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Midline mini-incision approach with superolateral facet joint quadrantectomy for extraforaminal disc herniations: A modified technique and outcomes

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ABSTRACT

Objectives: Extraforaminal disc herniations constitute 3-12% of all lumbar disc herniations. In the literature, many surgical procedures have been described for extraforaminal disc herniations, including roughly medial and lateral approaches. In our study, we discussed the clinical results of cases in which we applied the superolateral quadrantectomy (resection of the superolateral quarter of the facet joint) technique described in the literature but modified by us, and we made conclusions about the technique. Patient outcomes were evaluated using the Macnab criteria: excellent, good, fair, and poor.

Methods: Between 2019 and 2023, 72 patients who were operated on with the diagnosis of single-level extraforaminal lumbar disc herniation and underwent superolateral facet joint quadrantectomy via mini incision-midline approach in our clinic were retrospectively analyzed.

Results: Preoperative Visual Analog Scale scores were 4-10 (mean: 8.5±2.17). Postoperative scores were 0-1 (mean: 0.3±0.1). According to the Macnab classification, 37 (51.39%) of the patients were evaluated as excellent, and 27 (37.50%) in the third postoperative month. Postoperative follow-up dynamic radiographs showed no instability in patients at the end of the 1st year. There were no perioperative complications in any of the cases.

Conclusions: The modified technique that we have described offers the potential advantages of preserving the facet joint capsule and reducing the size of the incision.

Keywords: Extraforaminal disc herniation, superolateral quadrantectomy, combined approach, mini-incision

Extraforaminal disc herniations constitute 3-12% of all lumbar disc herniations [1-3]. This group includes protruded discopathies extending beyond the neural foramen [4]. However, in some cases, lumbar disc herniation is found simultaneously in foraminal and extraforaminal localization [5]. This is often one of the causes of persistent or recurrent leg pain after micro-decompression of the extraforaminal disc alone [5, 6].

In the literature, many surgical procedures have been described for extraforaminal disc herniations, roughly medial and lateral approaches [6, 7]. Medial or midline approaches include laminectomy, laminotomy, hemilaminectomy, and subtotal or total facetectomy. In almost all of these approaches, access to the extraforaminal region requires significant bone resection and major facet joint removal. This leads to instability and permanent low back pain [6].

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Lateral paraspinal approaches and endoscopic techniques are superior since they do not require bone resection [8, 9]. However, these procedures are more complicated, especially at the L5-S1 level, due to the distance's specific narrow and oblique anatomical structure [10]. Another disadvantage of lateral approaches is the difficulty in reaching the foraminal disc component and the preforaminal bulging, which occurs just before the intervertebral foramen, the opening where spinal nerves exit the spinal column, and which often causes permanent irritation of the associated root. In these cases, an additional medial approach is required [6].

Dereymaeker *et al*. [6] briefly described the superolateral facet joint quadrantectomy. A 4 to 5-cm incision is made targeting the disc space of the herniated level. The aponeurosis is cut using a cautery, and the multifidus is released from the spinous process on one side using a curved chisel until the articular bone is exposed. The facet joint, which is located slightly more cranial to the disc space, is then exposed, and fluoroscopic control is performed. Under microscopic view, the facet capsular ligament of the facet joint and especially the mamilloaxicular ligament at the L2 and L3 level, as well as the medial branch of the posterior ramus are cauterized, and the superolateral quadrant of the facet joint is removed with a high-speed drill. The ligamentum flavum is opened with blunt dissection, and the root is followed to the level where it exits the foramen, and the free fragment is removed. In case of additional preforaminal bulging or herniation, decompression with a classic medial approach may be performed [6]. We have been using the same technique for about five years. However, our technique offers potential advantages, such as preserving the facet joint capsule and reducing incision size, compared to the technique described by Dereymaeker *et al*. [6].

In classical paramedian lumbar disc herniations, it is possible to perform single-distance microdiscectomy microscopically using a 3-5 cm skin incision [4]. However, a longer incision is required for lateral extension in the midline approach defined for extraforaminal lumbar discopathies with a preforaminal component [4]. In extraforaminal disc cases, if the midline approach is to be used, it is necessary to extend laterally from the midline and simultaneously reveal the facet joint. This extension increases the incision approximately two times. However, a shorter skin incision has advantages such as aesthetics, less skin integrity disruption, and less infection risk.

Our study discussed the clinical outcomes of patients with single-distance extraforaminal (with or without multicomponent content) lumbar disc herniation operated on with this technique between 2019 and 2023.

METHODS

The study was started with Bursa Yüksek Ihtisas Education and Research Hospital ethics committee approval with protocol number 2024-TBEK 2024/04-09. Between 2019 and 2023, 72 patients who were operated on with the diagnosis of single-level extraforaminal lumbar disc herniation and underwent superolateral facet joint quadrantectomy via mini-in-

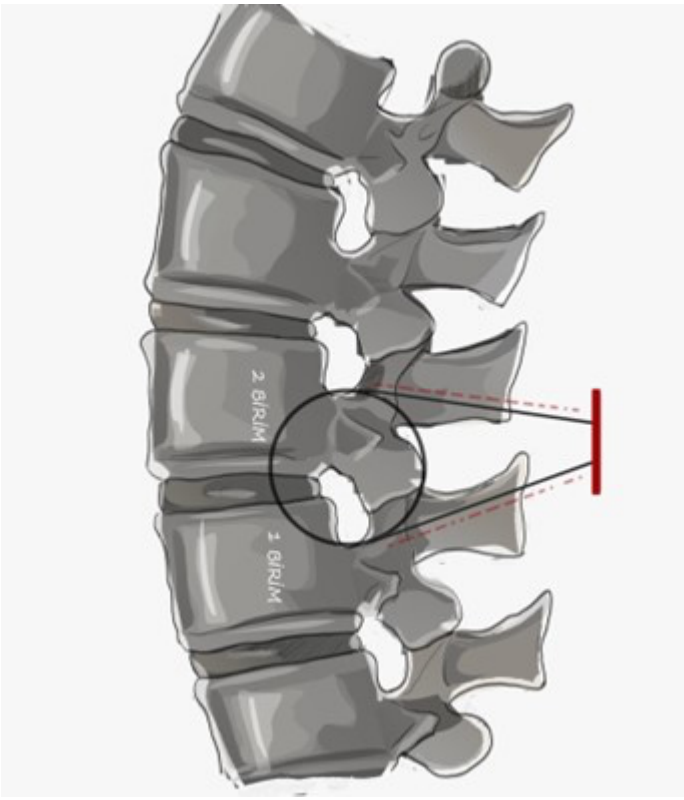

Fig. 1. Lateral view of the lumbar region. A midline, vertical, linear mini skin incision was made. 2/3 of the incision was made on the upper part of the distance and 1/3 on the lower part. A cone-shaped approach was made from the skin to the base to create a sufficient field of view at the base. The thick red line represents the skin incision, the dashed thin red lines represent the cone-shaped approach, and the black circle represents the field of view at the base.

cision midline approach in our clinic were retrospectively analyzed. Age, gender, body mass index, preoperative symptoms, and examination findings were documented. Preoperative lumbar magnetic resonance imagings (MRIs) and follow-up lumbosacral dynamic radiographs were re-examined to determine the levels of intervention and the anatomical compartments of disc herniation and instability findings. The clinical status, length of skin incision, instability, peri-postoperative complications, and follow-up periods were determined according to modified Macnab criteria which are used to evaluate the success of spinal surgery based on pain relief and functional improvement. It categorizes post-surgical outcomes into four levels: "Excellent" means no pain, no restriction of mobility; "Good" indicates occasional non-radicular pain, relief of presenting symptoms; "Fair" signifies some improved functional capacity, still handicapped and/or unemployed; and "Poor" intends continued objective symptoms of root involvement. Based on the data, there were inferences about the technique's clinical advantages and possible disadvantages.

Surgical Technique

All patients were operated on under endotracheal general anesthesia. After general anesthesia, the patients were positioned together with the anesthesia team. The head of the patients who were turned to the prone position was placed in the gelatin headrest, mainly in the neutral midline or rarely on the side, and it was ensured that the eyes were not under pressure in the gelatin headrest. The abdomen and chest were not under pressure in the lumbar frame. In female patients, whether the breasts were free in the frame was checked to prevent necrosis in the breasts.

Subsequently, a vertical, linear mini skin incision was made to the targeted distance after necessary field cleaning, covering, and distance determination with a scope. 2/3 of the incision was made on the upper part of the distance and 1/3 on the lower part (Fig. 1). The aponeurosis was incised with a scalpel, and the paravertebral muscle was unilaterally dissected from the spinous process to the facet joint by using blunt mini spoons and dry sponges. A cone-shaped approach was made from the skin to the base, and a much smaller

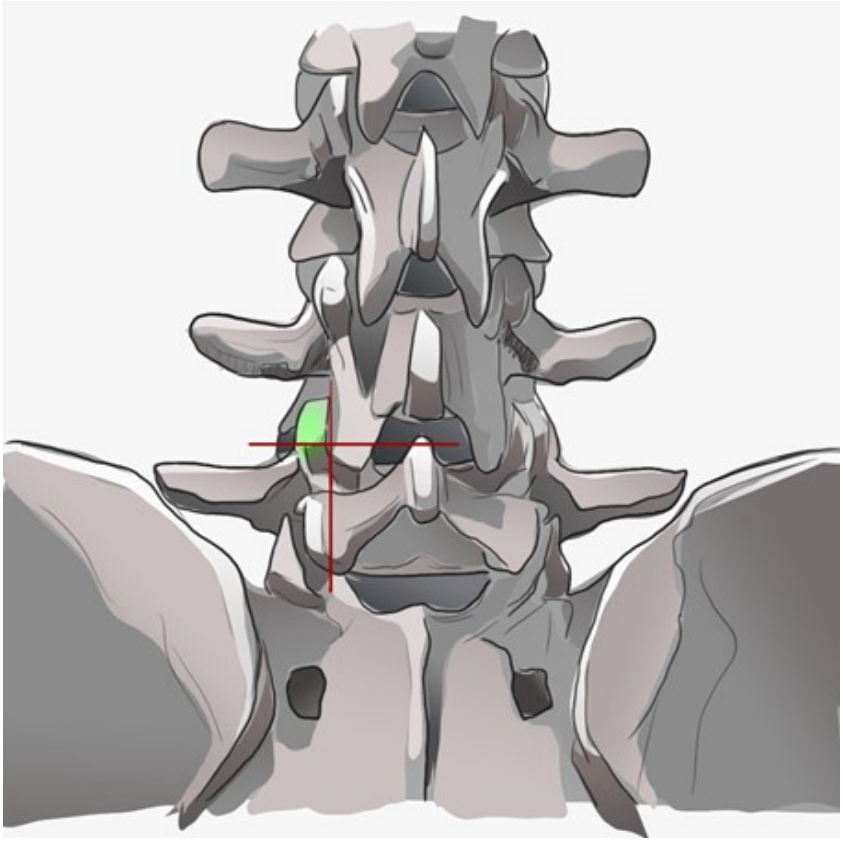

Fig. 2. Superolateral quadrantectomy (The upper outer quadrant of the facet marked in green was removed as described in the technique).

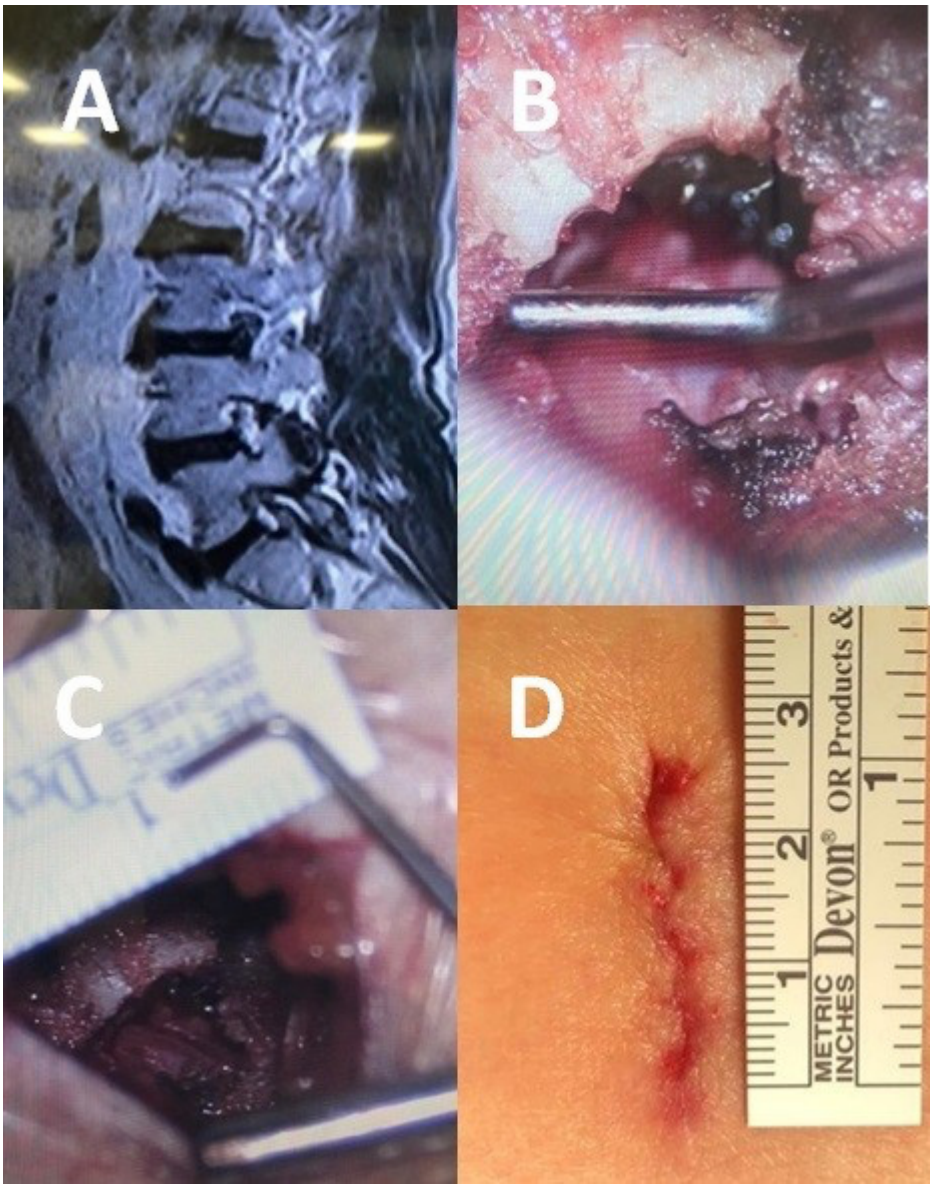

Fig. 3. (A) Lumbar MRI sagittal section, L3-4 right extraforaminal disc herniation, preoperative image. (B and C) Superolateral quadrantectomy of the facet joint. (D) Approximately 2.5 cm long skin incision.

skin incision was made to create sufficient visualization at the base (Fig. 1). After palpation of the facet joint, the microscope was brought to the surgical field with a repeat scope control to verify the distance. All cases were operated under xenon light using a HOX Leica M530 OHX microscope. In the superolateral quadrant of the facet joint, the joint capsule was incised with a number 11 scalpel and scraped upwards with a dissector. The facet capsule was not coagulated in any case. Cautery was not used at any stage of the operation. Then, the superolateral quadrant of the facet joint was removed with the help of thin Kerrison rongeurs (Figs. 2 and 3). (It is essential not to coagulate the facet capsule before this stage and not disrupt the facet joint's nutrition, ¾ of which will be preserved). The lower ligamentum flavum was lifted with the help of a hook and removed with the help of Kerrison rongeurs. The free fragment was found and removed following the upper root to the exit point. Microdiscectomy was performed laterally to the distance in necessary cases.

In many cases, the root may appear completely

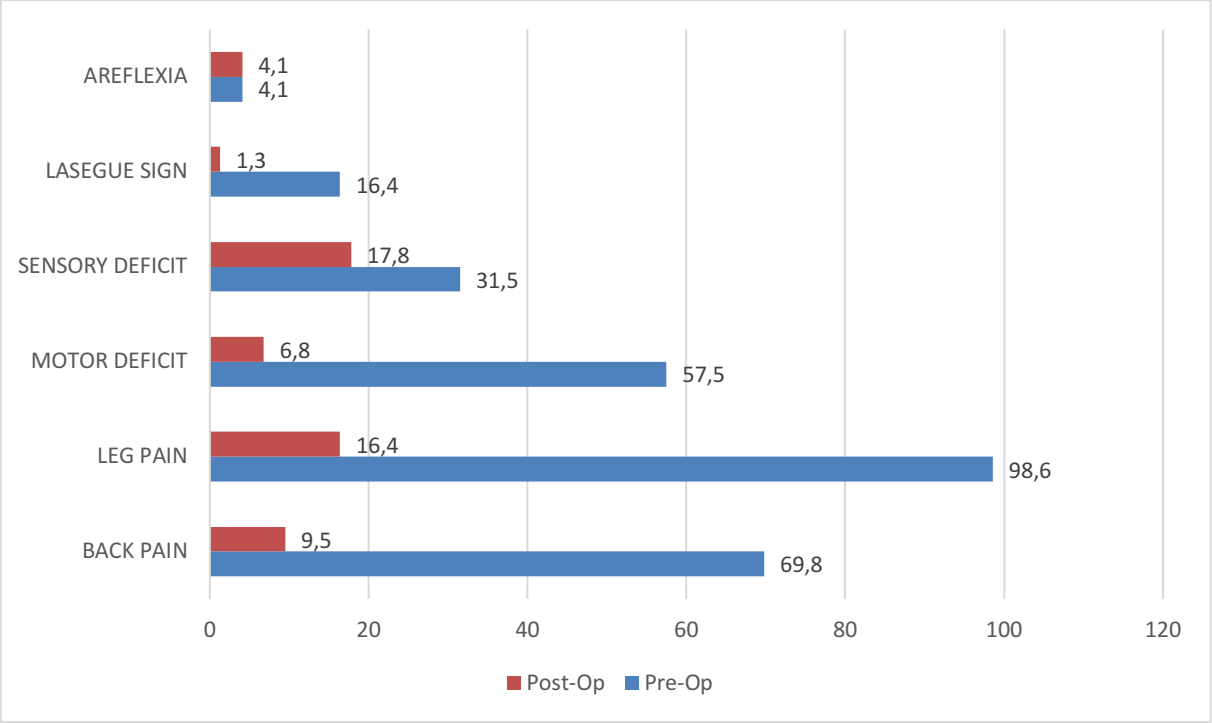

Fig. 4. Results of the McNemar test of motor deficit, sensory deficit, back pain, leg pain, Lasegue's sign, and areflexia comparing the preoperative to postoperative situation. The blue bars represent the preoperative situation and the red bars the postoperative situation. Numerical values indicate the percentage of patients in the study cohort.

flattened secondary to compression, giving the capsule the impression of a disc fragment. Therefore, clear visualization of the root by following the root up to the level of exit from the tectal sac may prevent possible root damage. After removing the disc fragment, the axilla and base of the root were checked with the help of a hook to check whether there were other fragments and whether the root was decompressed entirely. After bleeding control and washing, the folds were closed according to the anatomy.

Statistical Analysis

SPSS 15.0 for Windows statistical package program was used for statistical analyses. Continuous variables are presented as mean±standard deviation or median, categorical variables are presented as numbers and percentages. The conformity of the data to normal distribution and homogeneity of variances were examined using Levene test and Kolmogorov-Smirnov test. Motor deficit, sensory deficit, back pain, leg pain, Lasegue sign and areflexia were compared with the preoperative and postoperative status using the McNemar test. The results are shown graphically. Test results will be considered significant if $P<0.05$.

RESULTS

There were 40 (55.6%) females and 32 (44.4%) males. The age range was 38-72 years (mean: 50.43±13.54 years) in women and 38-64 years (mean: 53.34±9.71 years) in men. Body mass index was 21-39 kg/m2 (mean: 26.98±2.94 kg/m2). The intervened distances were 41 (56.94%) L4-5, 16 (22.22%) L5-S1, 11 (15.28%), L3-4, and 4 (5.56%), L2-3 distances. In 41 (56.94%) cases, discopathy was observed on the left and 31 (43.06%) on the right. Incision length was 2.5-5.1 cm (mean: 3.6±1.47 cm). Preoperative symptom duration was 2-30 days (mean: 11.75±5.76 days); 13 patients had only motor deficits, 29 patients had both motor and sensorial deficits, and three patients had both motor and sensorial deficits and unilateral areflexia (Fig. 4). In 12 cases, the Lasegue test was positive unilaterally. The follow-up period was 12-24 months (mean: 14.20±4.67 months) (Table 1). Preoperative Visual Analog Scale (VAS) scores were 4-10 (mean: 8.5±2.17). Postoperative VAS scores were 0-1 (mean: 0.3±0.1). According to the Macnab classification, 37 (51.39%) of the patients were evaluated as excellent, 27 (37.50%) as good, and 8 (11.11%) as fair

Table 1. Patient characteristics

	Data
Gender (male/female)	32/40
Age (years)	51.72±9.02
BMI (kg/m^2)	26.98±2.94
Level	
L2-L3	4
L3-L4	11
L4-L5	41
L5-S1	16
Preoperative Symptoms	
Back pain	51
Leg pain	72
Presence of motor deficit	42
Presence of sensory deficit	23
Lasegue sign	12
Areflexia	3
Postoperative neuropathic pain	
Presence	8
Absence	64
Incision length (cm)	3.66±1.47
Pre-Op Symptom Duration (days)	11.75±5.76
Follow-up period (months)	14.20±4.67

Data are shown as mean±standard deviation or number (n).

in the third postoperative month. Postoperative follow-up dynamic radiographs showed no instability in patients at the end of the 1st year. There were no perioperative complications in any of the cases. However, neuropathic pain was observed in the early postoperative period in 8 cases. Of the eight patients with neuropathic pain, 6 of them were relieved at the end of the 1st year with medical treatment.

In 63 cases, the root was pushed upward and laterally secondary to the compressing disc fragment from the axilla under the peduncle, whereas in 9 cases, a free fragment was seen that entered under the root instead of the axilla, extended laterally, and pushed the root medially and to the ceiling. Microdiscectomy was not performed in 23 cases, in which only sequestered fragments were observed. In 35 cases, microdiscectomy was performed laterally after removal of the free fragment.

In 24 cases with preforaminal bulging or herniation, paramedian microdiscectomy was performed by performing a classic medial opening in the same field after the lateral approach, lifting and preserving the medial ligamentum flavum after laminotomy.

DISCUSSION

In most lumbar disc herniations, the disc herniation protrudes mediolaterally into the spinal canal. However, the situation is different in extraforaminal lumbar disc herniations. Disc prolapse and nerve compression are at the exit of the intervertebral foramen and lateral to it. Since the compression is towards the cranial end, the axilla of the upper root, the clinical symptoms are caused by the compression of the upper root [5].

Lateral and medial procedures have been described in the surgical treatment of extraforaminal lumbar disc herniation [5, 6, 8, 9, 11]. When medial procedures are analyzed, interlaminar midline interventions are generally described, including laminectomy, laminotomy, hemilaminectomy, and subtotal or total facetectomy. However, case reports of spinal instability after total facetectomy are not few [5]. In the lateral paraspinal approach, reaching the extraforaminal and foraminal regions is possible without bone resection. Studies comparing lateral and medial approaches have reported that lateral interventions give far better results [9, 11]. However, the lateral approach must be revised at anatomically more challenging levels, such as the L5-S1 level [8].

The technique described by Dereymaeker *et al*. [6] is a medial approach with superolateral quadrantectomy to the facet joint and is much more advantageous than the other techniques described. It is a familiar method using anatomical landmarks in classical central or paracentral disc herniations. With this technique, the L5-S1 level can be easily reached, as in all other lumbar levels, and there is no need for extensive removal of the area, iliolumbar ligament, or peduncle [6].

Considering that extraforaminal disc herniation and foraminal, subarticular, paracentral, and central disc compression are also observed in some of these cases, it would be much more advantageous to use a technique that allows both lateral and medial approaches from the same access point instead of the lateral approach in cases involving additional compartments.

However, this technique's disadvantages are that the incision is much longer and the facet capsule is coagulated. The technique we have described is advantageous because it protects the facet joint capsule and reduces the skin incision by approximately half.

It is essential to preserve the anatomical structure as much as possible with a minimally invasive approach in any surgical intervention. From this point of view, it is essential to disrupt the skin integrity minimally and to protect the paraspinal muscles and facet joints as much as possible. Minimal disruption of skin integrity is essential regarding aesthetic appearance, patient psychology, postoperative pain secondary to the incision, and significantly minimizing the risk of infection. In contrast, protecting the underlying paraspinal muscles, facet joints, and the capsule that provides nutrition minimizes the risk of instability. In the study of Dereymaeker *et al*. [6], the rate of postoperative low back pain was reported as 13%, but this was reported as the value in week six. In our study, this rate was 9.7% in the postoperative third month. Our study's lower postoperative low back pain rate than in the original study may be because the facet joint capsule was not coagulated, and the incision was much shorter.

None of the patients operated on with this technique developed wound infection and instability. This may be because the facet joint is protected as much as possible, and the incision is much shorter. According to Macnab's classification, the rate of patients classified as "excellent" and "good" is 88.9%. In addition, the rate of patients with motor deficits recovered completely is around 88% (37 patients).

Limitations

Our study has some limitations. First, our study is a retrospective study with relatively few cases. The mean follow-up time of these cases was limited to approximately 14 months. This did not allow us to perform a long-term analysis. The lack of a comparative group of cases using traditional techniques also limits the ability to demonstrate the technique's advantages. However, our study is important in making a successful technique applied in extraforaminal lumbar discopathies even more advantageous. Prospective long-term studies planned compared to more extensive series may provide more transparent results. This study may be a source of inspiration for future studies.

CONCLUSION

In conclusion, the modified technique we have described offers the potential advantages of preserving the facet joint capsule and reducing the incision size.

Ethical Statement

This study was approved by the University of Health Sciences, Bursa Yüksek Ihtisas Training and Research Hospital, Medical Sciences Ethics Committee (Decision no. 2024-TBEK 2024/04-09, date: 17.04.2024).

Authors' Contribution

Study Conception: TK; Study Design: TK; Supervision: AK; Funding: TK; Materials: AK; Data Collection and/or Processing: TK; Statistical Analysis and/or Data Interpretation: TK; Literature Review: MB; Manuscript Preparation: TK and Critical Review: SB.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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The authors disclosed that they did not receive any grant during the conduction or writing of this study.

Editor's note

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