Original Study

Risk factors predicting less favorable outcomes in endoscopic lumbar discectomies

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Background: Endoscopic lumbar discectomy was among the first minimally invasive spine procedures commonly performed. As such, all the benefits of minimal invasion were seen, including less pain, less soft tissue destruction, and faster recovery. While outcomes compare favorably to micro and open discectomy, not all patients fare equally well. This paper examines independent risk factors to assess their correlation to suboptimal outcomes after endoscopic lumbar discectomy.

Methods: Retrospective analysis of clinical outcomes of 55 consecutive patients treated with endoscopic discectomy between June 2018 and March 2019 by the author. Primary outcome measures were postoperative reductions of visual analog score (VAS) for back and leg pain modified MacNab criteria as well as time to narcotic independence. Risk factors examined included smoking, facet disease, adjacent segments disc degeneration, obesity, alcohol abuse, and psychiatric illness.

Results: There were 31 males and 24 females with a mean age of 41.76±12.53. Most patients suffered from contained herniations (49.1%) followed by extruded herniations (18.2%). Follow-up ranged from 6–18 months. The most common surgical levels were L5–S1 level (30.9%), L4–S1 (29.1%), and L4–5 (25.5%). The mean return to work (RTW) was 23.83±26.01 weeks. The average body mass index (BMI) was 29.11±4.75. The average time for narcotic independence was 9.64±7.29 days. MacNab outcomes showed that 47.3% (26/55) had excellent, 36.4% good (20/55), 12.7% fair (7/55), and 3.6% had poor (2/55), respectively. The VAS scores for the back (7.69 to 2.65) and leg (6.78 to 2.65) pain reduced significantly (P<0.0001). Smoking (P=0.048), psychiatric disease (P=0.029), disc herniations larger than 10 mm, facet disease, obesity (BMI >30), diabetes, and alcohol abuse was associated with fair and poor MacNab outcomes.

Conclusions: Endoscopic lumbar discectomy safely and reliably reduces axial pain and radiculopathy from lumbar disc herniations. Risk factors associated with incomplete pain relief are large herniations, obesity, instability, smoking, advanced facet degeneration, and decreased ability to cope with the surgery.

Keywords: Endoscopic discectomy; risk factors; outcome

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Introduction

Minimally invasive spine surgery has shown many benefits when compared to open techniques. Shorter hospital stay (1), less blood loss with less frequent need for transfusion has also been demonstrated (2). With less soft tissue destruction and creation of smaller dead spaces, fewer infections are seen (3-8). These procedures help preserve lumbar musculature (9,10). The health care system and society benefit from minimally invasive spine surgery. There are cost savings compared to open procedures (11,12). Faster time to narcotic independence and less narcotic utilization has been demonstrated (13-18). More rapid return to the workforce is also seen (19-22).

The advent of tubular access retractor systems for fusion and decompression have made minimally invasive procedures more commonly performed. These procedures have been demonstrated to provide comparable outcomes

Table 1 Gender, diagnosis, and level distribution of spinal endoscopy patients

Outcome data	Frequency	Percent	Valid percent	Cumulative percent
Gender				
F	24	43.6	43.6	43.6
M	31	56.4	56.4	100.0
Total	55	100.0	100.0	–
HNP				
Central	27	49.1	49.1	49.1
Extrusion	10	18.2	18.2	67.3
Foraminal	9	16.4	16.4	83.6
Paracentral	9	16.4	16.4	100.0
Total	55	100.0	100.0	–
Procedure				
L2–L3	1	1.8	1.8	1.8
L2–L4	1	1.8	1.8	3.6
L3–L4	1	1.8	1.8	5.5
L3–L5	3	5.5	5.5	10.9
L3–S1	2	3.6	3.6	14.5
L4–L5	14	25.5	25.5	40.0
L4–S1	16	29.1	29.1	69.1
L5–S1	17	30.9	30.9	100.0
Total	55	100.0	100.0	–

HNP, herniated nucleus pulposus.

without increased morbidity when compared to open surgeries (2,21). Endoscopic lumbar discectomy has been shown to offer the same advantages seen with other tubular minimally invasive techniques. Other benefits of endoscopic surgery are the ability to perform these procedures under local anesthesia in an outpatient setting with a very low incidence of epidural fibrosis and scarring (23). Safety and efficacy of these techniques have been demonstrated over 40 years (24). Although favorable outcomes can be anticipated in approximately 80% of cases (25-31), certain risk factors may contribute to a suboptimal outcome. The purpose of this study is to evaluate risk factors to assess their correlation to poor results from endoscopic spine surgery.

Methods

This is a retrospective analysis of 55 consecutive patients treated with endoscopic discectomy between June 2018 and March 2019 for symptomatic lumbar disc herniation refractory to conservative care. There were 31 males and 24 females with a normal age distribution (*Table 1*, *Figures 1*,*2*). Clinical assessment of herniated nucleus pulposus (HNP) was confirmed with magnetic resonance imaging (MRI). Outcome measures assessed included numeric rating of pre and postoperative visual analog score (VAS) for back and leg pain (32). Additionally, functional outcome was assessed using modified MacNab criteria (33) including return to work (RTW) and activities, with favorable result reaching preoperative work level. Time to narcotic independence was also evaluated. Restoring pre-injury work activity, reducing leg pain by 75% and back pain by 75%, with narcotic independence was required for excellent outcome. Patients were deemed to have a good outcome with a 50% reduction of back and leg pain, narcotic independence and return to preoperative or pre-injury occupation. Fair outcome patients had a less than 50% reduction of back and leg pain, and or work restrictions or need for narcotic medications.

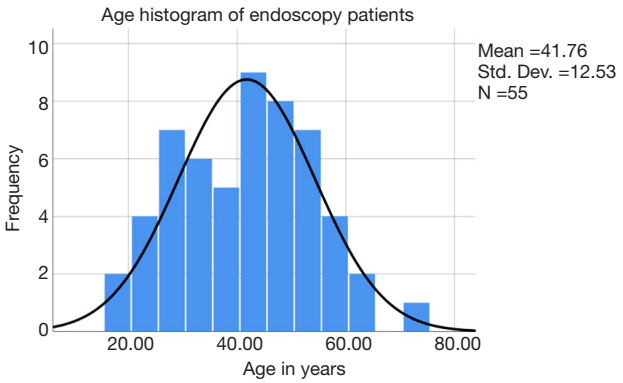

Figure 1 Age distribution of endoscopy patients examined for risk factors of less favorable outcomes after the outpatient decompression procedure. The black line indicates the expected normal distribution of the patients' age. Std., standard; Dev., deviation.

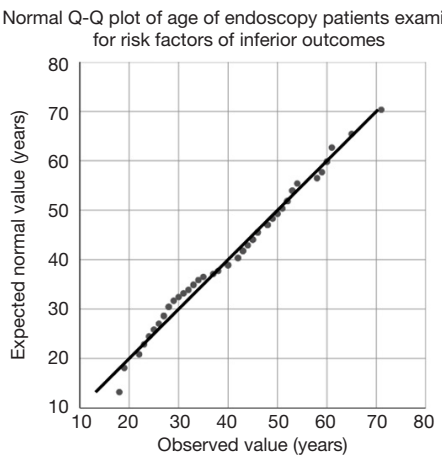

Figure 2 The quantile-quantile plot of the age of endoscopy patients examined for risk factors of less favorable clinical outcomes following the outpatient transforaminal decompression procedure. The average age was 41.8±12.5 years ranging from 18 to 71 years.

Patients unable to resume their preoperative or pre-injury employment activities were deemed to have at best a fair outcome irrespective of occupational work load. Patients requiring additional surgery at the index level were considered a failure of treatment. We tabulated the number of patients requiring injection therapy, but only assessed outcome after injections were completed. Several independent risk factors were studied and their effect on outcome was analyzed. These included obesity [body mass index (BMI) >30], tobacco use, psychiatric illness, extruded- or large lumbar disc herniations (greater than 10 mm), and facet arthropathy. Written informed consent was obtained from the patient for publication of this Original Study and any accompanying images.

Results

The patients' mean age was 41.76±12.53 ranging from 18 to 71 years old (*Table 2*). Most of the herniations were contained herniations (49.1%) followed by extruded herniations (18.2%; *Table 1*). Follow-up was at least 6 months in duration and ranged from 6–18 months. The surgical levels are listed in *Table 1*, with most surgeries having been performed at the L5–S1 level (30.9%), followed by surgery at L4–S1 (29.1%) and L4–5 (25.5%). The mean RTW was 23.83±26.01 weeks. The average BMI was 29.11±4.75. Patients with a BMI of over 30 were considered obese. The average time for narcotic independence was 9.64±7.29 days (*Table 2*). MacNab outcomes showed that 47.3% (26/55) had excellent, 36.4% good (20/55), 12.7% fair (7/55), and 3.6% had poor (2/55), respectively (*Table 3*). The VAS scores for the back (7.69 to 2.65) and leg (6.78 to 2.65) pain reduced significantly (two-tailed paired *t*-test P<0.0001; *Tables 4,5*).

The endoscopic decompression procedure was successful in the majority of patients (83.6%; 46/55) and 39 of the 55 study patients did not require any additional treatment. Most additional aftercare consisted of injections: 9 selective nerve root blocks (SNRBs) for irritation of the dorsal root ganglion, two interlaminar epidural steroid injections, and four facet injections, one of which also underwent subsequent laminectomy. Ultimately, one patient underwent an anterior lumbar interbody fusion (ALIF) to control recurrent back and leg pain (*Table 6*). In his busy endoscopic spine practice, the author empirically identified several risk factors associated with the failure of the endoscopic transforaminal decompression procedure (*Table 7*). Smoking was associated with fair and poor MacNab outcomes at a statistically significant level (P=0.048). Preserved disc height greater than 10 mm, facet disease, obesity (BMI >30), diabetes, and alcohol abuse also were associated with less favorable clinical outcomes (*Table 8*). However, this associated did not reach statistical significance on chi-square testing. However, the four patients with a history of psychiatric disease had less favorable clinical outcomes at a statistically significant level (P=0.029).

Four patients (7%) were unable to return to the pre-injury or preoperative work and activity level. Narcotic independence was not obtained in 2 patients (4%) at the

Table 2 Age, RTW, BMI, and time to narcotic independence

Outcome data	N	Minimum	Maximum	Mean	Std. deviation
Age, years	55	18	71	41.76	12.53
RTW, weeks	42 of 46 pts returned to pre-injury work status, 9 pts unemployed	7	168	23.83	26.01
BMI	55	21.6	44.6	29.11	4.75
Narcotic independence, days	53 out of 55 pts narcotics independent	7	42	9.64	7.29

RTW, return to work; BMI, body mass index; Std., standard.

Table 3 Modified MacNab outcomes obtained in spinal endoscopy patients

MacNab	Frequency	Percent	Valid percent	Cumulative percent
Excellent	26	47.3	47.3	47.3
Good	20	36.4	36.4	83.7
Fair	7	12.7	12.7	96.4
Poor	2	3.6	3.6	100.0
Total	55	100.0	100.0	–

Table 4 VAS score outcomes obtained in spinal endoscopy patients

Paired samples statistics	Mean	N	Std. deviation	Std. error mean
Paired *t*-test				
Pair 1				
Preoperative VAS back	7.69	55	1.016	0.137
Final VAS back	2.65	55	1.220	0.165
Pair 2				
Preoperative VAS leg	6.78	55	2.323	0.313
Final VAS leg	2.65	55	1.220	0.165

VAS, visual analog score; Std., standard.

Table 5 VAS score outcome data continued

Paired differences	Mean	Std. deviation	Std. error mean	95% confidence interval of difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1								
Preop VAS back—postop VAS back	5.036	1.333	0.180	4.676	5.397	28.024	54	<0.0001
Pair 2								
Preop VAS leg—postop VAS leg	4.127	2.365	0.319	3.488	4.767	12.941	54	<0.0001

Preop, preoperative; postop, postoperative; VAS, visual analog score; Std., standard; df, degrees of freedom; Sig., significant.

Table 6 Additional procedures performed after spinal endoscopy patients

Additional procedures	Frequency	Percent	Valid percent	Cumulative percent
None	39	70.9	70.9	70.9
ALIF	1	1.8	1.8	72.7
Epidural injection	2	3.6	3.6	76.4
Facet injection	3	5.5	5.5	81.8
Laminectomy & facet injection	1	1.8	1.8	83.6
SNRB	9	16.4	16.4	100.0
Total	55	100.0	100.0	–

ALIF, anterior lumbar interbody fusion; SNRB, selective nerve root block.

Table 7 Additional risk factors after spinal endoscopy patients

Risk factors	Frequency	Percent	Valid percent	Cumulative percent
Smoking				
No	46	83.6	83.6	83.6
Yes	9	16.4	16.4	100.0
Total	55	100.0	100.0	–
HNP size				
<10 mm	30	54.5	54.5	54.5
>10 mm	25	45.5	45.5	100.0
Total	55	100.0	100.0	–
Facet joint status				
Normal	30	54.5	54.5	54.5
Degeneration	25	45.5	45.5	100.0
Total	55	100.0	100.0	–
Obesity				
BMI <30	30	54.5	54.5	54.5
BMI >30 (obese)	25	45.5	45.5	100.0
Total	55	100.0	100.0	–
Other factors				
None	37	67.3	67.3	67.3
Annular tear	1	1.8	1.8	69.1
Diabetes	1	1.8	1.8	70.9
Alcohol abuse	1	1.8	1.8	72.7
Fibromyalgia	1	1.8	1.8	74.5
Spondylolisthesis	1	1.8	1.8	76.4
Psych	4	7.3	7.3	83.6
Smoking	9	16.4	16.4	100.0
Total	55	100.0	100.0	–

HNP, herniated nucleus pulposus; BMI, body mass index.

Table 8 MacNab outcomes versus type and size of disc herniation (HNP)

Herniation characteristics	Modified MacNab outcomes				Total
	Excellent	Fair	Good	Poor	
HNP type					
Central	14	4	9	0	27
Extrusion	5	2	2	1	10
Foraminal	3	1	4	1	9
Paracentral	4	0	5	0	9
Total	26	7	20	2	55
HNP size					
<10 mm	15	2	13	0	30
>10 mm	11	5	7	2	25
Total	26	7	20	2	55
Facet joint status					
Normal	13	4	11	2	30
Degeneration	13	3	9	0	25
Total	26	7	20	2	55
Other factors					
None	22	2	12	1	37
Annular tear	0	0	1	0	1
Diabetes	0	0	1	0	1
Alcohol abuse	0	0	1	0	1
Fibromyalgia	0	1	0	0	1
Spondylolisthesis	0	0	1	0	1
Psych	0	2	2	0	4
Smoking	4	2	2	1	9
Total	26	7	20	2	55

HNP, herniated nucleus pulposus.

6-month follow-up, 45 patients (83%) were off narcotics within 1 week. Seven patients (13.0%) required several weeks of narcotic therapy.

Using a threshold of a herniation greater than 10 mm *vs.* smaller than 10 mm, we noted 22 patients (40.0%) had at least one herniated disc greater than 10 mm. The subset of patients with a large herniation had averaged postoperative VAS pain score of 3 for back pain and leg pain of 1.72. Massive herniations had more unsatisfactory results for back and leg pain. When isolating the 9 cases with extrusions (16.4%), postoperative back pain VAS scores averaged 3.1, again not as good as non-extruded discs. Leg pain relief was comparable to non-extrusion cases with a VAS score of 1. There were 8 cases with large extruded herniations (14.5%). These patients were among the most symptomatic preoperatively with VAS scores of 7.6 for back pain and 7 for leg pain. Postoperative back and leg pain again as were the case with smaller extrusion improved to VAS of 3 and 1 respectively. Massive herniations (larger than 10 mm) 16 cases (29.1%) without extrusion exhibited the worst preoperative pain with VAS scores of 7.8 for back pain and 7.6 for leg pain. Back pain lessened to

2.9 postoperatively. Leg pain score was 1.8, not quite as good as other herniations.

The 4 patients (7.3%) with a psychiatric history had suboptimal outcomes with back pain VAS of 3.8 and leg pain 2.8 in spite of comparable preoperative pain scores of 8 for back pain, and 8 for leg pain. The 9 patients (16.4%) who used tobacco regularly with preoperative VAS scores of 8.1 for back pain, and 7.4 for leg pain improved to level 1 pain for leg pain postoperatively but still had level 3.2 back pain. Considering obesity, 17 patients (30.9%) had a BMI over 30. Their preoperative back pain, VAS 7.6, and leg pain 6.8 improved to 2.7 for back pain, and 1.6 for leg pain. The two patients who abused alcohol did poorly. One had only 50% relief of back and leg pain, and the other required a fusion at the index level.

Isolated facet joint degeneration at an adjacent level or other levels was very prevalent in our series, 10 patients (18.2%). Preoperative VAS pain scores of 8 for back pain, 7 for leg pain improved to 2.5 for back pain, 1.2 for leg pain. Bulging discs at other levels were seen in 11 patients (20.0%). These patients had less postoperative pain than those with facet degeneration with VAS scores of 2 for back pain, and 0.3 for leg pain. Those patients with bulging discs and facet disease at adjacent levels with operative preoperative VAS scores of 7.3 for back pain and 5.7 for leg pain still had acceptable results with back pain of 2.3 and leg pain of 1.3. Patients having annular tears or herniations at adjacent levels without a concordant pain pattern did not have these levels treated surgically (*Figure 3*). These cases (11%) with preoperative back and leg scores of 8.2 and 8 respectively still had good outcomes with VAS scores of 2.7 for back pain, and 0.7 for leg pain. The two patients with instability (3.6%) continued to have axial pain, average VAS of 4. Leg pain however improved to 1.

Discussion

The high success rate for relief of radicular pain from lumbar disc herniation with microdiscectomy has arguably made this procedure the "gold standard", for treating disc injury (34). Endoscopic discectomy results do compare favorably. There is an 85% improvement in leg radicular complaints after these procedures. Back pain improves as well by 65%. Return to gainful employment is among the most critical indicators of functional outcome. Our 93% success rate with this parameter is an exceptional outcome compared to traditional spinal decompression techniques.

Minimally invasive procedures lower the incidence of narcotic dependence. Only 3% of our patients were not off narcotics within 6 months of their procedure. Narcotic independence was achieved in 82% of cases within 1 week.

In spite of high success rates with endoscopic lumbar discectomy, there are risk factors that predict suboptimal pain relief. Large disc herniation has been shown to have a higher incidence of postoperative recurrence, and persistence of pain compared to small ones (20). This outcome is also seen after endoscopic discectomy. Relief of back pain is not as good with large herniations with postoperative VAS scores of 1.72 *vs.* 1. There was also slightly less relief of leg pain, VAS 3 *vs.* 2.7. Patients with a known psychiatric history did not have surgical outcomes as good as the control population. Improvement of radicular pain was only 3.8 points compared to 5.7 in patients without a psychiatric history. Back pain relief was also reduced compared to controls with a 3.8-point improvement versus 6.1-point improvement in the control group. Obesity compromises the results of leg pain relief with a VAS of 1.6 compared to 1 in the control group. Back pain relief was comparable to controls. Patients with instability, while having good relief of leg pain, had only a 50% relief of back pain. This was the most mediocre result for axial pain relief.

Other variables that were evaluated with a pre-study expectation of leading to poor outcomes were determined not to. While regular users of tobacco had higher preoperative back and leg pain, the postoperative score for leg pain of one was equal to controls. Relief of back pain was only 5% less with VAS of 3.2 rather than 2.7. Patients with adjacent level facet degeneration had comparable relief of low back pain and only slightly less relief of radiculopathy with VAS of 1.2 compared to 1. Annular tears or herniated discs at other levels not deemed to be primary pain generator and as such, left untreated did not produce adverse results; nor did bulging discs at adjacent levels. If bulges at adjacent levels were accompanied by facet degeneration back pain relief was comparable to controls but leg pain relief not as complete with VAS scores of 1.3 compared to 1. Extruded herniations, irrespective of size, once removed produced comparable outcomes for relief of back and leg pain.

When evaluating the 3% of patients with failed outcomes, requiring additional surgery at the index level, both had large herniations. One of the two cases used tobacco, abused alcohol, and had multilevel facet degeneration. The other had no comorbidities. Further study of the patients with fair results (7 cases) showed

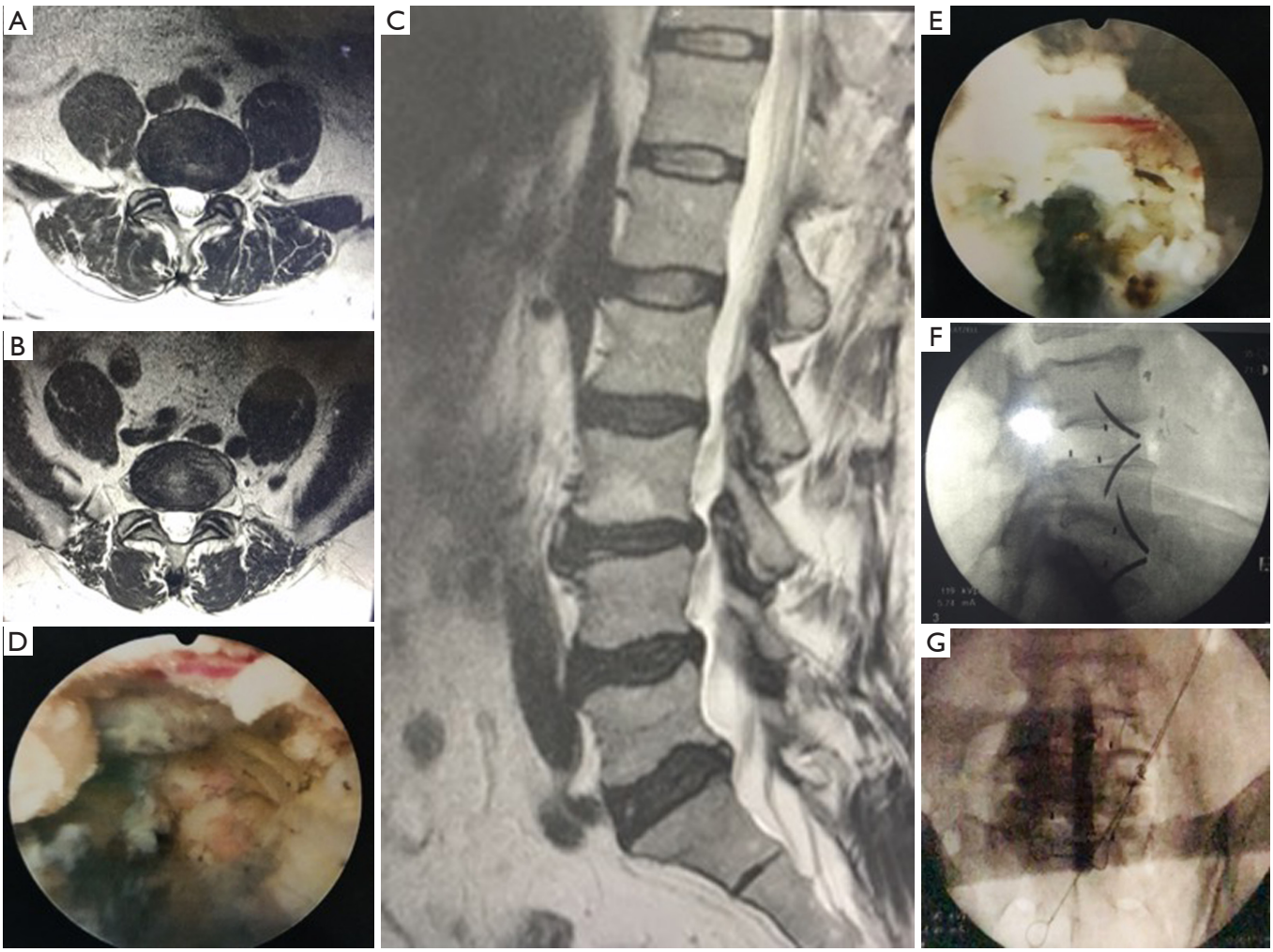

Figure 3 Exemplary case of a 61-year-old male complaining of low back pain and right lower extremity radiculopathy to the foot both level 8 in severity 3 months after a motor vehicle accident. The patient suffered from facet joint degeneration and had a history of alcohol abuse and had a BMI of 28. Physical examination revealed loss of lumbar lordosis, paraspinal muscle spasms, tenderness over the lumbar facet joints, and decreased range of motion to flexion and extension. The patient had a positive straight leg raise on the right side. (A,B,C) The MRI scan showed L3–4 disc bulge with facet fluid and hypertrophy, L4–5 left paracentral herniation with annular tear and bilateral facet hypertrophy, and L5–S1 left paracentral disc herniation with facet degeneration and fluid suggestive of instability; (A,B) the axial cuts also suggested foraminal stenosis noted at L4–5, L5–S1 due to facet degeneration. Initially, the patient was treated with a left-sided endoscopic discectomy at L4–5 and L5–S1; (D,E) intra-operative findings showed large annular tears with annular insufficiency. The postoperative course showed no relief of axial pain and dysesthesia radicular pain due to irritation of the dorsal root ganglion; (F,G) this patient had three risk factors: large annular defects, facet degeneration, stenosis. Ultimately, an ALIF was performed to lessen both axial and radicular pain. BMI, body mass index; MRI, magnetic resonance imaging; ALIF, anterior lumbar interbody fusion.

two patients had a psychiatric history and another abused alcohol. The others all had facet degeneration. One patient had instability and fibromyalgia.

The outcomes of this study support the efficacy of endoscopic discectomy for relief of radiculopathy and axial pain from symptomatic lumbar disc herniation. Relief of axial pain may not be complete, as other pain generators may be present, such as facet pathology. As is the case with other discectomy techniques, larger herniations do not fare as well as smaller ones. Large annular defects do

not heal completely and remain visible on subsequent MRI. Patients with a known psychiatric history should be counseled preoperatively that complete pain relief may be an unrealistic expectation. These patients are less likely to rejoin the workforce.

This retrospective study has limitations. The sample size is small, precluding it from sophisticated statistical analysis because of lack of power. Preoperative images were performed at different institutions, and their respective reports were of variable quality. Lastly, our follow up for these cases is only 6–18 months. At least in part, some of these limitations are a result of societal pressure. Patients seeking an endoscopic, minimally invasive solution to intractable pain will not allow randomization to an open procedure. Often even in the presence of instability, authorization for fusion might not be forthcoming. Many patients with instability will prefer an attempt at pain relief with discectomy because of the stigma associated with spinal fusion, and its potential failure and a long convalescence. The concepts presented herein should be validated on a larger patient sample.

Conclusions

Endoscopic discectomy safely and reliably reduces axial pain and radiculopathy from lumbar disc herniation. Risk factors predictive of less favorable outcomes include advanced degenerative changes of the intervertebral disc and the facet joint complex, large herniations, psychiatric history, obesity, instability, and tobacco use. The presence of persistent axial pain in patients with instability suggests a need for additional study for techniques to lessen this symptom. The merits of adding fusion to the endoscopic spine surgery needs to be evaluated further to see if this can help this subset of patients. We typically advise them that fusion surgery may be required for more reliable pain relief. Follow up diagnostic work-up for vertical instability may be demonstrated by progressive disc space collapse. The risk factors shown to contribute to poor outcomes, at a minimum, need to generate discussion with patients preoperatively to advise them that incomplete pain relief is a possibility as is the need for additional surgery. Follow-up studies with larger patient numbers will need to validate the concepts presented herein with statistical power.

Acknowledgments

None.

Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. IRB approval was obtained for this study (CEIFUS 106-19). Written informed consent was obtained from the patient for publication of this Original Study and any accompanying images.

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