Received: 11 Oct 2023 | **Accepted:** 16 Oct 2023 **Genel Tıp Derg. Volume** 33/**Issue** 5 (October), 627-632
DOI: 10.54005/geneltip.1374425

ORIGINAL ARTICLE

Is Less Surgical Treatment Possible in the Treatment of Degenerative Spine Diseases? Four-Year Follow-up Results of Foraminal Epidural and Facet Joint Injection Treatments

Dejeneratif Omurga Hastaliklarinin Tedavisinde Daha Az Müdahale Mümkün Mü? Foraminal Epidural ve Faset Eklem Enjeksiyon Terapilerimizin Dört Yillik Takip Sonuçları

[1]Derya Karaoğlu Gündoğdu, [2]Yunus Kaçar

[1]Selcuk University School of Medicine Department of Neurosurgery,Konya, TÜRKİYE
[2]Koru Ankara Hospital, Department of Neurosurgery, Ankara, TÜRKİYE

Correspondence

Derya Karaoğlu Gündoğdu, M.D., Selcuk University School of Medicine Department of Neurosurgery, Konya, TÜRKİYE

E-Mail: derya853@hotmail.com

How to cite ?

Karaoğlu Gündoğdu D. , Kaçar Y. Is Less Surgical Treatment Possible in the Treatment of Degenerative Spine Diseases? Four-Year Follow-up Results of Foraminal Epidural and Facet Joint Injection Treatments. Genel Tıp Dergisi. 627-632.

ABSTRACT

Aim: The study aims to examine the long-term outcomes of foraminal epidural injection and facet joint injection therapies in patients over the age of 60 who have been recommended for surgical intervention for degenerative spinal diseases but have declined surgical treatment due to comorbidities, anesthesia risks, and surgical risks.
Material and Methods: Between 2018-2019, patients over the age of 60 diagnosed with Degenerative Spinal Disease who declined the recommended surgical treatment and underwent foraminal epidural and facet joint injection therapies were retrospectively evaluated. Patients were assessed using the visual pain scale and MacNab classifications during an average follow-up period of 57.14 (45-68) months. Inclusion criteria for the study included patients being continuously followed up and treated at the same center, regularly attending check-up examinations, and not having emergency surgical indications.
Results: The study included 35 patients with an average follow-up period of 57.14 months. Patients were treated with either facet joint or foraminal epidural injections in a single session based on their symptoms and complaints. The most striking result of our study is that the visual pain scale and MacNab classification outcomes after spinal injection therapy can be used as indicators for long-term results.
Conclusion: Sharing the outcomes of commonly practiced spinal injection therapies in the literature more frequently will provide guidance for the treatment planning of challenging conditions, especially like degenerative spinal disease.

Keywords: facet, foraminal, epidural, injection, degenerative, spine

ÖZ

Amaç: Bu çalışma, dejeneratif omurga hastalığı nedeniyle cerrahi müdahale önerilen ancak ek hastalıklar, anestezi riskleri ve cerrahi riskler nedeniyle cerrahi tedaviyi reddeden 60 yaş üzeri hastalarda foraminal epidural enjeksiyon ve faset eklem enjeksiyon tedavilerinin uzun dönem sonuçlarını incelemeyi amaçlamaktadır.
Yöntemler: 2018-2019 yılları arasında, Dejeneratif Omurga Hastalığı tanısı almış, önerilen cerrahi tedaviyi reddedip foraminal epidural ve faset eklem enjeksiyon tedavilerine başvuran 60 yaş üzeri hastalar retrospektif olarak değerlendirildi. Hastalar, ortalama 57.14 (45-68) aylık bir takip süresince görsel ağrı ölçeği ve MacNab sınıflamaları kullanılarak değerlendirildi. Çalışmaya dahil edilme kriterleri arasında hastaların sürekli olarak aynı merkezde takip edilmesi, düzenli olarak kontrole gelmesi ve acil cerrahi göstergelerinin bulunmaması yer aldı.
Sonuçlar: Çalışmaya, ortalama takip süresi 57, 14 ay olan 35 hasta dahil edildi. Hastalar, semptomlarına ve şikayetlerine bağlı olarak tek seansta ya faset eklem ya da foraminal epidural enjeksiyonları ile tedavi edildi. Çalışmamızın en çarpıcı sonucu, omurga enjeksiyon tedavisinden sonra görsel ağrı ölçeği ve MacNab sınıflama sonuçlarının uzun dönem sonuçları için göstergeler olarak kullanılabileceğidir.
Sonuç: Literatürde sıkça uygulanan omurga enjeksiyon tedavilerinin sonuçlarını daha sık paylaşmak, özellikle dejeneratif omurga hastalığı gibi zorlu durumların tedavi planlaması için rehberlik sağlayacaktır.

Anahtar Kelimeler: faset, foraminal, enkeksiyon, dejeneratif, omurga

Introduction

Degenerative Spinal Diseases (DSD) typically exhibit a progressive nature and can potentially lead to limitations in a person's walking distance, malalignment in spinal orientation, and an inability to maintain daily activities (1-3). However, some patients, despite having similar radiological findings, may never require surgical intervention throughout their lives (3-5). This can lead to uncertainties in determining the appropriate treatment method, especially in patients with symptoms ranging from mild to moderate. The term "degenerative spine" encompasses all variations seen across the entire population with age and is defined as a disease when symptomatic (1, 2). Early surgical intervention may not always be the ideal solution for these patients; especially if the symptoms have just begun, it is recommended that patients initially be managed with conservative treatment (3-5). Indeed, many individuals can experience long pain-free periods without surgical intervention. However, excessively delaying surgical intervention is not advised; over time, the benefits to be obtained from surgery progressively diminish (6-8). This study aims to evaluate the long-term follow-up results of patients diagnosed with DSD who were recommended surgical treatment but declined

Peer-Review: Double anonymized - Two External
Plagiarism Checks: Yes - iThenticate
Complaints: geneltip@selcuk.edu.tr

it due to additional diseases, comorbidities, and anesthesia risks, but underwent foraminal epidural injection (FEI) and facet joint intra-articular injection (FJII) treatments. In our study, the characteristics and long-term results of these patients were examined, focusing on two main questions; 1) Should FEI and FJIAI methods be included in the treatment algorithms of degenerative spinal diseases? 2) What is the ideal timing for resorting to surgical treatment in patients diagnosed with DSD?

Material and Methods

Between the years 2018-2019, patients over the age of 60, who were recommended surgical treatment due to DSD but declined surgery because of their comorbidities, anesthesia risks, and the potential risks of surgical treatment, were retrospectively evaluated. The analysis was conducted on patients who met the study criteria during their average follow-up period of 57.14 (45-68) months.

Our inclusion criteria were as follows:

• Patients had not undergone surgical treatment during their follow-up period.

• Patients had been treated with FJII and/or FEI.

• Patients had consistently participated in control examinations.

• None of the patients had any indications for emergency surgery.

• At the time the study was planned, the patients were still alive.

Exclusion criteria included:

• Patients with comorbidities and additional diseases who were no longer alive when the study was planned.

• Those who underwent surgical operations at another center or our clinic during control examinations.

• Patients who only received medical and physical therapy and did not undergo FJII and/or FEI treatment.

• Those who were recommended surgery due to trauma, instability, or similar reasons.

• Patients with evident instability linked to degenerative spinal disease.

• Patients whose complaints were alleviated with medical treatment and rest therapy, and who were not recommended for surgical treatment.

Statistical Analysis

Statistical analysis was conducted using the SPSS 22.0 software. Categorical data were expressed as the number of cases (%) and were compared using the Chi-square test or Fisher's exact test. The normality of the distribution of continuous variables was assessed by the Kolmogorov-Smirnov test.

Results

A total of 35 patients were included in the study. Their average age was 71.8 (ranging from 60 to 92). 51% (n: 18) of the patients were female. The average follow-up duration was 57.14 (ranging from 45 to 68) months. The majority of patients had histories of multiple chronic diseases, anticoagulant use, cardiac angiography, coronary artery disease (CAD), and/or coronary bypass surgery. The distribution of these conditions was as follows: 62.8% (n: 22) had type-2 diabetes (DM), 77.1% (n: 27) had hypertension (HT), 74.2% (n: 26) had a history of cardiac angiography, 51.4% (n: 18) had undergone coronary bypass surgery, 45% (n: 16) were long-term smokers, 88.5% (n: 31) were on anticoagulants, 77.1% (n: 27) had a neurological disease history (like prior strokes, Parkinson's, Alzheimer's, etc.), 37.1% (n: 13) were morbidly obese (body mass index (BMI) > 35), and 65.7% had chronic obstructive pulmonary disease (COPD). No statistically significant differences were observed in the distribution of these comorbidities between genders.

All patients were initially treated with medical and rest therapies. Due to the persistence or even worsening of their symptoms, surgical treatments were suggested. 45.7% (n: 16) were recommended only decompression surgery (Figures 1, 2, 3), while 54.2% (n: 19) were suggested both decompression and instrumentation. None of the patients accepted the surgical intervention, and none underwent surgery during the follow-up period.

The American Society of Anesthesiologists (ASA) assessment given by the anesthetist for these patients indicated a risk stage-4 and 22.8% (n: 8) of the patients refused surgery after preparing for anesthesia.

Patients presented with multiple simultaneous complaints; 54% (n: 19) had leg pain, 71.4% (n: 25) had back pain, 91.6% (n: 33) reported a decrease in walking distance, and 97.1% (n: 34) experienced numbness in their legs.

Those with radiculopathy were treated with foraminal epidural injection (FEI) (Figures 2, 3), while others received facet joint intra-articular injection (FJII) (Figure 1). Specific criteria, such as lateral bending and facet sensitivity tests, were not required for the FJII treatment. 45.7% (n: 16) received FEI, and 54.2% (n: 19) received FJII. All procedures were carried out in the operating room under fluoroscopic guidance without anesthesia. Most patients were discharged on the same day (Figures 1, 2, 3). One patient was observed overnight due to severe hypotension. Another experienced a transient ischemic attack (TIA) during the procedure and was assessed by the neurology department. A patient who underwent FEI experienced sudden loss of strength in the foot after the procedure and was hospitalized; the strength loss improved after 8 hours.

The majority of the procedures were performed with the patient in the prone position. However, two patients with severe scoliosis and pain were treated while lying on their side. Initial assessments were performed using the VAS and MacNab scale were performed. The average VAS scores 4 years prior were 8 (ranging from 6 to 10), with MacNab evaluations being 0% Excellent,

0% Good, 71.4% (n: 25) Fair, and 28.5% (n: 10) Poor.

After injection treatments, early assessments indicated an average VAS of 3.5 (ranging from 1 to 6), with MacNab evaluations being 8.5% (n: 3) Excellent, 57.1% (n: 20) Good, 28.5% (n: 10) Fair, and 5.7% (n: 2) Poor.

Upon evaluating the average 4-year follow-up results, the VAS score averaged 2.5 (ranging from 1 to 4). The MacNab evaluations were 11.4% (n: 4) Excellent, 48.5% (n: 17) Good, 34.2% (n: 12) Fair, and 5.7% (n: 2) Poor.

Both FJII and FEI were targeted at multiple locations during treatments, but no patient underwent procedures in more than one session.

In the 4-year follow-up, 17.1% (n: 6) of the patients received injections for other joints like knees and hips by the orthopedics department. 34.2% (n: 12) received inpatient treatments from the physical therapy and rehabilitation department, and 40% (n: 14) were started on medical treatments due to the intensification of neuropathic symptoms.

Table 1: Patients' VAS and MacNab evaluation results at the time of hospital admission, during their first examination after injection treatments, and after an average of 4 years of follow-up.

	At the time of hospital admission	At the first examination after injection treatments	At the late examination after injection treatments
VAS	8 (6-10)	3. 5 (1-6)	2.5 (1-4)
MacNab;			
Excellent	0%	8.5% (n: 3)	11.4% (n: 4)
Good	0%	57.1% (n: 20)	48.5% (n: 17)
Fair	71.4% (n: 25)	28.5% (n: 10)	34.2% (n: 12)
Poor	28.5% (n: 10)	5.7% (n: 2)	5.7% (n: 2)

VAS: Visuel Analog Scala

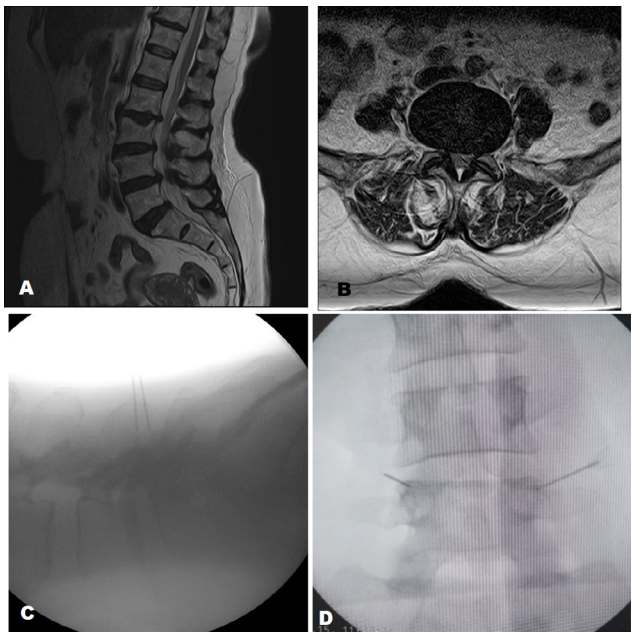

Figure 1: A 72-year-old female patient complaining of a reduction in walking distance for a year. Severe back pain had been present for the last 2-3 months. In her neurological examination, no neurological deficit was detected; neurogenic claudication (NC) was between 20-50 meters, pain was present with bilateral lateral bending, and she described numbness especially in the feet. The patient had a history of diabetes mellitus (DM), hypertension (HT), coronary angiography, and was on anticoagulants. At the time of her admission to the hospital, her MacNab score was reported as "fair". She doesn't describe a significant VAS for leg pain, but when evaluated with back pain, she reports a VAS of 6. **1A)** In the patient's sagittal T2 sections, a narrow L4-5 canal and flavum hypertrophy were observed. **1B)** In the T2 axial sections, bilateral foraminal stenosis and facet hypertrophy were present. Decompression surgery at L4-5 was recommended to the patient. She declined surgical treatment. Instead, intra-articular facet joint injection (IAFJI) pain treatment was applied to the bilateral L4-5 facets. **1C)** The application made under the scope is shown in the sagittal view and **1D)** The procedure, viewed from the front and back, is important both to ensure that the treatment is applied to the correct level and to minimize the risk of neural tissue damage during the application. After the injection treatment, in the patient's early post-treatment evaluations, her VAS result was 1 and her MacNab result was "excellent". Upon reassessment 55 months later, while her VAS result remained at 1, her MacNab score was "good". She reported NC between 50-100 meters.

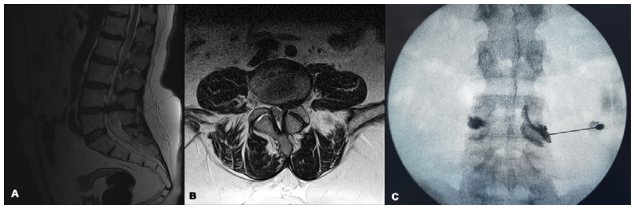

Figure 2: A 63-year-old male patient had been experiencing intensifying pain in the lower back and left leg for 10-15 days. The Straight Leg Raise (SLR) test was positive at 15 degrees. He did not have any notable neurological deficits. His VAS score was 9, and MacNab was described as "poor." The patient had a history of a week-long analgesic treatment and rest, but it had not been beneficial. From the lumbar MRI taken upon his admission: **2A)** Sagittal T2 sections show a narrow canal consistent at the L4-5 distance, with the presence of flavum hypertrophy. **2B)** Axial sections depict a pathology consistent with lumbar disc herniation (LDH) disease, especially on the left side, causing significant L5 root compression and foraminal stenosis. L4-5 facet hypertrophy was also observed. The patient was recommended surgical treatment for L4-5 left LDH: L4-5 discectomy and L5 foraminectomy. The patient had a history of hypertension (HT), diabetes mellitus (DM), and past coronary bypass surgery and was on anticoagulants. The patient, who declined surgery, received an intra-articular facet joint injection (IAFJI) at left L4-5 and **2C)** a Foraminal Epidural Injection (FEI) treatment to the left L5 root. In the early post-procedure evaluation, the VAS score was 3 and MacNab was "good", while after a 67-month follow-up, the VAS score was 1, and MacNab was rated as "excellent".

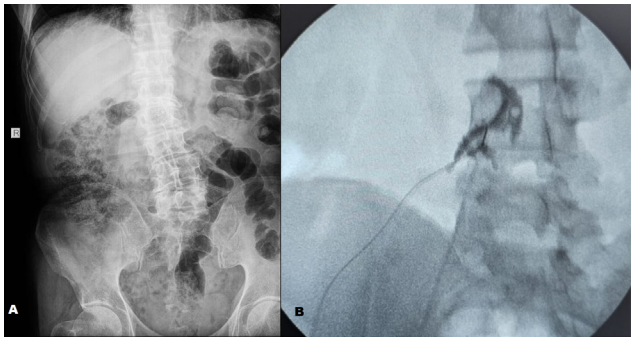

Figure 3: A 91-year-old male patient reports that his long-standing lower back and right hip pain has intensified over the past 3 months. He describes a pain that radiates from the right hip, spreading to the front of the right thigh and down to the ankle. The patient is unable to mobilize independently. His VAS score is 10, and MacNab is described as "poor." **3A)** As can be seen from the patient's anteroposterior (front-back) X-ray, there is a degenerative scoliosis appearance consistent with hypertrophy in the right L4-5 facets and foraminal stenosis. The patient was recommended a surgical treatment involving right L5

foraminectomy and L4 hemilaminectomy. The patient, who has a history of Chronic Obstructive Pulmonary Disease (COPD), Parkinson's Disease, and anticoagulant use, along with his close relatives, declined the surgical treatment. The patient was treated with a right L4-5 Intra-articular Facet Joint Injection (IAFJI) and **3B)** a Foraminal Epidural Injection (FEI) treatment to the right L5 root. In early post-procedure evaluations, the VAS score was 3, and MacNab remained "poor". However, after a 46-month follow-up, the VAS score improved to 2, and MacNab was rated as "good". The patient reported that he was able to mobilize unaided for 5 meters, which is considered "good".

Discussion

Degenerative Spine Disease (DSD) is entirely distinct from other spinal pathologies due to its presentation with varying symptoms from person to person and its treatment exhibiting individual differences (9). While it can be asymptomatic in many patients, significant symptoms can develop in some due to disc degeneration, nerve root compression, or both (9-11). Surgical treatment is not required for DSDs as long as they remain asymptomatic, but close monitoring is always recommended (10). Occasionally occurring mild symptoms typically respond to analgesics and muscle-strengthening treatments (10, 11). In patients whose complaints persistently continue despite non-surgical treatment, decompression and/or fusion therapy may be required (11-13). In today's literature and practical application, questions about when to perform surgical treatment, when fusion should be applied, how extensive a fusion should be carried out, and what treatment should be applied to patients who do not accept surgery, remain unanswered (11). Our study offers significant insights in this regard. We have evaluated the long-term outcomes of FJII and FEI treatments applied to the patients who could not undergo surgical treatment because of serious comorbidities but undoubtedly had surgical indications. When assessed alongside studies in the literature, the approximately 4-year results of the FEI and FJII applications provide quite an extended period of follow-up in terms of pain management treatment (10-13).

Although our study was planned retrospectively, patients were closely monitored by us for 4 years. Assessing the general condition of the patients with the Visual Pain Scale (VAS) during the follow-ups was found insufficient, prompting a search for a simpler evaluation. In this context, the MacNab scale was implemented as the simplest evaluation measure that could summarize the patients' conditions (Table 1). Indeed, the inclusion of many patients from the elderly age group and the presence of neurological comorbidities (such as Alzheimer's, Parkinson's, and past cerebrovascular accidents) underscores the need for clear and simple assessments for these patients. During this process, the most appropriate test was determined as the MacNab assessment, and both the patients and their caregivers were asked to evaluate the patients' symptoms according to the MacNab criteria. Based on the average 4-year follow-up results of the patients, while the VAS was an average of 2.5 (1-4), the MacNab assessment was 11.4% (n: 4) Excellent, 48.5% (n: 17) Good, 34.2% (n: 12) Fair, and 5.7% (n: 2) Poor (Table 1).

In our follow-ups, despite obvious improvements on the VAS scale, there were patients who described their condition as "poor" in the MacNab assessment. Some patients, despite relief from pain, had a significant reduction in walking distance and evaluated their long-term outcomes as "good" on the MacNab test since their main complaint at the time of presentation was pain. The primary reason for this is that all non-surgical treatments for DSDs are pain-focused. Indeed, the earliest improving symptom with non-surgical treatment in these patients has been pain.

Although the VAS and MacNab tests provide a subjective assessment, in our study, it was observed that VAS and MacNab tests without early improvement after injection treatment could be an indicator of poor long-term outcomes. However, a larger patient population is needed for these results to be statistically significant.

In many studies, the variety of symptoms in degenerative spine and the individuality of treatment have been attributed to variations in patients' muscle quality (12-14). Our study also highlights the effect of paraspinal muscles on the pathogenesis in patients who have reported improvement with FJII and FEI treatments. Indeed, our patient population is an elderly group in terms of DSD (Degenerative Spinal Disease). While DSD symptoms peak especially in the 4th and 5th decades, the average age in our study is 71.8 (60-92). Patients included in our study have high comorbidities and poor muscle quality. It is not difficult to speculate that muscle pathology plays as crucial a role in symptom manifestation as DSD does.

In the literature, there are numerous studies examining paravertebral muscles in DSD treatment, and these assessments are typically made through muscle mass measurements in Magnetic Resonance Imaging (MRI) results before and after treatment (7, 8). In our study, there are patients with high comorbidity who did not accept surgical treatment. These patients did not undergo a new MRI. Therefore, patients included in our study are not suitable for mathematical analysis of paravertebral muscles. At the same time, aside from muscle mass, several factors affect the onset of pain and its treatment in these patients. Especially in diabetic patients, after the pain complaint subsided, they described a significant numbness sensation and indicated that the primary pathology obstructing their mobilization was numbness. Consequently, neuropathic treatment was initiated for some patients.

Many complications related to iatrogenic and application factors have been reported in the literature following spinal injections (15-17). Local anesthetics are generally used for analgesia in these injections, and corticosteroids are used in some types of injections. In our study, both local anesthesia and corticosteroids were applied to all patients except for those with irregular blood sugar regulation due to diabetes. Insoluble suspensions were preferred as corticosteroids, allowing for a prolonged effect due to

the gradual release of active ingredients (18-20). No patient received multiple sessions.

The literature emphasizes the potential for temporary erythema, facial warmth, and facial flushing related to corticosteroids, as well as the need for caution regarding increased blood sugar levels in diabetes (16-18). In facet joint intra-articular injections (FJII) and foraminal epidural injections (FEI), multiple sites have been targeted, but no patient received injections in multiple sessions. The primary reason for this approach is to protect patients from the side effects of chronic steroid doses and especially to avoid post-procedural blood sugar regulation challenges in the patient population with diabetes (DM) (12-14). Indeed, frequent use of cortisone injections is not recommended due to the potential to cause bone pathologies. Therefore, not only were repeat applications not performed, but patients were also informed about the possibility of using corticosteroid content in injection treatments applied to other joints by orthopedics, physical therapy, and algology (18-20). In our study, during an average 4-year follow-up, 6 patients (17.1%) had received knee and sacroiliac joint injection treatments by orthopedics and algology.

Allergic reactions and abscess or infection at the site of application are frequently mentioned in the literature regarding spinal injections (21). Serious complications (either temporary or permanent), such as spinal cord infarction, cerebellar infarction, cortical blindness, epidural hematoma, paraplegia, and quadriplegia, have been reported as rare cases in the literature, especially after transforaminal and interlaminar cervical, lumbar, and thoracic injections (22). Kamp and colleagues, with a large series, stated that they did not experience any complications in computerized tomography (CT) and/or fluoroscopy-assisted transforaminal epidural steroid injection applications (23). In our study, all patients were given injection treatment under operating room conditions with fluoroscopy imaging (Figures 1, 2, 3). Nevertheless, one of our patients had a temporary neurological deficit due to the local anesthetic used in the FEE block matching the applied root, but their examination returned to normal after our 8-hour follow-ups. The fact that the patient did not describe any pain, even though the content of the injection and most likely the tip of the needle matched the radix during the procedure, underscores the necessity of performing this procedure with imaging guidance. Even when performed with imaging guidance, the risk is not entirely eliminated. Despite the high comorbidity of the patients included in our study and many of them using anticoagulants, none of our patients experienced complications such as abscess, infection, hematoma, etc. Results like these can create a misconception among physicians and patients underwent spinal injection therapy that the treatment has no complications and is an entirely safe method. However rare complications might be, the possibilities should always be shared with the patient.

Limitations

The retrospective nature of our study, the limited number of our patients, the subjective outcomes provided by the MacNab and VAS evaluations, and the presence of multiple variables affecting our treatment responses due to the high comorbidity of the patients are among the limitations of our study.

Conclusion

Spinal injections have recently become an integral part of conservative treatment for degenerative diseases. The presence of more literature data on this topic and the presentation of larger patient series might pave the way for injection therapies to be recommended as a step before considering surgery for degenerative spinal conditions.

Main Points

1.Degenerative Spine Disease (DSD) is unique due to individual symptom presentations and varied treatment responses.

2.The study's focus was on evaluating the long-term outcomes of FJII and FEI treatments in patients with surgical indications but who could not undergo surgery because of serious comorbidities.

3.Both VAS and MacNab scales were used for patient assessment, with MacNab emerging as a simpler and more effective scale for evaluating conditions, especially in elderly patients with neurological comorbidities.

4.In our study, the overall effectiveness of spinal injections aligns with findings from the broader literature. However, the potential for complications underscores the importance of meticulous procedural planning, the use of accurate imaging guidance, and thorough patient briefing. Adding to existing literature, our findings suggest that a patient's initial response to spinal injection treatments is indicative of their long-term prognosis.

5.Muscle quality and neuropathic conditions play significant roles in symptom manifestation and treatment response for DSD patients.

What This Paper Contributes

Degenerative spine disease manifests with individualized symptoms, making treatment planning equally individualistic. This paper underscores the significance of incorporating spinal injection treatments into conservative treatment strategies, barring any contraindications. An essential observation from our study, which is not heavily emphasized in existing literature, is the correlation between early responses to spinal injections and the patient's long-term prognosis. We noted that patients who experienced relief within the first 24 hours of injection treatment reported sustained improvement during extended follow-ups, even if their degenerative spine diseases progressed.

Ethics Committee Approval

The study protocol was approved by Ankara Koru Hospital Turkey, Ankara Koru Hospital Scientific Researches Ethical Board in conformity with the Declaration of Helsinki (approval date/ number: 2023/3471). Informed consent has been obtained from the patients whose tests and images have been shared.

Authorship Contributions

Concept: DKG, YK, Design: DKG, YK, Supervision: DKG, YK, Fundings: DKG, YK, Materials: DKG, YK, Data Collection and/or Processing: DKG, YK, Analysis and/ or Interpretation:DKG, YK, Literature Search: DKG, YK, Writing: DKG, Critical Review: DKG, YK.

Disclosures

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study had received no financial support.

Resources

1.McPhee B, Swanson CE. The surgical management of degenerative lumbar scoliosis: posterior instrumentation alone versus two stage surgery. Bull Hosp Joint Dis. 1998; 57(1):16–22.

2.Grubb SA, Lipscomb HJ, Coonrad RV. Degenerative adult onset scoliosis. Spine 1988;13(3):241–45.

3.Hanley1 EN Jr. The indication for lumbar spinal fusion with and without instrumentation. Spine 1995; 20 (24):143–53

4.Benner B, Ehni G. Degenerative lumbar scoliosis. Spine 1979; 4(6):548–52.

5.Daffner SD, Vaccaro AR. Adult degenerative lumbar scoliosis. Am J Orthop 2003; 32(2):77–82.

6.Teichtahl AJ, Urquhart DM, Wang Y, Wluka AE, Wijethilake P, O'Sullivan R et al. Fat infiltration of paraspinal muscles is associated with low back pain, disability, and structural abnormalities in community-based adults. Spine J. 2015; 15, 1593–601.

7.Kim WJ, Shin HM, Lee JS, Song DG, Lee JW, Chang SH, et al. Sarcopenia and Back Muscle Degeneration as Risk Factors for Degenerative Adult Spinal Deformity with Sagittal Imbalance and Degenerative Spinal Disease: A Comparative Study. World Neurosurg. 2021, 148, 547–55.

8.Hiyama A, Katoh H, Sakai D, Tanaka M, Sato M, Watanabe M. The correlation analysis between sagittal alignment and cross-sectional area of paraspinal muscle in patients with lumbar spinal stenosis and degenerative spondylolisthesis. BMC Musculoskelet. Disord. 2019; 20, 352.

9.Ploumis A, Transfledt EE, Denis F. Degenerative lumbar scoliosis associated with spinal stenosis. Spine J 2007; 7 :428–36.

10.Tribus CB. Degenerative lumbar scoliosis: evaluation and management. J Am Acad Orthop Surg 2003; 11:174–83.

11.Berven SH, Deviren V, Mitchell B, Wahba G, Hu SS, Bradford DS. Operative management of degenerative scoliosis: an evidence-based approach to surgical strategies based on linical and radiographic outcomes. Neurosurg Clin N Am 2007; 18:261–72.

12.Banno T, Yamato Y, Hasegawa T, Kobayashi S, Togawa D, Oe S, et al. Assessment of the Cross-Sectional Areas of the Psoas Major and Multifidus Muscles in Patients with Adult Spinal Deformity: A Case-Control Study. Clin. Spine Surg. 2017; 30, 968–73.

13.Jermy JE, Copley PC, Poon MTC. Demetriades, A.K. Does pre-operative multifidus morphology on MRI predict clinical outcomes in adults following surgical treatment for degenerative lumbar spine disease? A systematic review. Eur. Spine J. 2020; 29, 1318–27.

14.Zhu W, Wang W, Kong C, Wang Y, Pan F, Lu S. Lumbar Muscle Fat Content Has More Correlations with Living Quality than Sagittal Vertical Axis in Elderly Patients with Degenerative Lumbar Disorders. Clin. Interv. Aging 2020;15,1717–26.

15.Kim JB, Chang MC. Spinal cord injury by direct damage during trigger point injection: a case report. J Int Med Res. 2021;49.

16.Mather LE, Chang DH. Cardiotoxicity with modern local anaesthetics: is there a safer choice? Drugs. 2001; 61:333–42.

17.Zink W, Graf BM. The toxicity of local anesthetics: the place of ropiv-acaine and levobupivacaine. Curr Opin Anaesthesiol. 2008; 21:645–50.

18.Shimba A, Ikuta K. Control of immunity by glucocorticoids in health and disease. Semin Immunopathol. 2020; 42:669–80.

19.Feeley IH, Healy EF, Noel J, Kiely PJ, Murphy TM. Particulate and non-particulate steroids in spinal epidurals: a systematic review and meta-analysis. Eur Spine J. 2017; 26:336–44.

20.Derby R, Lee SH, Date ES, Lee JH, Leeet CH. Size and aggregation of corticosteroids used for epidural injections. Pain Med. 2008; 9:227–34.

21.Engel A, King W, MacVicar J. The efectiveness and risks of fuoroscopi-cally guided cervical transforaminal injections of steroids: a systematic review with comprehensive analysis of the published data. Pain Med. 2014; 15:386–402.

22.Manchikanti1 L, Candido KD, Singh V, Gharibo CG, Boswell MV, Benyaminet RM, et al. Epidural steroid warning con-troversy still dogging FDA. Pain Physician. 2014; 17:451–74

23.Kamp JPM, Bartlett J, Fahmy A, To K, Hossain R, Akula M . CT-guided vs. fuoroscopically guided transforaminal epidural steroid injections for lumbar radiculopa-thy: a comparison of efcacy, safety and cost. Arch Orthop Trauma Surg 2022.