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Comparison of the efficacy of anatomical, ultrasound-guided and fluoroscopy-guided intra-articular lumbar facet joint injection: A comparative study

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Abstract

Lumbar facet joint syndrome (LFJS) is a potential cause of chronic lower back pain that can occur by osteoarthritis, spondyloarthritis or trauma. Pain arises with spinal rotation and extension in the lower back, and outer thighs, sometimes pain spreads below the knee joint and increases with sitting-standing activities. Facet joint injections are gaining importance day by day and imaging technique guidance is thought to be safer during joint injection, yet the superiority of fluoroscopy, ultrasound (US) or landmark injections has not been demonstrated for intra-articular injection. Sixty patients from outpatient clinics diagnosed as LFJS were participated in the study. They were randomized into three different groups with equal participants based on intervention; anatomical, US-guided, and fluoroscopy-guided. Pain, functionality and range of lumbar motion were recorded pre-treatment and at first month follow-ups with Visual Analog Scale (VAS) and revised Oswestry Disability Index (rODI), respectively. All groups showed improvement in terms of pain and functionality compared to the baseline. However, VAS and rODI scores of US-guided and fluoroscopy guided groups were significantly lower than anatomical injection group ($p<0.001$). Changes in flexion direction showed differences between anatomical and US-guided groups ($p=0.036$). Changes in extension direction were higher in the US-guided group compared to anatomical injection and fluoroscopy-guided groups ($p=0.002$, $p=0.007$). Changes in lateral bending were also higher in the US-guided group compared to anatomical injection and fluoroscopy-guided groups ($p=0.001$, $p=0.008$). Changes of rotation for the lumbar region were higher in the US-guided and fluoroscopy-guided groups than in the anatomical injection group ($p<0.001$, $p=0.022$). Current study showed pain and recovery seem to be superior in the US and fluoroscopy groups.

Keywords: Pain, facet joint, intra-articular injection, low back pain, injection, ultrasound

Introduction

Lumbar facet joint syndrome (LFJS) is a potential cause of chronic lower back pain (CLBP), reported in approximately %15-45 of the cases. The most common cause of facet joint syndrome is osteoarthritis; with inflammation, cysts, and tumors as other rare causes [1]. Repetitive rotational traumas, overuse traumas, spinal strains, obesity, and age play an important role in etiopathogenesis [2]. Cases of facet joint cysts or tumors that cause radicular findings are less common. Patients experience pain with spinal rotation and extension movements in the lower back, and outer thighs, that rarely extends below the knee joint. The pain increases with waking up in the morning or sitting-standing activities [3]. Treatment options include pharmacological treatment, physical therapy modalities, exercise, medial branch radiofrequency ablation, or paravertebral injections [4-7]. Importance of interventional procedures for treatment increases day by day, yet the superiority of fluoroscopy, ultrasound (US) or landmark injections has not been demonstrated for intra-articular injection. To address this gap, we aimed to compare the effectiveness of intra-articular facet joint injection performed with three different methods, assessing the impact on pain, functionality, and intervention time.

CITATION
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Material and Methods

The current study was conducted in Ankara Bilkent City Hospital, Physical medicine and Rehabilitation Hospital. We included 60 patients from outpatient clinics aged between 18-70 years, experiencing lower back pain lasting more than four weeks. Patients were diagnosed with LFJS after the exclusion of other lower back pain causes with a thorough physical examination and Magnetic resonance imaging (MRI) of the lumbar spine. The study was approved by the 2nd Ethics Approval Committee of Ankara Bilkent City Hospital (Approval No: E2-22-1746, Date: 27.05.2022). The study was conducted in line with the Helsinki Declaration, and all patients signed informed consent prior to participation. The protocol was registered in the ClinicalTrials.gov database (NCT06325631).

Diagnosis of LJFS was performed based on history, physical examination and MRI after ruling out other pathologies that cause CLBP by an experienced pain physician.

Inclusion criteria were: 1) continuous or intermittent axial low back pain lasting for three months or longer more than 3 according to the visual analog scale (VAS) 2) no significant improvement in response to conservative treatments such as analgesics and physiotherapy 3) increased pain especially with sitting/standing activities and lumbar extension and rotations; pain radiating to the posterior or lateral part of the buttock 4) paraspinal pain or tenderness 5) MRI-detected facet joint osteoarthritis, hypertrophy or synovitis in the lumbar segments.

Exclusion criteria were: 1) history of low back trauma, fractures, malignancies, spinal surgery and inflammatory diseases 2) allergies to medications such as lidocaine, contrast 3) uncontrolled systemic diseases such as diabetes mellitus, cardiac diseases 4) bleeding diathesis (INR>1.2) 5) neurologic signs or symptoms 6) specific etiology for low back pain such as intervertebral disc disorder, radiculopathy, spinal stenosis or spondylolisthesis.

Patients diagnosed with LJFS were randomized into three different groups with equal participants based on intervention; anatomical, US-guided, and fluoroscopy-guided. Closed envelope method was used to divide into three groups. We assessed sociodemographic and clinical features prior to intervention (Figure 1). Physical examination, including paravertebral muscle spasm control and lumbar joint range of motion measurements, was performed before and a month after the procedure. Pain and functionality were measured using the outcome measures noted below. The level of the facet joint that was injected was also recorded. Anatomical and ultrasound-guided injections were done by the same physician, another experienced physician was approved fluoroscopy-guided injections. Apart from these two physicians the assessor completed the procedures that were done at pre-treatment and follow-ups.

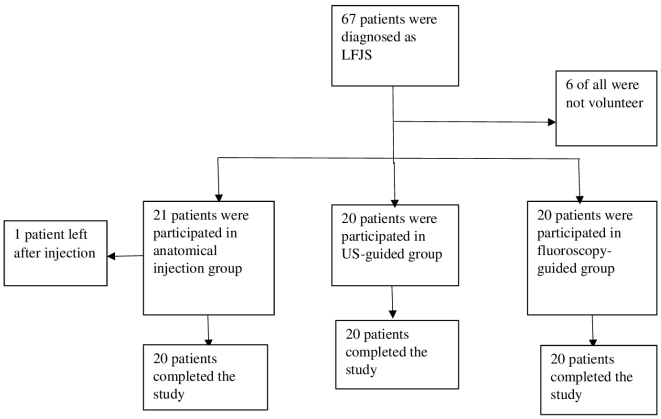

Figure 1. Flowchart of participants

Outcome Measures

Visual Analog Scale (VAS): Ten-cm VAS was used as a self-report measure for lower back pain intensity [8].

Revised Oswestry Disability Index (rODI): Self-reported measure including 10 items to evaluate disability and functionality associated with lumbar conditions. All questions are scored from 0-5, with higher scores indicating high disability levels due to lower back pain [9].

Lumbar range of motion measurement (ROM): The same physician performed the measurement for the joint ranges in each plane of the joint with a goniometer at baseline and follow-up. The goniometer's pivot point was positioned on the lateral projection of the lumbosacral joint while subjects stood upright. The fixed arm aligned parallel to the lateral femur line, while the movable arm tracked the trunk's lateral midline movement towards the axilla. Participants executed slow and incremental flexion and extension movements until maximum amplitude. This procedure was repeated twice, and the average of the measurements was documented [10].

Interventions

Anatomical (Landmark) intra-articular facet joint injection procedure: For each facet joint, 1 mL 9.26 mg dexamethasone 21-phosphate disodium/ 2mL solution and 1 mL of 1% lidocaine solution; a total of 2mL of injection solution was prepared for the injection. In the prone position with a pillow under the abdomen, the areas to be injected were marked anatomically on patients, considering the line drawn from the level of crista iliacas corresponds to the L4-5 interspinous space. Spinous processes to be injected were determined and the borders of the coronal section of a spinous process were drawn with a pencil that is not affected by antiseptic and 2.5 cm lateral (right or left) from the lower 1/3 section was marked. After marking, antiseptic precautions were taken, sterile environment was prepared. A 22 G spinal needle was entered 3-5 cm deep with a 15° inclination towards the spinal midline. After bone contact, the needle was withdrawn very slightly checking for aspiration. Injection was performed after confirming the absence of aspiration [11] (Figure 2).

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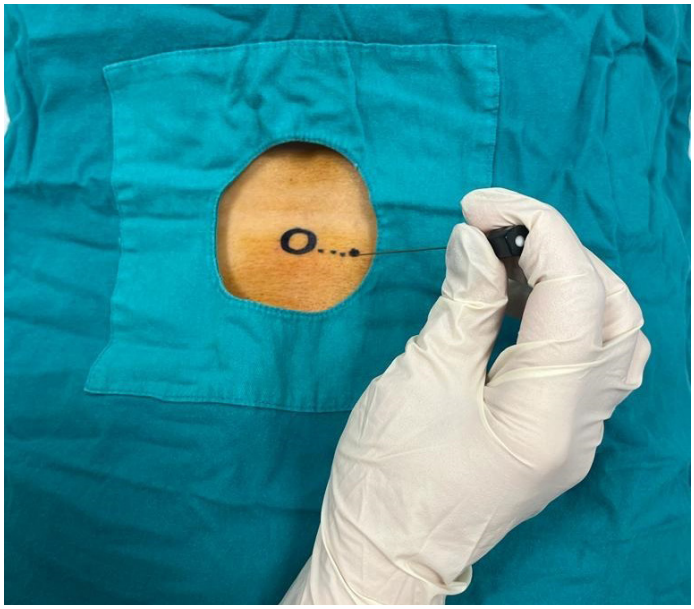

Figure 2. Anatomical landmark facet intra-articular injection

Ultrasound-guided intra-articular facet joint injection procedure: The same physiatrist with over 10 years of experience in the procedure performed the scanning and ultrasound (US) guidance for the injection. A 5 to 3-8 MHz convex probe (Loqiq P5, GE Medical systems) was used for US. In the prone position with a pillow under the abdomen, facet joints of the patients were screened. First, the spinous process of the level to be injected was visualized; the facet joint and joint space were visualized by moving to the right or left. A 22 G needle was inserted at an angle of 45 ° using the in-plane technique and directed into the hypoechoic space resembling the facet joint. After aspiration to check bleeding, 2mL of mixture was injected without any resistance [11] (Figure 3,4).

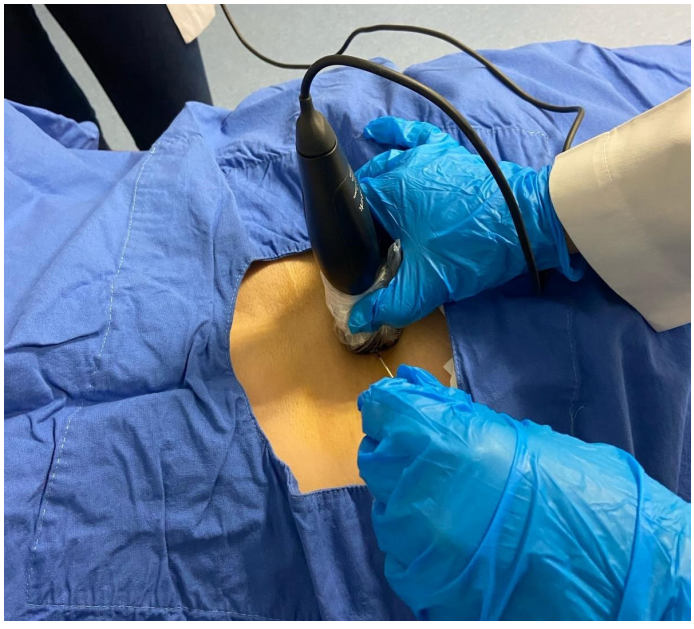

Figure 3. Ultrasound guided facet intra-articular injection

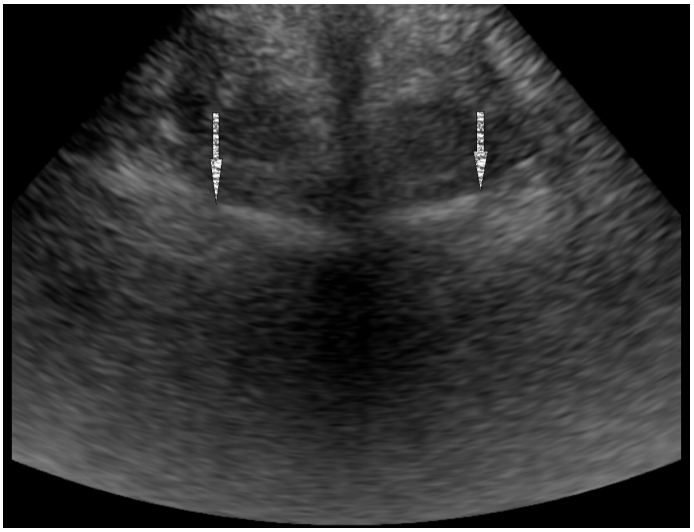

Figure 4. Sonographic imaging of facet joints

Fluoroscopy-guided intra-articular facet joint injection procedure: This injection was performed in the prone position with a pillow under the abdomen for the patients. The procedure area was sterilized, and the fenestrated sterile cover was placed. After the procedure level was determined by fluoroscopy, the C-arm was rotated axially to align the X-ray beam parallel with the end plates of the discs. Then the C-arm was rotated to the ipsilateral side approximately 15-20 ° to make the facet joint more visible. The injection point was marked on the skin and a 22 or 25-G spinal needle was directed towards the facet joint coaxial to the X-ray beam under the oblique view of the fluoroscopy. After the needle was located in the facet joint, a minimal quantity of contrast agent (iohexol) was injected under fluoroscopy and the intra-articular space was identified by contrast. Then, the injection was performed after confirming no aspiration (Figure 5).

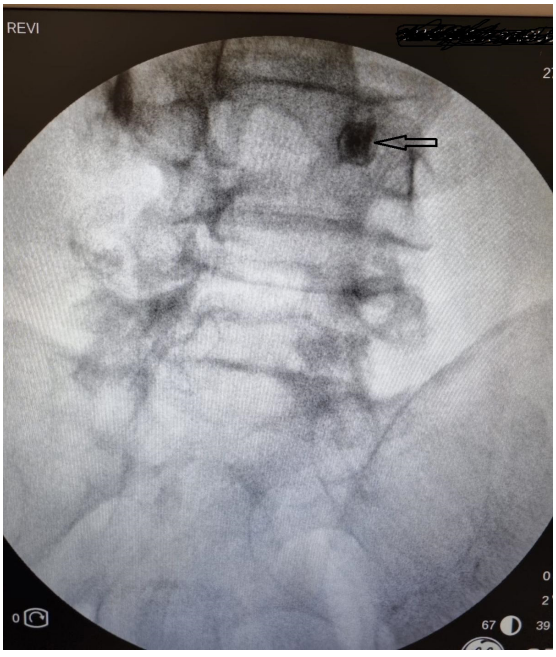

Figure 5. Fluoroscopic imaging of facet joints

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Sample Size Calculation

The sample size was calculated using the G* power (V3.1.7). To achieve at least a 50% change in the VAS with treatment with an α=0.05, 80% power, and d=0.631 for effect size, at least 20 patients for each group were required.

Statistical Analysis

Analyzes were performed with IBM SPSS version 27.0 (IBM Corporation, Armonk, NY, USA). Continuous variables are reported as mean±standard deviation and categorical data as numbers and percentages. For continuous variables, normality analyses were performed using the Kolmogorov-Smirnov Test. For data with normal distribution, one-way ANOVA (LSD for posthoc) and t-tests; for non-normal distribution, Kruskal Wallis Test (Mann Whitney U Test with Bonferroni correction for posthoc), and Wilcoxon Sequential Signs Test were used for between- and within-group comparisons, respectively. Categorical data were compared with Chi-Square Tests. p<0.05 was considered statistically significant.

Results

The age, gender, body mass index values, distribution of facet joints, and presence of radicular pain of the participants were similar between the three groups (p>0.05), CLBP duration of participants was significantly higher in the US-guided group than the fluoroscopy-guided group (p=0.030). Duration of intervention, the time between the end of antiseptic preparation and completion of the injection, was significantly longer in the fluoroscopy-guided group than in the anatomical group (p=0.047) (Table 1).

Table 1. Sociodemographic and clinical features of participants

	Anatomical (n=20)	Fluoroscopy-guided (n=20)	US-guided (n=20)	p
Age (year) (Mean±SD)	50.10±14.09	50.25±11.58	54.25±13.69	0.532*
BMI (kg/m²) (Mean±SD)	25.90±4.16	27.79±4.46	26.83±3.12	0.329*
Duration of LBP (month) [median (min-max)]	12 (2-60)	6.5 (1-36)[a]	21 (3-36)[a]	**0.030****
Injection duration (min) [median (min-max)]	10 (5-15)[a]	14 (5-40)[a]	13 (5-15)	**0.047****
Gender (n,%)				
Female	11 (55.0)	9 (45.0)	7 (35.0)	0.446***
Male	9 (45.0)	11 (55.0)	13 (65.0)	
Localization of injected facet joint (n,%)				
Bilateral	11 (55.0)	7 (35.0)	11 (55.0)	0.283***
Unilateral	9 (45.0)	13 (65.0)	9 (45.0)	
Presence of radicular pain (n,%)				
(+)	11 (55.0)	11 (55.0)	11 (55.0)	1.000***
(-)	9 (45.0)	9 (45.0)	9 (45.0)	

BMI: body mass index, LBP: low back pain, *One way ANOVA test (Posthoc: LSD), **Kruskal Wallis test (Posthoc: [a]Bonferroni adjusted Mann Whitney U test), ***Chi-square test

All groups showed significant improvement with interventions, as compared to the baseline VAS and rODI scores (p<0.001). VAS and rODI scores on the first-month follow-up were not different for the US-guided and fluoroscopy-guided groups (p=0.265; p=0.314, respectively); VAS and rODI scores of the anatomical injection group were significantly higher (p<0.001) (Table 2).

Table 2. Comparison of pain scores and rODI scores between and within groups

	Anatomical (n=20)	Fluoroscopy-guided (n=20)	US-guided (n=20)	p
	Median (min-max)	**Median (min-max)**	**Median (min-max)**	
VAS (pre-treatment)	7 (5-8)	7 (5-8)	7 (6-8)	0.965*
VAS (1st month follow-up)	5 (1-7)	2 (1-3)	2 (1-3)	**<0.001***
	p<0.001**	**p<0.001****	**p<0.001****	
rODI (pre-treatment)	28 (15-44)	34.5 (17-44)	32 (17-44)	0.487*
rODI (1st month follow-up)	23.5 (10-42)	10.5 (8-24)	10 (8-14)	**<0.001***
	p<0.001**	**p<0.001****	**p<0.001****	

VAS: visual analog scale. rODI: revised Oswestry Disability Index; *Kruskal Wallis Test (Posthoc: [a]Bonferroni correction Mann Whitney U Test), **Wilcoxon Signed Rank test

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Changes in the ROM measurements are given in Table 3. Changes in flexion direction showed differences between anatomical and US-guided groups (p=0.036). Changes in extension direction were higher in the US-guided group compared to anatomical injection and fluoroscopy-guided groups (p=0.002, p=0.007, respectively). Changes in lateral bending were also higher in the US-guided group compared to anatomical injection and fluoroscopy-guided groups (p=0.001, p=0.008, respectively). Changes of rotation for the lumbar region were higher in the US-guided and fluoroscopy-guided groups than in the anatomical injection group (p<0.001, p=0.022, respectively).

The presence of paravertebral spasm was not different between the groups before the interventions (p=0.111). The presence of paravertebral spasm on the first-month follow-up in the anatomical injection group was %75; significantly higher than the US-guided (%0) and fluoroscopy-guided (%5) groups (p<0.001).

In a previous study, it is stated that hyperglycemia due to corticosteroid use was most frequently observed after lumbar facet injection [12]. In our study, we did not detect any adverse reactions.

Table 3. Comparison of lumbar range of motion changes after treatments of three groups

	Anatomical (n=20)	Fluoroscopy-guided (n=20)	US-guided (n=20)	p
	Median (min-max)	Median (min-max)	Median (min-max)	
Change in flexion	0 (-30-50)a (4.50±17.91)	0 (-30-30) (9.00±19.70)	15 (0-60)[a] (16.50±18.14)	0.122*
Change in extension	0 (-10-20)[a] (2.25±6.17)	0 (-10-20) (3.75±7.58)	15 (-15-35)[a] (13.25±12.48)	**0.002***
Change in lateral bending	0 (0-20)[a] (3.25±5.19)	0 (-10-15) (3.50±6.50)	10 (0-15)[a] (9.50±5.35)	**0.001***
Change in rotation	0 (-10-10)[a] (3.50±5.87)	15 (-10-20)[a] (8.82±8.57)	15 (0-20)[a] (12.25±6.97)	**0.001***

*Kruskal Wallis Test (Posthoc: [a]Bonferroni correction Mann Whitney U Test)

Discussion

In this study comparing the outcomes of lumbar intra-articular facet joint injection, US and fluoroscopy-guided injections were not found to be superior to each other in terms of pain scores and functionality, but as expected, both of them were found to be superior to anatomical injection. In terms of ROMs, US-guided injection was found to be slightly superior to others in the direction of lumbar extension and lateral bending.

Facet joint syndrome accounts for nearly half of CLBP. However, to the best of our knowledge, no prior studies compared the effectiveness of anatomical marking, US- and fluoroscopy-guided injections for treatment. Our findings suggest that in clinics where imaging is not possible, intra-articular facet joint injection can be performed with anatomical marking, but its effectiveness may be relatively lower. Previously, Karkucak et al. Compared US-guided injection with anatomical injection. In the short term (2-6 weeks), US-guided injection was found more effective in terms of pain and functionality as we replicated in our study [1]. In a recent systematic review, the effectiveness of US and fluoroscopy-guided injections was reported to be the same in the short term. Gofeld et al. reported the superiority of US-guided injection over anatomical injection just in the short term. Both are consistent with our findings [12]. The lack of long-term follow-up continues to be a limitation and a gap in the literature.

The current finding regarding the similar effects of US- and fluoroscopy-guided injections is noteworthy. US-guided seems to be more effective in lumbar lateral bending and extension gains, which are the most affected directions in LFJS. In a previous study, US and fluoroscopy-guided injections had similar effectiveness for medial branch block intervention, and US was noted as potentially the first choice because it does not involve additional irradiation [7]. This is consistent with our findings. Anatomical injections are more frequently preferred in clinics that imaging methods are not accessible. During injections performed with landmarks, it is challenging to determine for certain whether the solution is around the medial branch, intra-articular region, or in the multifidus muscle. There are also contradictory findings noting a lack of superiority of the methods in terms of pain and function [13-15]. However, significantly higher pain and functionality gains and low complication rates in the US and fluoroscopy injection groups reduce the choice of anatomical method [15,16].

We also compared the duration of interventional procedures, and the longest procedure duration was found in the fluoroscopy-guided group. In previous studies, the duration of US and fluoroscopy procedures was found to be similar [7]. This difference may be due to the different physicians performing the procedures in our study, which is an important limitation.

Paravertebral muscle spasms are one of the most frequent symptoms for patients. Paravertebral spasm occurs through ramus dorsalis, due to pain through segmental stimulation of the paravertebral muscles [17,18]. Since pain and inflammation are suppressed by corticosteroid and local anesthetic injection into the facet joint, the decrease in paravertebral spasm is in line with the literature and

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consistent with our findings. However, this is less common with anatomical injections. Since the joint space cannot be visualized, the medial branch block may contribute to a limited amount of spasm to decrease [18]. As a result, LFJS is more common than expected and frequently underdiagnosed. However, it was previously noted that 79% of CLBP have facet joint pathology demonstrated by MRI [4]. Our study showed improvement in all treatment groups compared to baseline, but pain and recovery were significantly different in the US and fluoroscopy groups. The lack of significant difference between the two may drive the selection of either option based on easy accessibility and radiation rate.

Limitations

The small sample size is a limitation of our study, findings should be confirmed in larger cohorts. The procedures not being performed by the same physician may introduce a significant bias, especially in terms of intervention duration. Another limitation is the baseline CLBP duration of the participants in the US-guided group, as it was significantly longer than the other groups. The lumbar ROM of the participants were measured with a manual goniometer, and electronic devices may serve as more reliable measurements for ROM change.

Conclusion

Facet joint pathologies are common in society but are often overlooked. It is important to diagnose with a good history, physical examination and correct imaging method and then treat. Due to the difficulty of diagnosis, patients usually present with chronic pain and limited functionality. Currently, all three lumbar facet joint injection techniques showed similar results at the end and all techniques seems to be effective, however imaging guided techniques improved symptoms more than blinded injections. Further studies are needed to demonstrate the difference of imaging methods with larger sample sizes.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
Approved by Institutional Review Board at Ankara Bilkent City Hospital, 2nd ethics committee (Approval No: E2-22-1746, Date: 27.05.2022). Informed consents were signed by participants.

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