microlumbar discectomy: a conservative surgical approach to the virgin herniated lumbar disc. *Spine (Phila Pa 1976)*. 1978;3:175–182.
32. Yasargil MG. Microsurgical operation of herniated lumbar disc. *Adv Neurolurg*. 1977;4:81.