

# Multilevel Unilateral Pedicular Screw Fixation with Interbody Fusion in Surgery of Double- and Triple-Segment Lumbar Disc Pathology

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## ABSTRACT

**Background Data:** In double- and triple-segment lumbar disc herniation, a facet hypertrophy is more encountered specially in the same side of disc herniation with subsequent ipsilateral concave curve scoliosis. Lumbar fixation with interbody fusion surgery is a scientific and feasible option. Some authors believe that unilateral pedicle screw fixation can provide similar biomechanical support to the traditional bilateral pedicle screw fixation.

**Purpose:** To assess the strategy of use of unilateral pedicle screw fixation with lumbar interbody fusion in surgical treatment of multilevel (2-3) symptomatic lumbar disc herniation syndromes.

**Study Design:** Retrospective observational analytic study.

**Patients and Methods:** Retrospective evaluation of 216 patients' files who underwent unilateral pedicular screws fixation for management of degenerative lumbar disc pathology, from July 2007 to June 2017. Only 24 patient's files were selected with multilevel symptomatic lumbar disc prolapse who were managed by unilateral pedicular screw fixation with interbody fusion. All patients were presented with symptoms of nerve root compression. Patients' data included age, gender, levels of disc prolapse, preoperative and postoperative Visual Analogue Scale (VAS) for back and leg and Oswestry Disability Index (ODI) for functional outcome, presence of complications, and finally patients' satisfaction according to Odom's criteria. VAS and ODI were retrieved preoperatively, immediately postoperatively, and 6 months postoperatively.

**Results:** They were 18 males (75%) and 6 females (25%) with a male-to-female ratio of 3:1 and age ranging 35–63 years with a mean age of  $49 \pm 9.8$  years. Double-level disc prolapse was recorded in 20 (83.3%) patients, while it was triple in 4 cases (16.7%). At the last follow-up, back pain VAS improved from  $7.5 \pm 1.47$  to  $1.12 \pm 1.03$ , leg pain VAS from  $8.7 \pm 1.04$  to  $0.33 \pm 0.63$ , and ODI from  $78 \pm 8.3$  to  $11.08 \pm 4.6$ . Excellent and good Odom's outcomes were reported in 95% of our patients.

**Conclusion:** Our study suggests that unilateral pedicular screw fixation with interbody fusion for the management of multiple level ipsilateral lumbar disc disease could be considered as an effective and less invasive method with satisfying clinical outcomes. (2019ESJ191)

**Keywords:** Lumbar spondylosis, Transforaminal lumbar interbody fusion, TLIF, Unilateral fixation.

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## INTRODUCTION

Lumbar fusion is a widely used means for surgical management of degenerative lumbar diseases including spinal canal stenosis, spondylolisthesis, and lumbar disc herniation, both de novo or recurrent. Pedicle screw fixation is mandatory to achieve a stable fixation regarding satisfactory bone fusion rate and corrected alignment.<sup>6</sup>

Many studies<sup>4,17,2,1</sup> discussed the issue of bilaterality of screw insertion in lumbar disc pathologies. The results were not clear regarding clinical and radiological outcomes.<sup>17</sup> Other studies<sup>15,10</sup> found that unilateral fixation harbored poorer biomechanical criteria, whereas, theoretically, unilateral fixation offers much shorter operative time, less bleeding, and less costs.<sup>7,16</sup> Therefore, unilateral fixation is considered spine surgery's grey zone and its efficacy is still not fully understood.<sup>5</sup> The evaluation of the technique should be judged by revising the spectrum of clinical and radiological differences pre- and postoperatively.<sup>7</sup> Lumbar interbody fusion techniques, including posterior and transforaminal approaches, combined with pedicle screws fixation can additionally provide anterior column support and hence further local stability.<sup>18,4,8</sup>

The MRI and CT scans reveal a sizable ipsilateral disc protrusion in another level in addition to a significant recurrence of the previous disc site. This double-level unilateral compression may be accentuated by facet hypertrophy in one or both sides. A noninstrumented surgery for multilevel nerve root decompression does not solve the deformity and could progress to further long-term complications that may require a third operation. Herein, the purpose of this retrospective study was to assess the strategy of use of unilateral pedicle screw fixation with lumbar interbody fusion in surgical treatment of multilevel (2-3) and ipsilateral symptomatic degenerative disc disease.

## PATIENTS & METHODS

From July 2007 to June 2017, 216 patients' medical records were retrospectively examined. Only 24 patients were selected with multilevel ipsilateral (2-3) symptomatic lumbar disc prolapse who underwent operation with unilateral pedicular screw with interbody fusion for the study of the clinical and radiological outcome over a postoperative follow-up time between 24 and 36 months.

Inclusion criteria were as follows: (1) all patients presenting with strictly unilateral symptoms of nerve root compression (neurological deficit, motor weakness, and intolerable sciatica); (2) patients failing to respond to conservative management for up to a period of 3 months, where patients' work and life were compromised; (3) preoperative MRI revealing sizable ipsilateral multiple level (2-3) disc protrusion with or without facet hypertrophy. Exclusion criteria involved the following: (1) patients with poor general condition that preclude surgical intervention; (2) patients presenting with bilateral nerve root compression symptoms; (3) advanced spinal instability ruling out unilateral pedicle screw fixation.

Patient's preoperative clinical evaluation included full neurological assessment, Visual Analogue Scale (VAS) for back and leg pain, and Oswestry Disability Index (ODI). VAS and ODI were then retrieved immediately postoperatively and after 6 months; the presence of any neurological symptoms, emergence of any complications, and finally patients' satisfaction according to Odom's criteria were assessed.

Radiological evaluation included preoperative dynamic X-ray of the lumbar spine and MRI showing level of disc prolapses and postoperative X-rays of the lumbar spine immediately postoperatively, at three months, and then at six months. Successful fusion was described as continuous bone bridging on plain radiographs between vertebrae.<sup>18</sup>

We have selected a surgical method of unilateral pedicular fixation with multilevel interbody fusion in certain situations: (1) two or three levels

of radiological nerve root compression whether discal or hypophyseal or retrolisthesis and disc space narrowing with lateral gutter syndrome; (2) both levels being symptomatic, and if surgery is indicated, both should be dealt with at the same time; (3) the presence of segmental instability or deformity like loss of lordosis and scoliosis, or even iatrogenic instability which should be well expected and eventually avoided; (4) manifestation being strictly unilateral with no doubt of contralateral nerve root compromise.

### **Surgical Technique**

After induction of general anesthesia and positioning of the patient in the prone position, midline posterior lumbar incision is made. Subperiosteal muscle separation is performed. The side is chosen according to clinical and radiographic criteria.

The technique of transpedicular screw insertion is performed through the standard conventional fashion. Insertion of interbody fusion cage is initiated after emptying the targeted discs through the symptomatic side by curetting the space deep to the annulus and removing any fragment, with subsequent resection of the inferior facet (of the superior vertebra) and the upper segment of the superior facet (of the inferior vertebra) to expose the neural foramen. Then, single PEEK (polyetheretherketone) cage interbody device (EgiFix™, Egypt) is packed with bone cement (high viscosity with antibiotic augmentation). Usually, after facet hypertrophy is crushed by a rongeur, this will not prevent the disc space distraction by the TLIF cage especially if it is accurately centrally and anteriorly placed. This has been conducted by the following: (A) screw distraction; (B) introduction of the cage; (C) loosening of nob of screws; (D) rotation of cage; (E) further tightening of nob under radiological control. Wound was closed in layers and insertion of drain after hemostasis is accomplished.

Statistical analysis was conducted by SPSS software. All data were presented in mean  $\pm$  standard deviation (SD).  $P < 0.05$  was considered

significant. Paired data were tested by Wilcoxon's signed-rank test.

## RESULTS

Twenty-four patients were suffering from multilevel lumbar disc pathology presenting with strictly unilateral symptoms of nerve root compression and they were subjected to unilateral pedicular fixation with multilevel interbody fusion. They were 18 males (75%) and 6 females (25%) with a male-to-female ratio of 3:1 and age ranging from 35 to 63 years with a mean age of  $49 \pm 9.8$  years. Double-level disc prolapse was recorded in 20 (83.3%) patients, while it was triple in 4 cases (16.7%).

In our study, unilateral fixation was left-sided in 14 (58.3%) cases and right-sided in 10 (41.6%) cases. Five cases (20.8%) underwent operation previously at the same or adjacent level (recurrent degenerated disc prolapse). The levels that were targeted in surgery were L2-L5 in 1 patient (4.2%), L3-S1 in 3 patients (12.5%), L3-L5 in 7 patients (29.5%), and L4-S1 in 13 patients (54.2%), as depicted with levels L4-S1 being the most commonly targeted levels (54.2%) (Table 1).

All patients were examined clinically and compared according to pain (VAS) and disability index (ODI) preoperatively, postoperatively, and at 6-month postoperative follow-up period, revealing that there was a very good outcome regarding leg and back pain and also the disability index was reduced at 6-month follow-up with  $P < 0.001$ , showing a statistical significance for improvement of pain and disability status between pre- and postoperative time. At 6 months, drop of pain scores in back and leg was estimated to be 85% and 96%, respectively. At the last follow-up, back pain VAS improved from  $7.5 \pm 1.47$  to  $1.12 \pm 1.03$ , leg pain VAS from  $8.7 \pm 1.04$  to  $0.33 \pm 0.63$ , and ODI from  $78 \pm 8.3$  to  $11.08 \pm 4.6$  (Table 2).

In our study, the clinical outcome and improvement were assessed according to Odom's criteria of outcome and revealed that excellent outcome (no complaints referable to the lumbar disc disease and

no functional impairment) was found in 17 patients (70.8%), good outcome (intermittent discomfort without significant functional impairment) in 6 patients (25%), and fair outcome (subjective improvement but significant functional limitations) in 1 patient (4.2%) (Table 3).

There were only 5 cases (20.8%) in our study presenting with recurrence. All clinical data were compared again between recurrent and de novo cases. Presence of insignificant *p* values in preoperative pain and disability scales refer to homogenous distribution of recurrent cases among de novo cases. However, insignificant *p* values in postoperative intervals refer to unequal results (i.e., a recurrent case does not mean unimproved outcome) (Table 4). Excellent and good outcomes were found in 40% of recurrent cases, while 78.9%

of excellent cases were found in de novo cases. Low result was found in recurrence group. By conducting regression analysis, it has been found that recurrence affects outcome by 40% (*P*=0.035). Complications rate in our small nested retrospective study was found to be 41.6% (10 patients) and included the following: back stiffness in 2 patients (8.4%), neurogenic claudication in 1 patient (4.2%), numbness along S1 in 1 patient (4.2%), partial foot drop and numbness along L5 in 1 patient (4.2%), CSF leak in 1 patient (4.2%), temporary weakness in 1 patient (4.2%), and superficial wound infection in 3 patients (12.6%). Almost all complications were treated conservatively and, as depicted, superficial wound infection and back stiffness were among the most encountered complications (21%) (Table 5).

**Table 1.** Levels of lumbar spine targeted in our surgery.

Level	Frequency	Percent
L2-L5	1	4.2
L3-S1	3	12.5
L3-L5	7	29.2
L4-S1	13	54.2

**Table 3.** Patient outcome according to Odom's criteria.

	Frequency	Percent
Excellent	17	70.8
Good	6	25
Fair	1	4.2
Total	24	100

**Table 2.** Comparison of pain scale and disability index pre- and postoperatively.

	Preoperative	Postoperative	6 months	P value
Back VAS	7.5±1.47	3.3±1.2	1.12±1.03	0.0001
Leg VAS	8.7±1.04	1.95±0.8	0.33±0.63	0.0001
ODI	78±8.3	28.3±8	11.08±4.6	0.00001

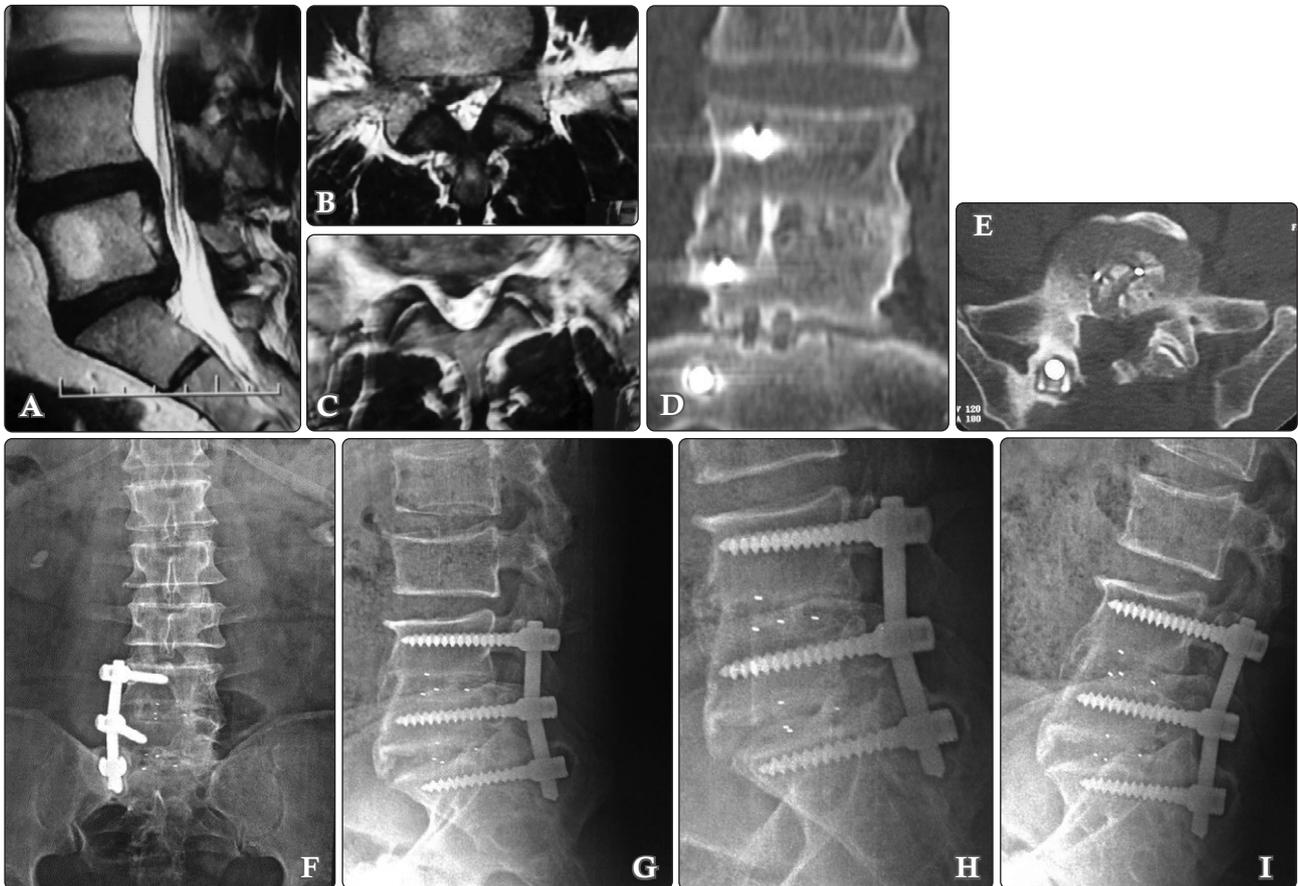
**Table 4.** Impact of recurrence on outcome parameters.

Parameters No (N=20)	Recurrence		P Value	
	Yes (N=5)			
Back pain VAS	Preop	7.58±1.54	7.20±1.30	0.81
	Postop	3.32±1.16	3.60±1.52	0.48
	6 mos Postop	1.21±1.08	.80±.84	0.82
Leg pain VAS	Preop	8.68±1.06	8.80±1.10	0.577
	Postop	2.00±.82	1.80±.84	0.877
	6 mos Postop	.42±.69	.00±.00	0.34
ODI	Preop	78.5±37.94	76.20±10.64	0.49
	Postop	28.37±8.10	28.40±8.96	0.266
	6 mos Postop	11.47±4.78	9.60±4.16	0.925

Preop: preoperative; Postop: postoperative; mos: months; ODI: Oswestry Disability Index; VAS: Visual Analogue Scale.

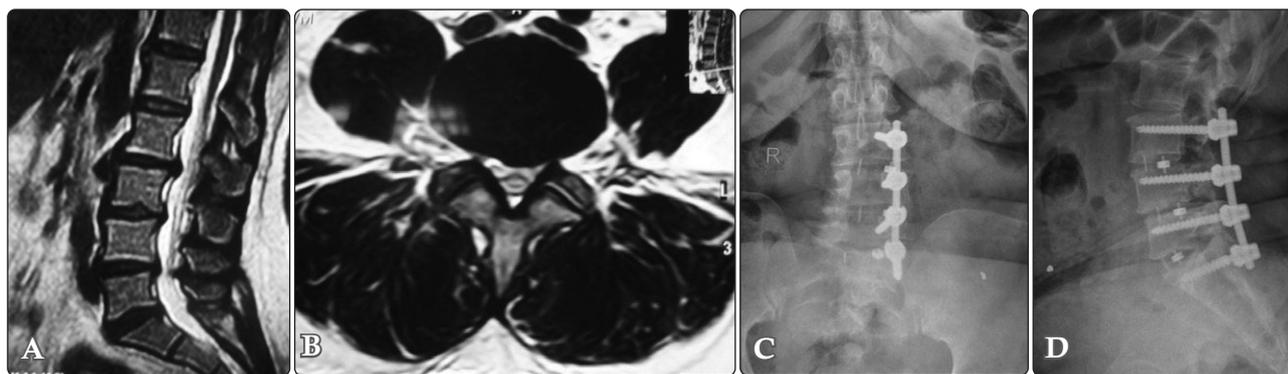
**Table 5.** Complications reported in this study.

Parameters	Frequency	Percent
Back stiffness	2	8.4
Neurogenic claudication	1	4.2
Numbness along S1	1	4.2
Partial foot drop and numbness along L5	1	4.2
Superficial wound infection	3	12.6
CSF leak	1	4.2
Temporary weakness	1	4.2
Total	10	41.6



**Figure 1.** A 42-year-old male patient presenting with low back pain and right leg pain (VAS scores for back and leg were 6 and 10, resp.). ODI was 88. MRI lumbosacral spine revealed L4-L5-S1 disc prolapses. (A-C) Unilateral fixation and TLIF were performed (D-K). Apart from numbness at S1 dermatome, no major complications emerged during or after surgery. Patient recorded fair results when he was questioned about results. Postoperatively, both back and leg pain scores were 2. Six months later, leg and back pain completely disappeared (i.e., equal to zero on VAS score). ODI immediately postoperatively and after 6 months was 20 and 6, respectively.

Preoperative MRI lumbosacral spine sagittal T2-WI weighted image: (A) sagittal and axial images showing (B) L4-L5 and (C) L5-S1 degenerated prolapsed discs centrolateral more to the right side. Postoperative MS-CT scan of lumbosacral spine coronal (D) and reformatted L5/S1 axial (E) images showing interbody fusion cages at L4-L5 and L5-S1 level with unilateral screwing of L4-L5-S1 pedicles 6 months postoperatively. Note complete fusion at L4/L5 and incomplete fusion at L5/S1. Plain X-ray lumbosacral spine 6 months postoperatively; (F) anteroposterior, (G) lateral, (H) flexion, and (I) extension views showing stable construct of a two-level interbody fusion.



**Figure 2.** A 57-year-old female patient presenting with severe low back pain and left leg pain (VAS scores for back and leg were 7 and 10, resp.). Her preoperative ODI was 81. Her MRI for lumbosacral spine revealed three levels of lumbar disc prolapse more to the left side particularly at L4-L5-level (A,B). Unilateral left side fixation and interbody fusion insertion were performed at L3-S1 (C,D). No major complications took place. Patient scores for back and leg pain were 3 and 2, respectively, following surgery. Six months later, leg and back pain were 2 for both describing satisfactory clinical outcome. Her ODI postoperatively and at 6 months following surgery shows a result of 30 and 15 respectively.

Preoperative MRI lumbosacral spine: (A) sagittal T2-WI showing L3/L4, L4/L5, and L5/S1 degenerated disc prolapse discs and (B) axial T2-WI showing L4/5 disc more to the left side. Plain X-ray for the lumbosacral spine 6 months postoperatively and (C) anteroposterior and (D) lateral views show stable construct and adequate interbody fusion at all levels.

## DISCUSSION

The optimal surgical management for degenerative spine disorders including disc herniation syndromes remains controversial. Lumbar interbody fusion is an efficient surgical option for patients with instability and disc prolapse by limiting segmental motion and reducing mechanical stress at the involved space<sup>11</sup>. Insertion of screws together with this technique is designed to provide and ensure stability<sup>18</sup>. Some authors speak about the disadvantages of the unilateral approach because it may cause fewer fusion rates and less stabilization and cage migration compared to the bilateral approach.<sup>14</sup>

According to literature, previous researches of biomechanical studies show negative impact regarding the biomechanical properties of unilateral fixation procedure in maintaining adequate stability of the spine to promote fusion. Meanwhile, it has other advantages shown in a study by Goel et al.<sup>6</sup> who have shown that unilateral pedicular screws fixation has reduced the rigidity and diminished stresses arising in adjacent upper

and lower spinal levels. A study by Kasai et al.<sup>9</sup> reported that the spinal stability reported by unilateral pedicular screws fixation was less than that achieved by bilateral fixation in all directions. However, some authors were satisfied with the cons and pros of unilateral pedicular screws fixation including Chen et al.<sup>2</sup> who reported that unilateral fixation with cage insertion was a good alternative to bilateral fixation in maintaining the stability of the lumbar spine. Additionally, in 1992, Kabins et al.<sup>8</sup> reported a similar fusion rate in the unilateral screw fixations group compared to the bilateral pedicle screw spinal fixations group. Xianzhou Li et al.<sup>20</sup> in their meta-analysis have reported that there was no significant difference detected between their two groups of patients in terms of primary outcomes. There was no significant difference regarding the fusion rate between the bilateral and unilateral approaches showing that the efficacy of unilateral pedicular fixation procedure might be similar to the bilateral pedicular fixation procedure. Meanwhile, they reported a tendency toward a higher fusion rate in patients treated with bilateral pedicular screws

fixation. This result reported that although unilateral instrumentation may provide sufficient stability, greater stiffness of the bilateral screw led to a higher fusion rate.

Our study showed competent clinical and radiographic results of unilateral screws compared to bilateral fixation, denoting that unilateral pedicular screws (PS) fixation with interbody fusion for multiple level ipsilateral lumbar disc herniation syndromes can provide efficient stability to promote fusion; satisfactory clinical outcomes based on VAS, ODI, and Odom scores were demonstrated, with further advantages of reducing operative time, intraoperative blood loss, and hospital stay, and complete avoidance of manipulating the contralateral “virgin” root and possible hazards of contralateral screws application.

In vitro models showed that the stability obtained by bilateral fixation is much higher than that seen in unilateral pedicular screws fixation.<sup>14</sup> However, the accompanied limitation of certain movements at range of motion can be predisposed to fusion failure.<sup>3,10</sup> On the other hand, unilateral fixation is found to be fair enough to accomplish what bilateral screws can do. Kabins et al.<sup>8</sup> studied this fact earlier comparing the clinical and radiographic results between unilateral and bilateral fixation with L4-L5 fusions with a similar sample size involving 16 and 20 patients, respectively.

Liu et al.<sup>11</sup> conducted a meta-analysis to compare unilateral versus bilateral screw fixation in lumbar interbody fusion. They also found that unilateral pedicle screw fixation appears to be as safe as bilateral fixation with less operation time and less blood loss. This is in accordance with the results obtained by Wang and coworkers<sup>19</sup> who found no superiority between two methods for lumbar interbody fusion in degenerative lumbar spine in terms of functional and radiological outcomes; however, less blood loss was correlated with unilateral approach. Similar clinical findings were reported by Luo et al.’s<sup>13</sup> meta-analysis assessing the feasibility of lumbar interbody fusion and unilateral fixation versus bilateral fixation, as less

complications were reported in unilateral fixation cases.

To sum up, blood loss, complication rates, medical expenses, operating time, and hospital stay are in favor of unilateral compared to bilateral fixation.<sup>1,6,10,12,13</sup> Although our study harbored some limitations including relatively small sample size, it showed satisfactory midterm clinical outcomes. Additionally, a comparative study with a larger number of cases and long-term follow-up between unilateral and bilateral pedicular screws fixation with interbody fusion for treatment of unilateral multiple level disc herniation would be recommended.

## CONCLUSION

Our study suggests that unilateral pedicular screws fixation with interbody fusion for the management of multiple level ipsilateral lumbar disc diseases could be considered as an effective and less invasive method with satisfying clinical outcomes, while reducing operative time, blood loss, and hospital stay.

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## الملخص العربي

### التثبيت المتعدد المستويات من جانب واحد بالمسامير اللولبية مع الدمج بين الفقرات في جراحة اعتلال الغضروف القطني المزدوج أو الثلاثي

**البيانات الخلفية:** في الحالات المزدوجة من فتق الغضروف القطني أو الثلاثية، يكون التضخم المواجه أكثر وضوحًا وخاصة لو كان فتق الغضروف متتالي في نفس الجانب أو على جانب واحد مسببا انحناء جانبي غير طبيعي في الفقرات. والتثبيت للفقرات القطنية مع جراحة الدمج بين الفقرات هو خيار علمي ومجد في حين يعتقد البعض أن التثبيت بالمسمار يمكن أن يوفر دعمًا ميكانيكيًا حيويًا مشابهًا للتثبيت التثائي التقليدي بالمسمار الجراحي.

**الغرض:** هدفنا هو تقييم استراتيجية استخدام التثبيت بالمسمار من جانب واحد مع الدمج بين الفقرات القطنية متعددة المستويات في العلاج الجراحي لمتلازمات فتق الغضروف القطني متعددة الأعراض

**تصميم الدراسة:** دراسة تحليلية وصفية عن طريق الملاحظة بأثر رجعي

**المرضى وطرق البحث:** قمنا بتقييم عدد 216 ملف بأثر رجعي للمرضى الذين خضعوا لتركيب مسامير جراحية من جانب واحد لرعاية أمراض الغضروف القطني التنكسية، من يوليو 2007 إلى يونيو 2017. تم اختيار عدد 24 حالة من إجمالي الحالات متعددة المستويات التي تم علاجها بتركيب مسمار جراحي على جانب واحد مع الدمج الفقاري كل الحالات كانت تعاني من أعراض الضغط على جذر العصب وتم جمع بيانات كل المرضى وتضمن العمر والجنس ومستوى الفتق الغضروفي وتم الأخذ في الاعتبار مدى شدة الألم بقياساته المختلفة قبل وبعد الجراحة وحدثت أي مضاعفات جراحية وتم تجميع البيانات قبل الجراحة وبعدها مباشرة وبعد ستة أشهر.

**النتائج:** أظهرت النتائج أن معدل المضاعفات الجراحية نسبها 41.6% من جميع الحالات في حين أسفرت النتائج عن حدوث تحسن ممتاز بنسبة 40% من الحالات الانتكاسية وبنسبة 78.9% من الحالات التي لم يسبق لها إجراء جراحة من قبل. وبالتحليل الإحصائي تبين أن الانتكاسة تؤثر على النتائج النهائية بنسبة 40%.

**الاستنتاج:** أظهرت هذه الدراسة أن التثبيت الخلفي على جانب واحد مع الدمج الفقاري لمرضى تعدد مستويات الفتق الغضروفي القطني على نفس الجانب هو علاج فعال مع نتائج أفضل إكلينيكيًا بالمقارنة بطريقة التثبيت على الجانبين.