The Debate on Most Ideal Technique for Managing Recurrent Lumbar Disc Herniation: Where are we?

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Abstract

Background: Though different techniques have been previously employed in the treatment of recurrent lumbar disc herniation, the one which is most ideal has remained a controversial issue, particularly with no current generally accepted guidelines for surgical care.

Objectives: We review previous publications comparing the available operative options, with the aim of determining if any of the available interventions gives better outcomes compared to others.

Method: A systematic literature review of previous publications on the various techniques employed in the surgical treatment of recurrent disc herniation.

Results: All publications investigated in this review clearly demonstrate quite comparable outcomes, and none of the studies shows any superiority of one method over the other. In spite of less time, less cost, faster recovery and early return to work commonly associated with the minimally invasive techniques, their overall results and outcomes still remain quite comparable to the older conventional techniques and they appear to have no overall advantage over the older techniques. We suggest that where the expertise is available, revision by minimally invasive techniques should be preferred to the conventional open surgical approaches. If otherwise, the choice of operative technique should simply be based on the experience of the surgeon, the armamentarium of available facilities and equipment. Fusion should not be undertaken in all recurrences or for subsequent herniations but should only be considered as an option for revision when spinal instability, spinal deformity or associated radiolucentancy is present.

Keywords

Disc revision surgery; Recurrent single-level disc prolapse; Re-do minimally invasive lumbar discectomy and Re-do discectomy

Abbreviations: MILD: Minimally Invasive Lumbar Discectomy; MED: Microendoscopic Discectomy; PLIF: Posterior Lumbar Interbody Fusion; PELD: Percutaneous Endoscopic Lumbar Discectomy; OLM: Open Lumbar Microdiscectomy; VAS: Visual Analogue Scale; MIS: TLIF: Minimally Invasive Transforaminal Lumbar Interbody Fusion; ODI: Oswestry Disability Index; PLF: Posterolateral Fusion; CSF: Cerebrospinal Fluid; JOA Score: Japanese Orthopedic Association Score; DVT: Deep Venous Thrombosis

Introduction

Recurrent disc herniation has been defined as the presence of herniated disc material at the same level, whether ipsilateral or contralateral, in a patient who has experienced a pain-free interval of at least 6 months following initial surgery for disc herniation [1-4]. A clinically more appropriate definition, however, is occurrence of disc herniation at the previously operated level and side [1]. Recurrence of either back pain or leg pain after discectomy is a well-documented sequel with an incidence of 5-15% in one report and as much as 28% in another report following initial surgical treatment for primary lumbar disc herniation, and it has surgical intervention rates of up to 18% [1,3,5,6]. The mean interval for recurrence of pain associated with recurrent herniated disc after the initial surgery was approximately 18 months in one series, but a range of 6 months to 17 years in another [1,2,7,8]. Various reasons have been suggested for this wide variation in the statistics [7]. Evidence has clearly shown that its surgical management can be a major financial burden [9].

The removal of recurrent lumbar disc herniations requires meticulous surgical technique and use of the operating microscope to greatly improve identification and separation of tissues [1,7]. This is particularly because revision disc surgery, just as for any other recurring spine-related problem, carries a higher risk of complications due to epidural scar formation along with greater difficulty in defining tissue planes and identifying useful landmarks compared to the initial surgery [2-4,6,10,11]. Yet, the debate on which procedure would be the most effective for these patients still remains unresolved [2,5,8,11]. Meanwhile, the list of available options of revision involving minimal access is on the increase. As part of the spectrum of minimally invasive methods, endoscopic procedures for revision surgery following recurrent disc herniation have also been well described [12-15] (Table 1). Endoscopic approaches for disc re-herniation are however highly technically demanding procedures and should not be attempted without specific training for it [12-14].

In this article, we revisit this topic and review the literature on publications involving comparison of operative options of revision following recurrence of disc herniation, with the aim of determining if any of these techniques would be most appropriate for the surgical treatment of recurrent disc herniation.

Method and Selection Criteria

An initial systematic search of peer-reviewed literature on surgical techniques for recurrent disc herniation was performed using PubMed database and Google search engine with the key phrases "disc revision surgery", "re-do minimally invasive lumbar discectomy", "disc re-operation", and "recurrent single-level disc surgery". The key selection criteria included studies on comparison of surgical techniques for recurrence of single level disc herniation at the same level in the lumbar spine involving at least two techniques. The search was limited to articles published in English language. Recent publications on recurrent disc herniation occurring from spine...
surgery and studies after the year 2000 till date which focused on the techniques employed, as well as on outcome analysis and follow-up were further selected for evaluation. The reference section in these articles was also reviewed for any further relevant material. Articles were included if they contained either qualitative data or quantitative information on outcome and complications of the surgery with each of the techniques used.

Information was carefully extracted from selected eligible studies based on the level of the spine involved, techniques compared and approach used at surgery, age and gender of the patients, functional outcome and improvement of symptoms (particularly pain in terms of post-operative assessment using recognized standards such as visual analogue scale, Oswesty Disability Index and so on) for each technique, complications from the surgery, costs of the re-operation, as well as length of hospital stay and duration of follow-up. Selected publications were categorized into three groups:

1. Comparison between methods of revision which did not involve fusion,
2. Comparison between methods of revision involving fusion
3. Studies comparing only discectomy as the revision with techniques which involved fusion.

**Results**

Eight publications were finally selected in the final subset as the information source for this review. Out of these comparative studies, only one involved methods of revision which did not involve fusion, while four publications were on methods of revision involving fusion. Studies comparing only discectomy as the revision surgery with other techniques which involved fusion were three. The key findings from these publications are as summarized in tables and discussed further in this paper (Tables 2-4).

**Comparison between methods of revision with fusion**

Of the entire eight articles reviewed, only one publication by Lee et al., comparing percutaneous endoscopic lumbar discectomy (PELD) in 25 patients with open lumbar microdiscectomy in 29 patients fell into this category (Table 2). The level operated in all patients in that study was L4/5, with significantly better disc height preservation (p=0.0001), significantly shorter operating time and shorter post-operative hospital stay (p<0.001) as well as fewer complications observed in the PELD group than in the open surgery group (4% versus 10.3% respectively) [16]. However, the mean improvements of back pain, leg pain and functional improvement were 4.0, 5.5, and 40.9% for PELD group compared to 2.3, 5.1, and 45.0% for OLM group respectively [16] (Table 2). These did not show any statistically significant difference in improvement of both VAS and ODI pain scores after surgery for both groups and the authors concluded that both procedures showed equally favourable clinical and radiologic outcomes.

**Comparison between methods of revision involving fusion**

Of the four publications in this category, two studies by Wang et al., and Niesche et al., respectively compared minimally invasive and open forms of TLIF (transforaminal lumbar interbody fusion), one study by El Shazly et al., compared TLIF with PLF (posterolateral fusion) and the one publication by Sonmez et al., compared outcomes of minimally invasive TLIF and unilateral instrumentation with minimally invasive TLIF with bilateral instrumentation (Table 3). In the study by Wang et al., patients in the minimally invasive TLIF group had less blood loss, less post-operative VAS pain scores, fewer complications but more intraoperative exposure to radiation [17]. However, there was no statistical difference in operating time for both groups [17]. In the study by El Shazly et al., in comparing TLIF with PLF, there was neither any significant difference with

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**Table 1: Previous publications on surgery for single-level recurrent herniation using endoscopic techniques.**

<table>
<thead>
<tr>
<th>Authors and year</th>
<th>No. of patients studied</th>
<th>Age range (in years) (mean, years)</th>
<th>Sex distribution (M:F)</th>
<th>Surgical technique evaluated</th>
<th>Surgical complications</th>
<th>Spinal level operated</th>
<th>Key findings / outcomes</th>
<th>Maximum/ Mean follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shin et al., 2011</td>
<td>41</td>
<td>25 - 70 years (mean, 42.5 years)</td>
<td>28:13</td>
<td>Percutaneous endoscopic lumbar discectomy (PELD) : 32 (78%) via an interlaminar route; remaining 9 (22%) through transfornaminal route</td>
<td>2 cases of recurrence, 2 cases of dural tear and CSF leak and 2 cases of transient postoperative dystemia</td>
<td>L2/3 in 1; L3/4 in 1; L4/5 in 26; L5/S1 in 13</td>
<td>No significant operation-related worsening of leg and back pain, VAS for leg and back significantly reduced</td>
<td>Excellent or good outcomes in 90.2%</td>
</tr>
<tr>
<td>Hou et al., 2015</td>
<td>25</td>
<td>27 - 62 years (mean, 50 years)</td>
<td>12:13</td>
<td>Posterior microendoscopic discectomy</td>
<td>No complications observed.</td>
<td>L4/5 in 13; L5/ S1 in 12</td>
<td>Excellent or good occurred in 96% Significantly reduced leg pain and lower ODI scores. (p &lt;0.05)</td>
<td>16 months (range, 13 to 42 months)</td>
</tr>
<tr>
<td>Hoogland et al., 2008</td>
<td>262</td>
<td>46.4 years average</td>
<td>71%; 29%</td>
<td>Transforaminal endoscopic excision</td>
<td>Overall complication rate of 3.8%. 3 cases of nerve root irritation; 7 early recurrent herniations.</td>
<td>N/A</td>
<td>Excellent or good in 85.71%. Recurrence rate of 4.82%.</td>
<td>1-6 years (mean, 3 years)</td>
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</tbody>
</table>

**Key**

- N/A = Information not available
- CSF = cerebrospinal fluid
- VAS = visual analogue scale
- ODI = Oswestry disability index

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**Comparison between methods of revision without fusion**

Of the entire eight articles reviewed, only one publication by Lee et al., comparing percutaneous endoscopic lumbar discectomy (PELD) in 25 patients with open lumbar microdiscectomy in 29 patients fell into this category (Table 2). The level operated in all patients in that study was L4/5, with significantly better disc height preservation (p=0.0001), significantly shorter operating time and shorter post-operative hospital stay (p<0.001) as well as fewer complications observed in the PELD group than in the open surgery group (4% versus 10.3% respectively) [16]. However, the mean improvements of back pain, leg pain and functional improvement were 4.0, 5.5, and 40.9% for PELD group compared to 2.3, 5.1, and 45.0% for OLM group respectively [16] (Table 2). These did not show any statistically significant difference in improvement of both VAS and ODI pain scores after surgery for both groups and the authors concluded that both procedures showed equally favourable clinical and radiologic outcomes.

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**Comparison between methods of revision involving fusion**

Of the four publications in this category, two studies by Wang et al., and Niesche et al., respectively compared minimally invasive and open forms of TLIF (transforaminal lumbar interbody fusion), one study by El Shazly et al., compared TLIF with PLF (posterolateral fusion) and the one publication by Sonmez et al., compared outcomes of minimally invasive TLIF and unilateral instrumentation with minimally invasive TLIF with bilateral instrumentation (Table 3). In the study by Wang et al., patients in the minimally invasive TLIF group had less blood loss, less post-operative VAS pain scores, fewer complications but more intraoperative exposure to radiation [17]. However, there was no statistical difference in operating time for both groups [17]. In the study by El Shazly et al., in comparing TLIF with PLF, there was neither any significant difference with
Table 2: Previous publication on surgical techniques for single-level recurrent herniation comparing methods without fusion.

<table>
<thead>
<tr>
<th>Authors and year</th>
<th>No. of patients</th>
<th>Age range (in years)</th>
<th>Sex distribution (M:F)</th>
<th>Surgical technique evaluated</th>
<th>Surgical complications</th>
<th>Spinal level operated</th>
<th>Key findings / outcomes</th>
<th>Maximum/ Mean follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee et al., 2009</td>
<td>54</td>
<td>45 years (range 26-67 years)</td>
<td>38:16</td>
<td>Percutaneous endoscopic lumbar discectomy (PELD) in 25</td>
<td>Complication rate: 4% in PELD group 10.3% in OLM group. 1 persistent leg pain for PELD group; Voiding difficulty and dysesthesia on perineal area in 1 patient; dural tears in 2 patients for OLM group</td>
<td>L4/5</td>
<td>Mean operating time and hospital stay significantly shorter in the PELD than OLM group. Mean improvements of back pain, leg pain, and functional improvement better in the OLM group</td>
<td>34.2 months (range 25-41 months)</td>
</tr>
</tbody>
</table>

Table 3: Previous publications on surgical techniques for single-level recurrent herniation comparing methods involving fusion.

<table>
<thead>
<tr>
<th>Authors and year</th>
<th>No. of patients studied</th>
<th>Age range (in years)</th>
<th>Sex distribution (M:F)</th>
<th>Surgical technique evaluated</th>
<th>Surgical complications</th>
<th>Spinal level operated</th>
<th>Key findings / outcomes</th>
<th>Maximum/ Mean follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wang et al., 2011</td>
<td>52</td>
<td>31 – 76 (mean of 55.7 years)</td>
<td>28:24</td>
<td>Mis-TLIF in 25; Open-TLIF in 27</td>
<td>Dural tear in 3 and non-union in 1 for Mis-TLIF group Dural tear in 5, wound infection in 2, non-union in 1 for Open-TLIF group</td>
<td>N/A</td>
<td>The operative time and clinical and radiographic results basically identical for both groups.</td>
<td>12 – 38 months (mean of 27.5 months)</td>
</tr>
<tr>
<td>El Shazly et al., 2013</td>
<td>45</td>
<td>25-62 (mean age of 41.4 ±10.22 years)</td>
<td>25 : 20</td>
<td>Revision discectomy alone -(Group A) in 15; Discectomy with TLIF (Group B) in 15; Discectomy with PLF (Group C) in 15.</td>
<td>Comparing only the fusion groups (Groups B and C): 1 case of neurologic deficit post-op, 1 DVT and 2 dural tears in Group B; 1 dural tear and 1 superficial wound infection in group C</td>
<td>N/A</td>
<td>Comparing only the fusion groups (Groups B and C): 1.Findings quite comparable especially for intra-op blood loss and post-op low back pain 2. significantly less cost for PLF than TLIF.</td>
<td>24 – 54 months (mean of 37 ±7.85 months)</td>
</tr>
<tr>
<td>Niesche et al., 2014</td>
<td>33</td>
<td>54 years average (40–60) for Mis-TLIF</td>
<td>8:6</td>
<td>Mis-TLIF in 14</td>
<td>Mis-TLIF group: no serious complications Open TLIF group: 2 cases of Adjacent segment disease; 2 cases of pseudoarthrosis and loosening of screws</td>
<td>L4/5 in 9 patients; L5/S1 in 5 patients</td>
<td>Less blood loss and shorter post-operative stay for Mis-TLIF group. However, solid radiographic fusions in all patients at 24 months. Excellent outcome for 36.8% in Open TLIF group Good clinical outcome for 43% in Mis-TLIF group.</td>
<td>52 months (range of 48–69)</td>
</tr>
<tr>
<td>Sonmez et al., 2013</td>
<td>20</td>
<td>30 - 55 years (mean age of 47.3 and 45.6 years respectively for both groups)</td>
<td>9:11</td>
<td>Mis-TLIF with Unilateral percutaneous instrumentation in 10; Mis-TLIF with Bilateral percutaneous instrumentation in 10</td>
<td>No significant complications in either group.</td>
<td>L4/5 in 15 patients; L5/S1 in 4 patients</td>
<td>Unilaterally instrumented group: Radiological evidence of successful arthrodesis in 80% Bilaterally instrumented group: Radiological evidence of successful arthrodesis in 90% Hospital stay for both groups: 2.2 and 2.3 days, respectively (p&lt;0.05)</td>
<td>2 years (range of 1 – 3 years)</td>
</tr>
</tbody>
</table>

Key:
- N/A = Information not available
- JOA score = Japanese Orthopedic Association score for low back pain syndrome
- DVT = Deep venous thrombosis
- Mis-TLIF = Minimally invasive transforaminal lumbar interbody fusion
- Open-TLIF = Open invasive transforaminal lumbar interbody fusion
- PLF = Posterolateral fusion
Table 4: Previous publications on surgery for single-level recurrent herniation comparing non-fusion surgical techniques with methods involving fusion.

<table>
<thead>
<tr>
<th>Authors and year</th>
<th>No. of patients studied</th>
<th>Age range (in years)</th>
<th>Sex distribution (M:F)</th>
<th>Surgical technique evaluated</th>
<th>Surgical complications</th>
<th>Spinal level operated</th>
<th>Key findings / outcomes</th>
<th>Maximum/ Mean follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agharee et al., 2014</td>
<td>41</td>
<td>20-65 years</td>
<td>13:4 in discectomy only group; 17:7 in discectomy + PLIF group</td>
<td>Discectomy only in 17; Discectomy + PLIF in 24;</td>
<td>Temporary neurological deficit in 1 patient in discectomy group and 2 patients in discectomy + PLIF group; Wound infection in 1 patient from discectomy + PLIF group</td>
<td>N/A</td>
<td>Complete fusion achieved in all 24 patients of discectomy + PLIF group; Radicular pain significantly lower in discectomy + PLIF group; Back pain intensity and mean ODI the same in both groups. No significant difference between no. of patients who returned back to work for both groups</td>
<td>13.9 ± 2.8 months for Discectomy only group; 15 ± 3 months for Discectomy with PLIF</td>
</tr>
<tr>
<td>Fu et al., 2005</td>
<td>41</td>
<td>mean of 41.6 years (range of 17–73 years)</td>
<td>30:11</td>
<td>Discectomy only in 23; Discectomy + PLIF in 18</td>
<td>3 dural tears in the discectomy only group; 2 dural tears, 1 superficial wound infection and 3 patients with residual bone graft donor site pain in discectomy + PLIF group.</td>
<td>L4/S in 25 patients; L5/S1 in 16 patients</td>
<td>Significantly less intraoperative blood loss, length of surgery and length of hospitalization in discectomy only group. However, clinical outcome excellent for 83.3% in discectomy + PLIF group and 78.3% for discectomy only group. No different in post-op back pain scores. For both groups</td>
<td>88.7 months (range, 60-134 months)</td>
</tr>
<tr>
<td>El Shazly et al., 2013</td>
<td>45</td>
<td>25-62 (mean age of 41.4 ±10.22 years)</td>
<td>25 : 20</td>
<td>Revision discectomy alone (Group A) in 15; Discectomy + TLIF (Group B) in 15; Discectomy + PLIF (Group C) in 15.</td>
<td>Higher incidence of dural tear and postoperative neurological deficit but with less intraoperative blood loss, lower cost and shorter duration of surgery in non-fusion group (Group A) than in the fusion groups (Groups B and C).</td>
<td>L4-S in 27; L5-S1 in 18</td>
<td>No significant difference among all three groups for mean total postoperative JOA score. Recovery rate and satisfactory rate. No significant difference among all three groups for length of postoperative hospital stay.</td>
<td>24 – 54 months (mean of 37 ±7.85 months)</td>
</tr>
</tbody>
</table>

Key:
- N/A = Information not available
- PLIF = Posterolateral interbody fusion
- PLF = Posterolateral fusion
- ODI = Oswestry low back pain disability index

regards to intraoperative blood loss, length of surgery, mean post-operative JOA (Japanese Orthopaedic Association) score for back pain, recovery rate, length of post-operative hospital stay nor patient satisfaction [2]. However, PLIF had less cost on the total than TLIF [2]. Niesche et al., in their own evaluation of minimally invasive TLIF compared with open TLIF, reported significantly less blood loss, fewer complications and shorter post-operative stay in the minimally invasive group but similar decrease in post-operative ODI and VAS pain scores for both groups as well as satisfactory bony fusion for all patients by 24 months after surgery [18]. Finally, Sonmez et al., in comparing unilateral instrumentation with bilateral instrumentation for minimally invasive TLIF observed lower cost and shorter duration of surgery for the unilaterally instrumented group but improvement in both VAS and ODI scores were quite similar with no statistically significant difference between both groups, and there was also no statistically significant difference in blood loss or in duration of hospital stay for both groups [4]. Fusion rates were in addition, quite comparable for both groups [4].

Comparison between only discectomy with techniques which involved fusion

The three publications in this category included one retrospective study by Fu et al., another retrospective study by Agharee et al., and the study by El Shazly et al., (Table 4). In the retrospective review by Fu et al., of long term results following disc excision for recurrent lumbar disc herniation with or without posterolateral fusion (PLF) in 41 patients, the difference in pain-free interval (p=0.664), recovery rate (p=0.799), post-operative JOA score (p=0.837) and post-operative back pain scores (p=0.974) were not statistically significant for both groups [11]. While patients in the discectomy only group had significantly less intraoperative blood loss (p<0.0001), shorter durations of surgery (p<0.0001) and post-operative hospital stay...
There were more complications in the posterolateral fusion group [11]. They concluded by recommending discectomy alone as revision for recurrent disc herniation [11].

In the retrospective evaluation by Agharee et al., which also involved 41 patients, in whom long term results of disc excision for recurrent lumbar disc herniation with or without posterior lateral interbody fusion (PLIF) was studied, there was no statistical significance for post-operative low back pain (p=0.697) and the mean ODI scores (p=0.199) for both groups of patients [8]. There was also no statistical difference for both groups regarding number of patients returning back to their premorbid occupation (p=0.679) [8]. In addition, there was no clearly significant difference between both groups in terms of complications arising from surgery [8]. However, the PLIF group had significantly reduced radicular pain compared to the non-fusion group [8]. As a result of this, they recommended discectomy with PLIF as the more effective method of revision [8].

Finally, in comparing only discectomy as the method of revision with discectomy plus translaminar lumbar interbody fusion (TLIF) and discectomy plus posterolateral fusion (PLF) in their prospective randomized study, El Shazly et al., observed no significant difference in post-operative JOA score (p=0.327), recovery rate (p=0.554), length of post-operative hospital stay or satisfactory rate (p=0.968) [2]. However, the discectomy only group had significantly higher incidence of post-operative low back pain (p=0.017), post-operative neurological deficits and dural tears [2].

**Discussion**

These studies clearly demonstrate quite comparable outcomes among the various techniques, ranging from non-fusion techniques to surgeries involving no fusion at all. Overall results appear not to demonstrate any superiority of one method over the other for each of all eight studies, particularly in terms of relief of pain as a key symptom associated with the problem. In particular, the overall results and outcomes for the minimally invasive techniques appear quite comparable to those of the older conventional techniques with no real conclusive superiority demonstrated in view of evidence from these reviews.

Disc herniations can be classified into four groups based on the shape of the herniation:

1. Fragment–fissure herniations which are those with disc fragment and small annular defect.
2. Fragment–defect herniations which have larger disc fragment with massive posterior annular tear.
3. Fragment-contained discs which are those with incomplete annular tear.
4. Annular prolapsed herniation in which there is absence of fragment-contained herniations [1,19].

Of all four groups, the fragment–fissure type herniations often have the best outcomes and the lowest rate of re-herniation of about 1% after initial surgery and hence require the fewest number of revision procedures (of also about 1%) [1,19]. On the other hand, those with annular prolapse tend to be associated with the worst outcomes, with upto 38% of cases experiencing re-occurrence that may require revision surgery while rate of re-herniation for fragment-defect type was 27.3% [1,19].

Various reasons for recurrence of herniation following initial surgery for disc herniation have been suggested in the literature [1,2,3,5,8]. Recurrence has been attributed to local infection, foraminal stenosis, epidural fibrosis, iatrogenic segmental instability, progressive facet degeneration, sacroiliac joint pain and even arachnoiditis [5]. Also, studies have shown that the rate of re-herniation is closely related to the extent of the defect in the posterior annulus [1,20,21]. Recurrence is also related to segmental instability and directly proportional to the integrity of defect in the posterior annulus [1,20,21]. It has been suggested by some that annular incision which is commonly performed at primary discectomy may be a predisposing factor for recurrence [22], while others have shown that this does not really lead to recurrence [1]. One other controversial risk factor for recurrence is the shape of the disc itself [1]. Other factors such as the extent of discectomy at the initial surgery have also not been shown to cause recurrence [1]. Interestingly, diabetes mellitus has also been identified as one of the risk factors for recurrence of herniation and has been demonstrated by some to increase the tendency for prolonged hospitalization after initial primary discectomy, with reduction of proteoglycan content in the intervertebral disc of diabetic patients [1,10].

A general consensus on the surgical procedure that should be the most effective for the treatment of recurrent lumbar disc herniation is yet to be reached [2,3,5,8,11,23,24]. This was the same conclusion in another review regarding this same issue in the practice of spine surgery [5]. The lack of uniformity in surgical technique leads to an overall lack of objective evidence-based guidelines for management for these patients [3,11]. Currently, there is insufficient evidence from the literature and previous studies despite recommendation towards development of protocols and algorithms [3,24,25]. Most of the minimally invasive techniques typically require specialised equipment in form of C-arm intraoperative image intensifier for marking the required level with its associated exposure of the patient, the surgeon and other operating room staff to irradiation, as well as operating loupes or microscopes for magnification, and specialized retractors for adequate access [1,6,12,17]. In addition, while a minimally invasive approach may appear to be the ideal technique particularly because of the less time, less cost, faster recovery and early return to work commonly associated with them, there is a learning curve associated with successful execution of the procedure, patient safety and outcome [19,26,27,28]. Analysis on the depth of the learning curve involved in minimally invasive lumbar microdiscectomies has shown that it takes about an average of 15 cases for spine surgeons to be comfortable with, and to be proficient with the technique [28]. Generally, fusion is not routinely needed as an option for revision following initial discectomy, unless spinal instability, spinal deformity or radiculopathy is demonstrated [1,2,20,25]. Some proponents of revision surgery however believe that fusion of the previously operated symptomatic spinal segment as one of the available options for recurrence of disc herniation is related to a successful outcome [2,5]. Some of the studies in this review have clearly shown that combining fusion with revision discectomy significantly helps to reduce the postoperative low back pain, decreases the intraoperative risk of dural tear and damage to neural tissues and even more importantly reduces the postoperative incidence of mechanical instability which tends to occur following the repeated surgeries [2,11]. Furthermore, it reduces the amount of segmental motion generated at the affected level as well as the mechanical stress across the involved disc space [2,11,20]. Yet, fusion has its own challenges of extra cost, longer operative duration, more complications and so on.
Theoretically, one would expect interbody fusion to provide a more reliable and far better fusion for the lumbar spine by its capacity to immobilize the involved painful spinal segment better than posterolateral fusion can [2]. Yet, interestingly, the study by El Shazly et al., involving transforaminal lumbar interbody fusion and posterolateral fusion revealed quite comparable results for both fusion techniques [2] (Table 3), with no significant difference observed between both groups [3].

**Conclusion**

The debate on which procedure should be the best and most effective for these patients still continues. Quite interestingly, despite the less time, less cost, faster recovery and early return to work commonly associated with the minimally invasive techniques, their overall results and outcomes still remain quite comparable to the older conventional techniques with no real conclusive superiority. For these reasons, we suggest that where the expertise is available, revision by minimally invasive techniques should be preferred to the conventional open surgical approaches. If otherwise, the management strategy for surgical treatment of each case of recurrence should simply be based on the experience of the surgeon, the available facilities and equipment. Though fusion may give greater improvement in pain compared to other techniques without fusion, it should only be considered as an option for revision following initial discectomy, if spinal instability, spinal deformity or associated radiculopathy can be clearly demonstrated. These should be the major factors determining the treatment choice.

**Conflict of Interest**

The authors confirm that there are no disclosures, no conflicts of interest and no financial support.

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