Lumbar Facet Joint Injections: Is CT Guided Intra-Articular Needle Position Advantageous?

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Abstract

Background: Although facet joint injections of corticosteroids and local anesthetics are commonly performed for treating low back pain (LBP), their effectiveness remains questionable. This is partially due to lack of consensus regarding the correct needle-tip location within or nearby the facet joint.

Purpose: The present study was designed to test if computerized tomography (CT) guided intra-articular needle position yields better results than peri-articular position of the needle, while performing lumbar facet joints injections for chronic LBP.

Study Design/Setting: A prospective, randomized controlled trial conducted in A university hospital based pain clinic

Patient sample: Forty-nine patients with chronic LBP related to facet joint arthropathy.

Outcome measures: Scales of pain severity, analgesic drug consumption, lumbar motion, disability and patient's global impression of improvement.

Methods: Patients were randomized to receive CT-guided intraarticular (n= 26) or periarticular (n=23) needle-tip positions during facet joint injections steroids and local anesthetics. Selection of the facet joint for injection was based on medical history, physical findings, CT scan, and bone scintigraphy. Patients were followed for eight weeks.

Results: Although all outcome measures improved significantly from baseline throughout the entire follow-up period, none of them differed statistically or clinically between the two study groups.

Conclusions: Facet joint injections of corticosteroids and local anesthetics provide short-term improvements in pain and disability in patients with chronic low back pain due to facet joints arthropathy. However, efforts to precisely locate the needle-tip within the facet joint – as oppose to perform a peri-articular injection - are not advantageous.

Introduction

Low back pain (LBP) is a common health problem. One etiology of this disorder is lumbar facet joint pathology, which seems to be the primary pain generator in approximately 10–15% of chronic LBP patients [1]. Facet-related pain may be generated by different mechanisms, including secretion of inflammatory mediators into the facet joint cartilage and synovial tissue; distention and stretch of joint capsule by joint fluids; compression of the exiting nerve root in the neural foramen or spinal recesses by facet articular hypertrophy; spasm of the paraspinal muscles in response to capsular irritation or nerve entrapment by calcified mamilloaccessory ligament [1].

Facet interventions represent the second most common type of procedure performed in pain management centers throughout the United States [1]. These interventions include, among others, facet joint injections of corticosteroids that are aimed to reduce synovial inflammation and pain [1]. Although several studies have assessed the analgesic effect of facet joint injections, their efficacy remains uncertain [2-6]. Staal et al. [2] conducted a systematic review on the effectiveness of injection therapy for subacute and chronic low back pain. They concluded that there is conflicting evidence as to whether facet joint injections with corticosteroids are more effective than placebo injections for pain reduction and improvement of disability

[2]. Falco et al. [3] also concluded in their recent review that the evidence for the efficacy of IA injections is limited.

The mixed results regarding the efficacy of facet joint injections may be a consequence of inconsistent parameters used in patient selection for the procedure. For example, it has been shown that positive bone scans (with SPECT) helped in identifying patients who would benefit from a facet joint injection, thus leading to better clinical outcomes [7-9]. In addition, differences in injection techniques, including the volume and type of injected drugs and guidance techniques used, can also contribute to the outcome. Another important factor that may account for the inconsistency is the localization of the needle, namely whether it is placed inside the joint (intra-articular; IA) or nearby the joint (peri-articular; PA). Lilius et al. [4] compared the effectiveness of fluoroscopy-guided (IA) versus PA injections of steroids and local anesthetics. Their results showed no differences between these two injection techniques. On the other hand, Lynch et al. [10] demonstrated that fluoroscopy-guided injections into the joints were far more effective than extra-articular injections for achieving long-term pain relief.

In an effort to further address this issue, the present study was aimed to test if computerized tomography (CT) guided intra-articular needle position yields better results than peri-articular position of the needle, while performing lumbar facet joints injections of corticosteroid and local anesthetics for chronic facet arthropathy-induced LBP.

Methods

Subjects

Patients with low back pain related to facet joint arthropathy were recruited for the study, which was conducted at the Institute of Pain Medicine in Rambam Health Care Campus in northern Israel. The study was approved by the local Ethics Committee, and written informed consent was obtained from all participants following the provision of a detailed explanation about the study procedures.The diagnosis of facet arthropathy was based on the following clinical and radiological criteria 1) pain duration of at least three months; 2) unilateral or bilateral low back pain with or without pain referral to the flank, buttock, thigh, groin, or leg above the knee; 3) average pain intensity during the 24 hours prior to screening of at least 40 out of 100 on a 1-100 numerical pain scale (NPS), where 0 = "no pain" and 100 = "the worst imaginable pain; 4) pain exacerbation during back extension and/or back rotation towards the painful side; 5) CT findings supporting osteoarthritis in the facet joint(s) on the painful side; and 6) bone scintigraphy with single photon emission computed tomography (SPECT) positive for facet joint abnormalities in correlation with the clinical (sidewise) and CT (sides and levels of joint pathology) findings. Exclusion criteria were: 1) age under 18 years old; 2) pain radiating below the knee level; 3) presence of neurological findings in the affected limb; 4) pregnant or lactating women; 5) contraindications for the injection of corticosteroids and/or local anesthetics; 6) contraindications for conducting invasive procedures (e.g., use of anticoagulants that could not be terminated); 7) diagnosis of other causes of back pain, including infective or malignant diseases, spinal stenosis, spondylolysis, spondylolistyesis, osteoporotic fractures or evidence of inflammatory joint disease per history or imaging studies; 8) history of back surgery; and 9) previous facet joint injections during the six months prior to entering the study.

Determination of the affected joint(s)

The side of the affected joint(s) was initially determined by the patient's history and clinical examination. CT findings of osteoarthritis in the facet joints on the affected side(s) and enhanced uptake by the same joints on the bone scan, both consistent with the clinical findings, were used for final determination of the affected sides and levels. Patients in whom one or at most two affected joints could not be clearly identified were excluded from the study.

Self-assessment of pain intensity

Following the provision of careful instructions, patients were asked to document their average pain intensities during the 24 hours prior to each visit while in the following six positions: 1) bed rest; 2) rotating in bed; 3) sitting; 4) standing; 5) changing from a sitting to a standing position; and 6) walking. Pain intensities were measured using the 0-100 NPS. Self-assessed pain intensities were regarded as the primary outcome measures.

Assessment of evoked pain

Patients were requested to self-report their pain in increments during the following four tests: 1) leaning towards the affected side; 2) turning towards the affected side; 3) leaning forward; and 4) leaning backward. In the case of bilateral pain, leaning and turning towards the affected side was measured twice, one time for each side. Therefore, the number of patients and the number of affected sides (and consequently the number of injected joints) were not identical. Pain increments, in response to each test, were recorded as 'yes' or 'no.'

Analgesic drug consumption

Analgesic drug consumption during the last week before baseline and at each subsequent visit was recorded. Drugs were classified as opioids and non-opioids. A reduction from baseline in the consumption of drugs in at least one of the two classes or a transition from an opioid to a non-opioid drug was recorded as "a decrease in analgesic consumption." The percentage of patients for whom there was a decrease in analgesic consumption from baseline at each visit was calculated for both treatment groups (IA and PA).

Assessment of disability

The Hebrew version of the Oswestry Disability Index (ODI) questionnaire [12], which is a validated, self-administered 10-item questionnaire, was used to evaluate pain and pain-related disability. The first item rates the intensity of pain, and the other items describe its disabling effects on typical daily activities. The score for each item ranges from 0 to 5, and the sum of the ten scores is expressed as a total score, ranging from 0 (no disability) to 50 (maximal disability) [11,12].

Patient global impression of improvement

Patients were asked to rate their global impression of improvement on a scale ranging from 1 to 5, where 1 represents no improvement at all and 5 indicates complete resolution of symptoms.

Blinding and randomization

A 'block of four' computer-based randomization was used in the present study. Although the physician performing the facet joint injections was aware of the needle location (IA versus PA), both the

patients and the evaluating physician were blinded to the needle location.

Intervention

Patients were placed in a prone position on the CT table, with skin markers placed over the area of interest. The affected levels were scanned, using a 2 mm slice thickness. Then, under aseptic conditions and after local anesthesia of the skin and sub-cutaneous tissue (2–4 ml of 2% Lidocaine, Teva Pharmaceuticals IND, Israel), a 22G, 31/2" spinal needle was placed under CT guidance either inside the relevant facet joint capsule (IA group) or 2–4 mm away from the affected facet joint cleft (PA group). The CT scan typically consisted of 1 to 3 low-radiation intensity (30–50 mAs) images of 5 mm slice thickness, with no inter-slice gap. Once advanced to the target location, the absence of cerebrospinal fluid or blood was verified by means of aspiration. A mixture of 2 ml of 40 mg/ml Methylprednisolone acetate (Depo-medrol, Pfizer, Israel) and 1 ml 2% Lidocaine was subsequently injected. In the cases of two facet injections, the same mixture was equally divided between the two joints.

Study Design

The study was designed as a single-center randomized double-blind prospective trial. Eligible patients underwent a medical evaluation, which included a detailed medical history, a physical examination of the lower back, a neurological examination of the lower extremities, and a review of the CT and the bone scintigraphy. Results of the imaging studies were interpreted by a specialist in radiology (CT) and in nuclear medicine (bone scan). All outcome measures were completed by all patients prior to the injection (baseline) and at 1, 2, 4, and 8 weeks after the injection. In addition, patients were asked about possible side effects or complications of the procedure at the end and at one week after its performance.

Sample size justification

A power analysis for differences between independent groups (Repeated measure ANOVA, between factor) was performed (G*Power 3.1.6). Assuming alpha error=.05, number of groups=2, number of measurements=4 and correlation among measures=.45, samples of 50 subjects would have 80% probability (power=0.8) of detecting a small effect size of 0.20.

Statistical analyses

SPSS software for Windows Version 17 statistical package (SPSS Inc., Chicago, IL) was employed in the statistical analyses. Cronbach's Alpha test was used to assess the reliability of the NPS scores. T-tests were used to evaluate the group differences in the continuous demographic characteristics. RM-ANOVA tests were applied to examine the treatment effects on the continuous pain measures. Chi-square or Fisher's exact tests were used to study the differences between groups in the demographic characteristics and the categorical pain measures. Significance was considered at the $p < 0.05$ level.

Results

Patient characteristics

Of the 59 patients with a suspected diagnosis of facet-related LBP who were screened for the study, 49 met the inclusion criteria. Thirty-six were women and 13 were men. Their mean±SD age was 65.7 ± 11.1 years, (ranging from 45 to 82). Nineteen patients were employed (39%), and the rest were unemployed/retired.

Injections with IA needle positions were performed in 26 patients and with PA needle positions in 23 patients. No differences between the two study groups were found in any of the demographic characteristics, including gender, working status, age, or education. In 32 patients, the injections were performed bilaterally, for a total of 64 injected joints, while each of the other 17 patients received only one injection. No differences between the treatment groups in the number of patients who received bilateral injections were found (IA: 18 patients; PA: 14 patients; p=0.625). A total of 81 joints were injected, with 44 IA needle positions and 37 PA needle positions. A description of the subjects' characteristics in the two study groups is presented in Table 1.

Demographic characteristics	Intra-articular		Peri-articular			
	Count	%	Count	%	χ²	p value
Gender					0.004	0.947
Female	19	52.8%	17	47.2%		
Male	7	53.8%	6	46.2%		
Occupation					0.949	0.592
Employed	10	52.6%	9	47.4%		
Unemployed/retired	15	53.6%	13	46.4%		
	Mean	STD	Mean	STD	t	p value
Age (years)	66.4	10.3	65	12.1	0.433	0.667
Education (years)	14.1	4.5	13.2	3.3	0.727	0.471

Table 1: Subjects' characteristics.

Effects of IA and PA needle positions on pain intensity

The effects of IA and PA needle positions on pain intensity (NPS) for each of the six positions (at rest, rotating in bed, sitting, changing from a sitting to a standing position, standing, and walking) are presented in Figure 1. Since the NPS scores for the six positions demonstrated high reliability at all time points (Cronbach's Alpha >0.744), an overall effect on pain intensity, calculated as the mean of these six NPS scores, was used for further analyses of the primary outcome (Figure 1). A significant reduction in the average overall NPS score across time was found (RM-ANOVA; F=13.404, p<0.001). Post Hoc contrasts test revealed a significant reduction from baseline in the average NPS score at all four time points (week 1, 2, and 4: p<0.001; week 8: p=0.007). However, no significant differences between the two study groups were found in the average NPS score (RM-ANOVA; F=0.237, p=0.629). A complementary analysis consisted of categorization of subjects as 'responders' and 'non-responders' for each time point. 'Responders' were those who exhibited >50% reduction in the overall pain intensity (primary outcome). No significant differences in the percentage of responders between IA and PA groups were found at any of the post baseline time points (week 1, p=0.283; week 2, p=0.3; week 4, p=0.106; week 8, p=0.709) (Figure 2).
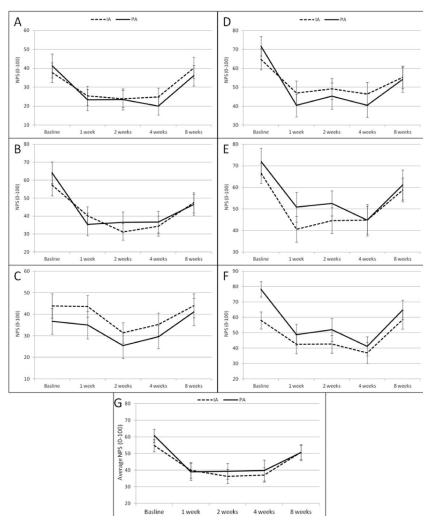
Figure 1: Average (mean ± SEM) pain intensity scores (NPS) in the six different positions and overall pain intensity in the two study groups (IA vs. PA). A. at rest; B. while rotating in bed; C. while in a sitting position; D. during the transition from a sitting to a standing position; E. while in a standing position; F. while walking; G. overall NPS.
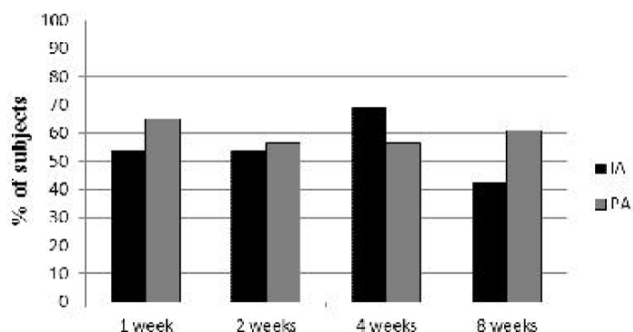

Figure 2: Percentages of responders in the two study groups across the eight-week follow-up period.

Effects of IA and PA needle positions on other outcome measures

Analgesic drug consumption

Chi-Square tests failed to demonstrate significant differences between the two treatment groups at any of the follow-up time points in the percentages of patients who decreased their analgesic drug consumption from baseline (week 1: p=0.419; week 2: p=0.851; week 4: p=0.357; week 8: p=0.195).

Disability

In both groups, a significant reduction in the Oswestry Disability Index score was found (RM-ANOVA; F=10.452, p<0.001). Post Hoc contrasts test revealed that this reduction from baseline was significant

at weeks 1, 2, and 4 (p<0.001; p=0.022; p<0.001, respectively), but not at week 8 (p=0.527). No significant differences were found between the two study groups in the Oswestry scores (RM-ANOVA; F=0.367, p=0.548) (Figure 3).
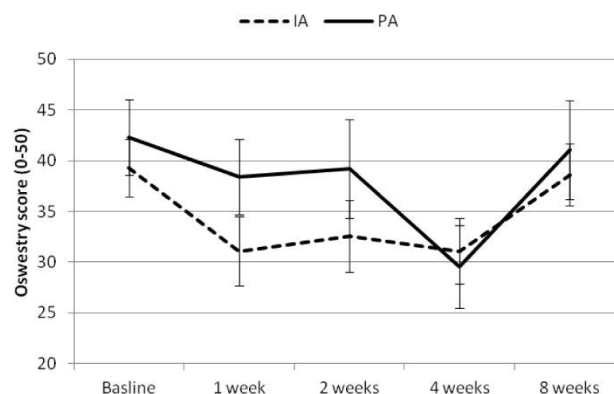

Figure 3: Oswestry Disability index scores in the two study groups (IA vs. PA).

Patient global impression of improvement

When requested to rate their subjective global impression of improvement using a 5-point scale (1 represents "no improvement at all" and 5 indicates "complete resolution of symptoms"), the average improvement in both groups was "moderate" (3/5) during the first four weeks following the procedure and only mild (2/5) at the eight-week follow-up (Figure 4). However, the comparison between the two groups revealed no significant differences in the patients' global impression of improvement (RM-ANOVA; F=0.764, p=0.387) (Figure 5).
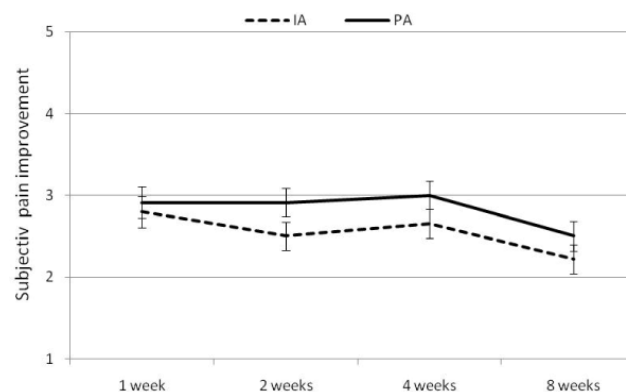

Figure 4: Global impression of improvement in the two study groups (IA vs. PA) on a 5-point scale (1 represents no improvement at all and 5 indicates complete resolution of symptoms).
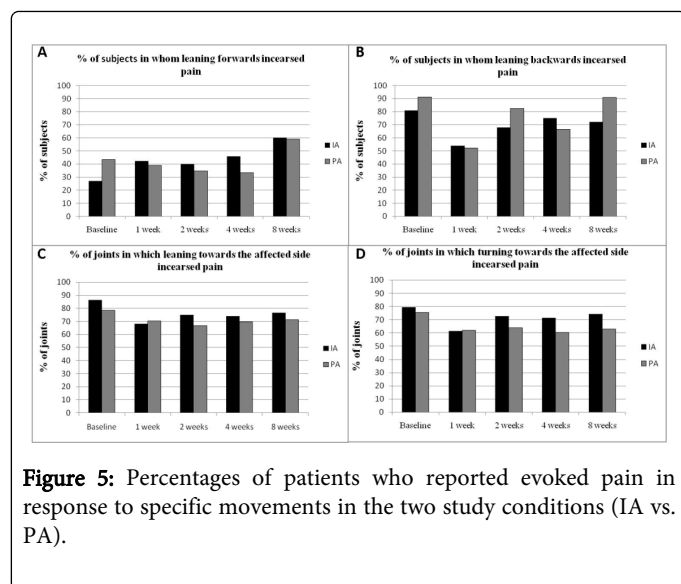
Figure 5: Percentages of patients who reported evoked pain in response to specific movements in the two study conditions (IA vs. PA).

Evoked pain

Only one side was injected in 17 patients (14 right and 3 left), and both sides were injected in 32 patients. Therefore, the analyses of evoked pain in response to leaning or turning towards the affected side included 81 injected sites. In contrast, the analyses of leaning forward and backward did not take into account the number of affected sites in each patient and thus included the total number of injected patients (n=49). The percentages of patients who reported a pain increment while leaning forward and backward in the two treatment groups at the five time points (baseline, 1 week, 2 weeks, 4 weeks, and 8 weeks) are described in Figure 5a and 5b, respectively. Chi-Square tests revealed no differences in the percentages of patients who reported a pain increment between the two treatment groups at any of the time points (p>0.224 for all comparisons). The percentages of injected joints in which a pain increment was reported while leaning and turning towards the affected side in the two treatment groups are described in Figure 5c and 5d, respectively. Chi-Square tests again revealed no differences in these percentages between the two groups (p>.482 for all comparisons).

Adverse events

Two patients felt that they were about to faint immediately after the procedure, but neither actually fainted. Nine patients reported that they suffered local tenderness at the injection site for several days following the procedure. This resolved spontaneously. Three patients with hypertension reported a temporary rise in blood pressure, which lasted for a few days. One patient with diabetes reported a temporary elevation in his glucose levels. All side effects reported were short-lived and remitted spontaneously without any significant consequences.

Discussion

The major finding of the current study is that neither clinical nor statistical differences were revealed in the response to IA versus PA needle positions, while performing facet joint injections. Specifically, none of the primary or secondary outcome measures differed between the IA and PA needle positions. In line with the current results, Lilus et al. [4] found no difference in the outcomes between IA and PA injections of steroids plus local anesthetics. They explained their negative results by the fact that the drugs were injected at a total volume of 8 ml, which is greater than the facet joint volume (1-2 ml). Thus, 5-6 ml of the solution must have leaked into the surrounding tissues. Despite the use of a lower injection volume in our study, no difference between the two needle positions was found. Clearly, some of the IA injected drugs in our study might have also leaked out from the joint. Yet, we wish to emphasize the fact that our study was not aimed to compare pure IA versus PA injections. Rather, it was designed to test if positioning the needle tip within the joint space and injecting at least some of the steroids/local anesthetics into the joint is advantageous. This bears clinical importance because locating the needle tip within a joint space, especially if it is distorted by arthritic changes, may require repeated attempts, which increase the procedure time length and the irradiation dose.

From the mechanism-related viewpoint, the fact that no differences were found between IA and PA needle positions in the current study may imply that underlying mechanisms additional to joint inflammation are involved in facet pain generation. In line with this assumption, McCall et al. [13] found no difference in the pain referral areas induced in healthy subjects by IA and PA injections of hypertonic saline.

Regardless of the similarities between the effects of the IA and the PA needle positions, an additional finding of the current study relates to the duration of the analgesic effect of these facet injections. Strong pain relief was evident in all outcome measures for up to four weeks after the injections. This effect subsequently subsided, and at the eight-week follow-up, only the primary outcome measure (overall pain intensity) remained significantly different from the baseline measurement. These results are similar to those reported by Chaturvedi et al. [14]. In their trial, most patients reported significant pain relief immediately after the procedure. The number of patients increased slightly at one week and reached a peak at four weeks, by which time as many as 93.3% of patients had responded. Pain relief declined at 12 and 24 weeks [14]. Marks et al. [15] found a similar short-lived response [15]. In contrast, a few other studies have reported longer analgesic effects, lasting for three months or more [10,16-18]. Differences in the duration of effect can be explained by differences in the drug type, volume, and dosage used in the different studies. In addition, variations in study methodology may also contribute to these inconsistencies. For example, in our study, questionnaires were completed four times during the eight weeks of follow-up, whereas in Fotiadou et al.'s [16] study, in which longer analgesic effects were demonstrated, questionnaires were completed only once at three months following treatment.

Both Carette et al. [19] and Lilius et al. [4] found no difference in pain reduction between steroid and placebo injections. Yet, in both studies, the placebo arm included an IA injection of normal saline. Notably, saline injection into the facet space may have therapeutic properties, given that inflammatory mediators can presumably be expelled following the injection. Indeed, normal saline has been shown to provide better pain relief than expected with a true placebo in a multitude of invasive procedures [1,3].

Determination of diagnosis and selection of the joint for injection are important factors in the treatment outcome. Some authors claim that a positive response to medial branch block is the only accurate test for the diagnosis of faced pain [20]. However, others find clinical and radiological findings as sufficient for establishing the diagnosis correctly [7-9,18,21,22]. In our study we have opted to use the second

set of criteria and the diagnosis of facet pathology was based on strict clinical and radiological parameters, including medical history and physical examination, as well as CT and bone scans.

Two study limitations should be considered. First, since no placebo control group was included in the present study, one cannot rule out the possibility that the improvement in the outcome measures found may be attributable to a placebo effect. A future study with random IA versus PA needle tip locations should include injections of an active drug or a placebo for excluding this possibility. Second, some joints were injected with half of the quantity of drugs as compared to others, due to the fact that in some patients only one joint was injected and in others two joints received the treatment. This may have reduced the consistency of the results. However, since this was done in similar numbers of patients from both groups, it is unlikely to have skewed the comparisons between the outcomes of the two injection techniques.

Lastly, two additional points deserve consideration. First, trends for differences between the groups in baseline pain intensities in five of the six tested positions (all but sitting) was found, with higher values for the IA group. Similarly, the magnitudes of drop in pain intensities are seemingly larger for the IA as compared to the PA group, in four of these positions. Although these trends have not reached statistical significance, they seem to justify larger-sized future trials to assure that no real differences in the efficacy between these interventions indeed exist. Second, a large drop in pain intensity in relation to those five positions occurred during the first post-injection week, whereas not similar drop was seen for the sitting position. This can be partially explained by the low baseline pain intensity during sitting relative to most other positions, which is typical for patients with facet pain.

In summary, the current study revealed no differences between IA and PA needle positions during facet joint injections. PA needle position is an easier technique that usually necessitates less radiation for verification of the needle position. Moreover, our clinical experience has demonstrated that in some cases, there are difficulties in inserting the needle into the joint space due to anatomical changes. Since both methods result in similar outcomes, the use of PA needle positions should be considered.

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