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The effect of lumbar facet joint injection levels on spinopelvic parameters and functional outcome

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Abstract.
BACKGROUND: Low back pain is a very common musculoskeletal complaint that impacts patients' quality of life in numerous ways. Facet joint injection is a widely used spinal intervention to relieve back pain. Effects of facet joint injection on spinopelvic parameters and the relationship between injection levels and spinopelvic parameter changes have not been evaluated before.
OBJECTIVE: To compare spinopelvic parameters before and after injections at different levels, and to evaluate the correlation between these changes and functional outcome.
METHODS: 144 patients were included in the study and retrospectively grouped by injection level: Group 1 ($n = 72$), L4-L5 and L5-S1, and group 2 ($n = 72$), L1-L2, L2-L3, L3-L4, L4-L5 and L5-S1. Pre- and post-injection Oswestry Disability Index (ODI), sacral slope, pelvic tilt, pelvic incidence, and intervertebral angles between T12 and S1 were compared. The correlation between ODI and radiographic parameter changes was evaluated.
RESULTS: The pre- to post-injection ODI change was significantly lower in group 2 ($p = 0.010$). There was no significant difference between the groups in terms of pre- and post-injection spinopelvic parameters before and after injection ($p > 0.05$) except pelvic tilt ($p = 0.001$ and $p = 0.007$, respectively). There was a significant moderate positive correlation between the change in the ODI value and the change in pelvic tilt ($P = 0.012$, $r = 0.581$).
CONCLUSIONS: Multilevel lumbar facet injections are clinically more effective than only two-level lower level lumbar injections. Pelvic tilt changes positively correlate with the ODI score changes.

Keywords: Facet joint injection, spinopelvic parameters, injection level, pelvic tilt, Oswestry disability index, low back pain

1. Introduction

Low back pain (LBP) is one of the most frequent symptoms among musculoskeletal pathologies [1]. LBP is a major cause of social and physical disability, and brings a huge financial burden due to the cost of treatment and the loss of labor [2]. Lumbar spine kine-

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matics vary at different levels of the spine [3]. It has been shown that the L4-L5 level has higher mobility during bending motions than more cranial segments, and that the range of flexion-extension is higher at the cranial L2-L3 segment compared to more caudal segments [4,5].

The primary function of facet joints is to stabilize the motion of the responsible segment during activities [6]. Lumbar facet joints carry approximately 18% of the load that is transferred to the lumbar spine [7]. Degenerative osteoarthritis (OA) can affect facet joints, manifesting as cartilage degeneration, narrowing of the joint space, synovial cyst formation, and osteophyte formation [8]. Lumbar facet joints have rich innervation provided by the medial branches of the dorsal primary rami, and they are susceptible to pain sensation [9]. Facet joint arthritis can cause pain with two mechanisms: degenerative changes in the articular cartilage that can cause pain, and degenerative changes in the joint such as osteophyte formation, can cause nerve root compression [7]. Nearly one-third of reported LBP can be attributed to facet joints [10]. Sagittal spinopelvic parameter changes have been associated with facet joint degeneration [11].

Facet joint injection (FJI) is the second most common spinal intervention after epidural injections and is widely used in the management of back pain. The frequency of FJI continues to increase [12]. Although effects on pain and functional scores have been widely evaluated [13], the effect of FJI on spinopelvic parameters and the relationship between injection levels, and changes in functional outcome scores and the spinopelvic parameter have not been evaluated before.

In this study, we aimed to evaluate the effect of the FJI level on spinopelvic parameters and functional outcome scores, as well as the correlation between functional outcome score and spinopelvic parameters change. Our primary hypothesis was that multilevel FJI is associated with higher improvement in functional outcome score and spinopelvic parameters change. Secondarily, we hypothesized that the changes in the functional outcome score would correlate with the changes in spinopelvic parameters.

2. Materials and methods

2.1. Ethical approval

This study was approved by the hospital's institutional review board (approval no. 2020-04/41). All patients signed an informed consent form prior to enrollment.

2.2. Patient selection

A total of 365 patients who received FJI as a treatment for facet joint arthritis between 2017 and 2020 were evaluated. Patients older than 45 years and patients who underwent facet joint injection (FJI) to the lower lumbar (L4-L5 and L5-S1 facet joints) or all lumbar levels (L1-L2, L2-L3, L3-L4, L4-L5 and L5-S1 facet joints) due to facet joint osteoarthritis-associated low back pain were included. Indications for FJI were radiologically confirmed, isolated, symptomatic facet joint arthritis that was unresponsive to medical treatment and at least three months of physiotherapy. Patients with other spinal pathologies (spinal stenosis, discogenic lower back pain, radicular pain, spinal deformity or a previous spinal surgery), severe sagittal plane malalignment (more than 5 cm anterior or posterior shift of C7 plumb line), rheumatologic disorders, neuropathic pain, thoracal or abdominal muscular or visceral pathology were excluded from the study. Other exclusion criteria were pregnancy, previous spinal or pelvic surgery, history of hypersensitivity to local anesthetics or steroids, and patients with a bleeding disorder. After exclusions, a total of 144 patients were included. Patients were divided into two groups based on the lumbar facet joint injection levels as group 1 (2 levels, L4-L5 and L5-S1, $n = 72$ patients) and group 2 (5 levels, L1-L2, L2-L3, L3-L4, L4-L5 and L5-S1, $n = 72$ patients).

2.3. Injection technique

All injections were performed bilaterally by the same surgeon using a previously described technique [14]. Patients were placed on a radiolucent table in the prone position and the targeted spinal levels were prepared with 10% povidone-iodine solution (Dermosept Baticonol, Aktas Ltd., Istanbul, Turkey). A spinal needle was inserted to the target facet joints under fluoroscopic guidance and the position of the needle was confirmed after the injection of contrast material (Omnipaque, Opakim Ilac, Istanbul, Turkey). Then, 1 cc of lidocaine (Jetokain, Adeka Ilac, Istanbul, Turkey) and triamcinolone acetonide (Kenacort-A, Deva Ilac, Istanbul, Turkey) (1:1 ratio) was injected into each facet joint.

2.4. Clinical assessment, follow-up, and study design

Patients were clinically and radiologically evaluated before and three months after the injections. The Oswestry Disability Index (ODI) was used to assess the functional outcome [15]. Standing anteroposterior (AP)

Table 1
Demographic characteristics of the two groups

	Group 1 ($n = 72$) Mean $\pm$ SD – n (%)	Group 2 ($n = 72$) Mean $\pm$ SD – n (%)	P value
Age	61.1 $\pm$ 5.9	60.5 $\pm$ 7.3	0.444
Gender (F/M)	44/28 (61.2%/38.8%)	40/32 (55.6%/44.4%)	0.596
BMI (kg/m^2)	29.2 $\pm$ 5.5	27.1$\pm$ 6.2	0.118

and lateral whole spine radiographs were obtained from all patients before and three months after the injections. Pelvic incidence, sacral slope and pelvic tilt values were measured. Sacral slope is defined as the angle between horizontal axis and endplate of the sacrum [16]. Pelvic tilt is the angle between the vertical axis and the line between the center of the femoral head and the midpoint of the sacral endplate [17]. Pelvic incidence is defined as the angle between a line from midpoint of the sacral endplate to center of the femoral head and an orthogonal line from midpoint of the sacrum [18]. Lumbar intervertebral angles (from T12 to S1) between consecutive vertebrae were also measured. All radiographic measurements were performed by two orthopedic surgeons, twice in two weeks.

ODI values and spinopelvic parameters before and three months after the injections were compared between and within groups 1 and 2. The correlation between the changes in ODI radiological parameters was evaluated.

2.5. Statistical analysis

Mean, standard deviation (SD), median, minimum, maximum, frequency, and ratio values were used for descriptive statistics. The distributions of variables were obtained using the Shapiro-Wilk test. The independent samples t-test was used in the analysis of changes between independent variables. The dependent samples t-test was used in the analysis of changes between dependent variables. The correlation between variables was evaluated using Pearson's correlation analysis. The correlation coefficient has a value between -1 (perfect negative linear relationship) and $+1$ (perfect positive linear relationship). Zero value indicates no linear relationship. The level of Pearson correlation coefficient (r) was determined as 0 to 0.3, negligible; 0.3 to 0.5, weak; 0.5 to 0.7, moderate; 0.7 to 0.9, strong; and 0.9 to 1.0, very strong [19]. Cohen's d was calculated to evaluate the effect size which helps to indicate the role of independent variable in determining results on the dependent variable regardless of sample size. A larger effect size indicates a more consistent influence of independent variable. The level of practical significance of Cohen's d is as follows: 0.2, weak; 0.2 to 0.45, weak to moderate; 0.45 to 0.65, moderate; 0.65 to 0.80, moderate to high; and 0.80 or above, high [20]. Intra- and interobserver agreement regarding radiographic measurement parameters were evaluated using intraclass correlation coefficient (ICC). The agreement levels for ICC scores were determined as follows: 0–0.2, slight agreement; 0.21–0.40, fair; 0.41–0.60, moderate; 0.61–0.8, substantial; and > 0.81 as perfect agreement [21]. In a prior sample size calculation, 67 patients per group were needed to detect a difference in measurements with 0.80 statistical power and 0.05 type 1 error rate associated with the null hypothesis test. We included 72 patients per group to reach the minimum sample size requirement. Statistical significance was set at $P < 0.05$. SPSS version 24.0 (SPSS Inc., Armonk, NY, USA) was used for the statistical analyses.

3. Results

The outcomes of 144 patients were evaluated. The mean age of the patients was 60.8 $\pm$ 7.6 years. Eighty-four (58.3%) of the patients were female, and 60 (41.7%) were male (Table 1). The mean pre-injection ODI value was 62.6 $\pm$ 6.9, and the mean post-injection ODI value was 58.9 $\pm$ 8.0 ($P = 0.009$). There was perfect intra- and interobserver agreement regarding radiographic measurement parameters (ICC > 0.86 for intraobserver measurements and ICC > 0.82 for interobserver measurements). There was a significant change in pelvic tilt between pre- and post-injection evaluations ($p = 0.032$). Pre-injection and post-injection values of ODI and spinopelvic parameters in group 1 and 2 are shown in Table 2. There was a significant improvement in the mean ODI score after injection in group 2 ($p = 0.010$). However, there was slight but not significant post-injection improvement in ODI score in group 1 ($p = 0.264$). There were significantly higher pre- and post-injection pelvic tilt values in group 2 ($p = 0.001$, $d = 1.95$ and $p = 0.007$, $d = 1.71$ respectively). However, pre- to post-injection changes in pelvic tilt were not significant in both groups ($p > 0.05$).

The correlation between changes in the ODI and spinopelvic parameters and angles between adjacent

Table 2
Changes in outcome measures before and after injection in both groups

		Group 1 ($n = 72$)		Group 2 ($n = 72$)		p	d
		Mean ± SD	Median	Mean ± SD	Median		
Oswestry Disability Index	Pre-injection	58.0 ± 7.1	58.0	67.3 ± 7.7	69.0	0.092	1.25
	Post-injection	55.6 ± 8.3	56.0	62.2 ± 7.3	62.0	0.143	0.84
	Intra-group difference p	0.264		***0.010***			
Pelvic incidence	Pre-injection	56.6 ± 6.1	55.8	62.4 ± 4.9	60.5	0.105	1.04
	Post-injection	57.0 ± 4.5	56.6	60.4 ± 5.0	62.0	0.344	0.71
	Intra-group difference p	0.644		0.123			
Sacral slope	Pre-injection	44.4 ± 5.4	43.9	39.1 ± 5.9	42.5	0.150	0.93
	Post-injection	43.6 ± 4.0	42.8	39.3 ± 4.7	43.5	0.229	0.98
	Intra-group difference p	0.502		0.799			
Pelvic tilt	Pre-injection	12.5 ± 4.4	12.4	23.9 ± 6.1	24.5	***0.001***	1.95
	Post-injection	13.1 ± 5.3	12.1	20.3 ± 4.7	21.8	***0.007***	1.71
	Intra-group difference p	0.252		***0.032***			
T12-L1	Pre-injection	2.2 ± 0.9	1.7	1.6 ± 0.4	1.8	0.237	0.86
	Post-injection	2.5 ± 0.8	2.4	1.5 ± 0.5	1.4	0.086	1.49
	Intra-group difference p	0.380		0.944			
L1-2	Pre-injection	3.7 ± 0.9	2.9	3.2 ± 0.8	2.6	0.283	0.58
	Post-injection	4.0 ± 1.1	3.6	3.6 ± 0.9	2.6	0.444	0.83
	Intra-group difference p	0.371		0.252			
L2-3	Pre-injection	6.0 ± 1.7	5.8	6.8 ± 1.4	6.1	0.536	0.51
	Post-injection	6.2 ± 1.3	5.4	6.0 ± 0.6	4.6	0.705	0.44
	Intra-group difference p	0.500		0.093			
L3-4	Pre-injection	7.5 ± 1.2	7.2	6.5 ± 0.9	7.2	0.094	0.94
	Post-injection	6.8 ± 1.1	6.7	6.0 ± 1.3	6.7	0.164	0.19
	Intra-group difference p	0.365		0.191			
L4-5	Pre-injection	9.9 ± 2.1	10.0	6.8 ± 1.9	5.9	0.057	1.54
	Post-injection	9.6 ± 2.0	10.7	7.7 ± 2.4	8.0	0.189	0.86
	Intra-group difference p	0.771	.	0.109			
L5-S1	Pre-injection	9.7 ± 2.8	10.2	12.5 ± 2.6	13.8	0.161	1.03
	Post-injection	9.4 ± 2.3	10.3	10.9 ± 2.9	10.5	0.223	0.57
	Intra-group difference p	0.376		0.125			

Table 3
Correlation between the changes in ODI, spinopelvic parameters and the lumbar intervertebral angles

		T12-L1	L1-2	L2-3	L3-4	L4-5	L5-S1	Pelvic incidence	Sacral slope	Pelvic tilt
Oswestry disability index	r	0.028	0.042	0.067	0.120	0.017	0.190	0.386	0.058	0.581
	p	0.870	0.804	0.692	0.478	0.920	0.260	0.018	0.734	0.012

vertebrae are shown in Table 3. There was a significant moderate positive correlation (linear relationship) between the change in the ODI value and the change in pelvic tilt ($P = 0.012$, $r = 0.581$). Also, there was a significant low positive correlation (linear relationship) between the change in the ODI value and the change in pelvic tilt ($P = 0.018$, $r = 0.386$). (Table 3).

4. Discussion

This is the first study that evaluates the effect of the FJI level on spinopelvic parameters as well as the correlation between spinopelvic parameters and functional outcome scores. The most important finding of this study was that multiple level injections led to a significant decrease in ODI and pelvic tilt values, while two-level injections did not. In addition, a significantly moderate correlation was found between ODI and pelvic tilt changes. Therefore, multilevel facet joint injection is thought to affect the lumbar lordosis and associated pelvic tilt parameter, resulting in changes in the facet joint orientations and improvement in functional outcome.

FJI is a common spinal intervention and several studies have investigated the method of injection, injection agent, and duration of efficacy [22–26]. Although physical therapy and oral NSAIDs are the first-line treatments for facet joint osteoarthritis, intraarticular injections to the facet joints have been widely used in the management of facet joint osteoarthritis [27].

Successful short-term results have been reported after steroid injection by two randomized studies, but these studies are not up to date [28,29]. Various studies

evaluated the effectiveness of injection treatment, and most of them reported a slight difference after injection over placebo and no difference after a few months. Also, most of them concluded that the evidence was not strong to support FJI [30–32].

Many studies concluded that patients had pain relief immediately after FJI, and that functional outcomes improve within three-six months [33]. Our results support these findings. Even though we only evaluated pre-injection and three months post-injection parameters, we found a significant improvement in the ODI value after injection when it was performed multilevel.

Different agents can be used in lumbar FJI. Local anesthetics, corticosteroids, hyaluronic acid, or a combination of these agents can be applied into the joint or periarticular area [34]. Wu et al. introduced an autologous platelet-rich plasma (PRP) injection for facet joint pain and reported promising results, but that study did not compare PRP with other treatment options [23]. However, the specific agent used in FJI is a source of controversy. Several studies have evaluated the effect of local anesthetics, steroids, saline (as a placebo), and a combination of these agents [2]. Manchikanti et al. compared different agents for epidural injections and FJIs in a systematic review, and found no difference between local anesthetics and a combination of local anesthetics with steroids for the improvement of facet joint pain [2]. In our study, we used a combination of a long acting corticosteroid (triamcinolone acetonide) and local anesthetic (lidocaine) for therapeutic injections.

There are several different methods to guide FJI, and fluoroscopic guidance has been used for decades [35]. Dietrich et al. compared radiation exposure for patients and physicians during X-ray-guided and CT-guided injections, and found that radiation exposure in fluoroscopy-guided injections was lower for patients, but higher for physicians compared to that in CT-guided injections [35]. A recent meta-analysis reported that ultrasonography-guided FJI are as effective as CT or fluoroscopy-guided FJI [36]. We preferred fluoroscopic guidance as it is easily accessible, inexpensive, and provides adequate guidance, despite radiation exposure.

Low back pain has been associated with increased lumbar lordosis [37]. The pelvis and the lumbar spine are affected by pelvic tilt and lumbar lordosis. Moreover, as the posterior pelvic tilt increases, lumbar lordosis increases [38]. Pelvic tilt, sacral slope, and pelvic incidence are widely used to assess sagittal spinal balance before and after spinal interventions. The relationship between spinopelvic parameter changes and pain, clinical outcomes, and quality of life have been evaluated previously [39]. This is the first study that evaluated the relationship between spinopelvic parameters and clinical results in patients with facet joint osteoarthritis.

A patient's pelvic incidence does not change, and larger lumbar lordosis with a more sagittal orientation of the lumbar facet joints has been associated with a higher pelvic incidence [40]. An increase in the posterior pelvic tilt is typically a compensatory mechanism in response to a decreased lumbar lordosis to maintain the normal sagittal balance and vice versa [38]. Normal values of spinopelvic parameters can show variation between different races, ages and sexes, but we focused on changes in spinopelvic parameters in patients with facet joint osteoarthritis [41]. Our findings show that clinical improvement after FJI correlates with pelvic tilt changes and related facet joint orientation.

There are some limitations of our study. First, the study population is not large enough to compare each treatment level to one another, so we combined levels and created two groups to make a comparative analysis possible. Second, the treatment response at different times after the injections was not evaluated. Only post-injection three-month parameters were evaluated. Third, we did not take the pain intensity into consideration but we used ODI score in which pain is represented by 10 points. Fourth, different treatment options were not evaluated. We used the same combination (lidocaine and triamcinolone acetonide solution) for all patient injections. The moderate correlation between ODI and pelvic tilt change and weak correlation between ODI and pelvic incidence supports that there is no strong relationship between ODI and spinopelvic parameters change.

5. Conclusion

In conclusion, the ODI score was significantly improved after multi-level injections. Accordingly, multi-level injections are more effective than two-level lower lumbar injections in improving the ODI and decreasing pelvic tilt in patients with lumbar facet joint osteoarthritis. Moreover, the change in the ODI is correlated with the change in the pelvic tilt.

Conflict of interest

None to report.

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