ORIGINAL ARTICLE

Clinical Outcome of Facet Joints Injection in Patients With Lumbar Facet Joints Arthropathy

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ABSTRACT

Introduction: Facet joint injection (FJI) combined with steroids is known to be effective for lumbar facet joint arthropathy (FJA). This study evaluates its impact using the Oswestry Disability Index (ODI) and Visual Analogue Scale (VAS) to measure function and pain, respectively, before and six months after treatment. Additionally, the study examined the relationship between body mass index (BMI), vitamin D levels, and functional outcomes as indicated by ODI scores. **Materials and methods:** Thirty-six patients underwent lumbar FJI at the L3/L4, L4/L5, and L5/S1 levels. Changes in ODI and VAS scores were analysed using paired T-tests. To examine the mean differences in ODI scores before and six months after treatment, a One-way ANOVA was conducted, with post-hoc analysis using the Dunnett T3 test for significant results. A p-value < 0.05 was considered statistically significant. **Results:** Significant improvements in functionality and pain were observed, as indicated by ODI and VAS scores. Notably, patients with a normal BMI showed marked functional improvement. The One-way ANOVA revealed a positive correlation between vitamin D levels and ODI scores, with the post-hoc analysis indicating that patients with optimal vitamin D status had the best outcomes. **Conclusion:** Patients with lumbar FJA who have a normal BMI and optimal vitamin D levels demonstrated significantly improved clinical outcomes at six months.
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INTRODUCTION

Low back pain (LBP) is well known to be the commonest pain syndrome, and it is a severely disabling, non-fatal, and cost generator public health problem worldwide (1,2,3,4,5). Lumbar facet joints (FJ) pain constitutes a common source of LBP, accounting for 15% - 45% cases (3,5,6,7,8,9,10,11,12). Ghormly came out with the term 'facet joint syndrome' (FJS) and was the first ever person who described the combination of the symptoms caused by FJ degeneration (13). FJS can be caused by instability, synovitis, and FJ degenerative osteoarthritis or to be known as facet joints arthropathy (FJA) (2,5,6,7,8,12,14,15).

The diagnosis of lumbar FJA can be confirmed using a clinical approach. This involves a thorough history of back pain and a physical examination (6,12), supported by index tests studied in various research works, including the Revel's criteria. These criteria consist of five or more of the seven clinical characteristics: pain relief in a recumbent position, age over 65 years, absence of pain worsening during coughing, absence of pain worsening when rising from flexion, forward flexion, hyperextension, and extension-rotation (8,15,16,17), with the support of plain radiograph (anteroposterior (AP), lateral and oblique views) with the features of FJ space narrowing, subchondral erosion/ sclerosis, and presence of osteophytes (5,8,12,18,19). Many published articles stated that FJS as the source causing back pain based on the diagnostic block (3,8,12,15,16,19); however, most of the studies have shown false-positive results and no correlation between the clinical symptoms and imaging such as plain radiograph, computerised tomography (CT) scan, magnetic resonance imaging (MRI) and single photon emission CT (SPECT) (6,7,8,10,19,21,22). CT scan and MRI offer complementary diagnostic benefits: CT excels at detecting bone changes, while MRI is better at identifying soft tissue conditions like inflammation,

oedema, and cysts. However, even when imaging shows signs of FJ osteoarthritis, these findings alone do not reliably indicate that the pain is coming from the FJ (4,12,16,19,20,21).

Facet joints injection (FJI) with local anaesthesia with steroid is one of the commonest procedures for FJS. This method serves both diagnostic and therapeutic purposes (1,4,5,9,12,19). Local anaesthesia offers immediate pain relief by breaking the pain-spasm cycle, while the corticosteroid effect takes about a week to be noticeable, with its peak anti-inflammatory action setting in around three weeks. Early studies demonstrated unsatisfactory outcomes in FJI for FJS (22). Nonetheless, some studies in recent years have reported optimistic results with this technique (2,5,8,12).

The relationship between obesity and LBP remains a topic of debate. Rahman Shiri et al. conducted a study exploring this association and reached the conclusion that overweight and obesity are most strongly linked to seeking medical attention for acute and chronic LBP (23). Numerous pieces of literature have indicated an association between LBP and vitamin D deficiency (24,25). However, it is worth noting that there is currently limited literature available that discusses the correlation between FJS and hypovitaminosis.

In this study, we assessed the treatment's effectiveness by administering 1cc of Diprospan (Betamethasone Dipropionate) along with 1cc of Lignocaine 2% to patients diagnosed with lumbar FJS. We employed the Oswestry Disability Index (ODI) scoring and Visual Analogue Scale (VAS) as the established assessment tools for this purpose. The ODI has demonstrated its reliability and validity as a scale for assessing disability in individuals with LBP (1,11,14,20,26). Concurrently, we conducted additional assessments to explore the potential correlation between BMI and vitamin D status and their impact on treatment outcomes, which were evaluated using ODI scoring.

MATERIALS AND METHODS

SThis study was a quasi-experimental one-group time series conducted on 36 individuals diagnosed with lumbar facet joint arthropathy (FJA) at IIUM @ Sultan Ahmad Shah Medical Centre, Kuantan. In the initial consultation, a senior spine consultant surgeon meticulously reviewed the patients' medical history and conducted a comprehensive clinical examination. Anteroposterior (AP), oblique, and lateral plain radiographs of the lumbosacral spine were taken and independently evaluated by a consultant radiologist. Analysis of the sets of plain radiographs revealed the absence of any abnormalities, although generalised osteoarthritic alterations in the lumbar spine or localised degenerative changes in FJ were observed. It is noteworthy that all individuals had previously undergone conservative treatment, which included oral analgesics and physiotherapy. Before undergoing FJI, all participants were screened for underlying infections and bacteraemia using a complete blood count to assess leukocyte levels and inflammatory markers, including erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP).

Patients were managed under day-care basis in a sterile operation under imaging guidance with lumbar FJ intra-articular steroid injections. Participants received full information about the use of necessary data, and their informed consent was obtained. The inclusion criteria specified individuals over eighteen years old experiencing axial LBP (without pain radiating past the knee) persisting for more than six months. Physical examinations revealed paramedian lumbar tenderness without midline tenderness, and pain was reproduced with hyperextension and lateral rotation (facet loading) (27); and for exclusion criteria, patients with a history spine trauma, infection, tumour or any form of spinal surgery, patients with positive finding of FABER test indicating sacroiliac pathology, patients with lower back pain with true sciatica ,patients with a history of adverse reaction to Lidocaine or corticosteroid injection and patients who are unable to understand inform consent or unstable psychosis.

Initially, patients were examined in an outpatient clinic, where their height, weight, body mass index (BMI), pain duration, and 25(OH) vitamin D serum level were recorded on the same day. Functional outcomes were evaluated using the ODI, and pain severity was measured using VAS. The questionnaire was administered prior to the procedure and was available in both Malay and English versions. The questionnaire comprises ten sections that encompass various aspects of a patient's daily life, including pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social activities, travelling, and changes in pain levels. Within each category, there are six statements describing different scenarios related to the topic. Patients are instructed to select the statement that best aligns with their level of disability. The scoring system ranges from zero to five, with the initial statement assigned a score of zero, indicating minimal disability, and the final statement receiving a score of five, signifying the highest degree of disability. The total scores of the answered questions are added up and then doubled to calculate the index, ranging from 0 to 100. The resulting score is classified as follows: minimal disability (score 0 to 19), moderate disability (score 20 to 39), severe disability (score 40 to 59), crippled (60 to 79), and bedbound (score 80 to 100). A date given for day-care admission for the procedure. On the scheduled date of procedure, the patient admitted in day-care ward. Vital signs recorded before the procedure as a baseline data. In operation theatre, patient placed in prone position. The anaesthesiologist gave the sedation. The procedure performed by the same senior

spine surgeon. Level of interest identified with image intensifier and marked on the skin. In this study, L3/L4, L4/L5, L5/S1 bilateral FJ performed in each subject. The bilateral FJ and three levels of FJ were routinely injected to allow for errors in diagnosis due to the overlapping sensory supply. After cleaned and draped, the levels re-confirmed with image intensifier. Skin infiltrated with lignocaine 2%. A 25G (0.5mm) spinal needle used to approach the FJ. The needle point guided to lumbar FJ cleft under image guidance. In anterior-posterior view, the needle aimed at lateral border of pedicle and mid-line of transverse process area of lumbar spine (Fig. 1A). In oblique view the needle aimed at point of the joint cleft in between inferior articular process and superior articular process (Fig. 1B) from the desired level. A mixture of 1cc Betamethasone Dipropionate and 1cc Lignocaine 2% prepared in a syringe. After the successful insertion of the needle, whole volume of 2 cc injected through the spinal needle placed into each joint. Post procedure, patient monitored at recovery bay of the operation theatre before sending to day-care ward for further observation. Patients discharged if they were well throughout the observation period. Patient regularly reviewed in out-patient clinic. At six months post procedure, patients' pain score and ODI scoring recorded again with the same senior spine surgeon. The measurement of the BMI done once at the beginning of the procedure in view of no weight reduction treatment given to the patient and the status will remain the same at six months duration. This also applied for the level of 25(OH) vitamin D which taken once in view of the cost and no further treatment given to treat the deficiency.

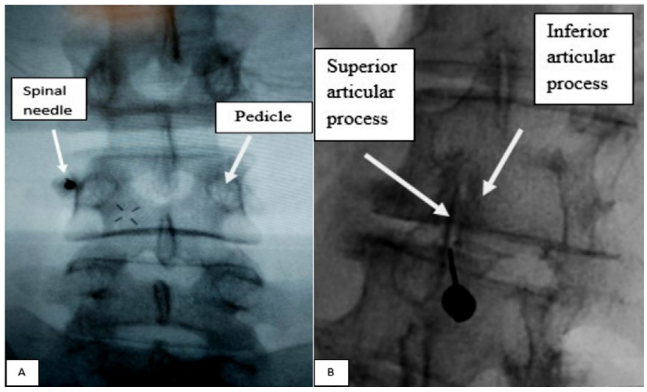

Fig. 1: Image intensifier projections of the lumbar spine with the spinal needle (A) in AP view, and (B) in oblique view. The spinal needle is targeting directly at the lumbar facet joint.

Sample Size Calculation and Statistical Analyses

The sample size calculation was conducted using repeated measures ANOVA, focusing on the percentage change in the ODI. This calculation was performed with G*Power software. The parameters set included a 95% confidence level (CL), 80% statistical power, and an effect size of 0.47, based on the study by Chuan Yen et al. (28). The resulting required sample size was determined to be 19 participants. To account for an anticipated 20% non-participation or dropout rate, the final adjusted sample size was increased to 24 participants, calculated by dividing the initial sample size by the expected participation rate (19 / 0.8 = 24).

The collected data processed by using IBM SPSS version 24. The statistical analysis of parametric data performed using descriptive analysis (mean and standard deviation), paired T-test, and ANOVA test. Statistically significant taken with p-value of <0.05.

Ethical Clearance

This study was approved by the International Islamic University Malaysia (IIUM) Research Ethics Committee (IREC) (Ref No.: IIUM/504/14/11/2/IREC 2019-038).

RESULTS

There were 36 patients who received treatment, including nine (25%) males and 27 (75%) females. The age ranged from 28 to 79 years. As average, the height for all patients was 1.56m and weight of 72.96 kg, which comprises the average of BMI with 29.78 kg/m2. Nineteen patients categorised as obesity (52.8%), followed by overweight with nine (25.0%) and normal weight with eight patients (22.2%). As for the vitamin D serum status, 20 (55.6%) categorised under deficient group, followed by 14 (38.9%) under insufficient group, and only two (5.6%) fell under the optimal group (Table I).

Table I: Demographic data (n=36)

Demographic Data	Mean (±SD)	Frequency	Percentage (%)
Gender			
Male		9	25.0
Female		27	75.0
Age (years)	58.31 (11.14)		
Age group			
20-40 years		3	8.3
41-60 years		16	44.4
More than 60 years		17	47.2
Height (m)	1.56 (0.10)		
Weight (kg)	72.96 (15.16)		
BMI Score	29.78 (5.40)		
BMI Category			
Underweight		0	0.0
Normal weight		8	22.2
Overweight		9	25.0
Obesity		19	52.8
Vitamin D Status (Serum 25(OH)D in ng/ml)			
Deficiency (≤ 20)		20	55.6
Insufficiency (21 – 29)		14	38.9
Optimum (> 30)		2	5.6

SD = standard deviation, BMI = body mass index

In ODI scoring, most of the patients categorised under severe disability with 15 (41.7%) and followed by moderate disability and crippled with 14 (38.9%) and seven (19.4%) respectively. After six months of treatment, the trend for severe disability remains the same with

highest percentage 41.7% or fifthteen patients, followed by moderate and minimal disability (both recorded with eight, 22.2%) and only 13.9% or five patients recorded for crippled category (Table II). In VAS assessment, Majority of the patient presented with moderate pain (55.6%) on the first visit. 38.9% of patients presented with severe pain (38.9%), and only 5.6% of patients presented with mild pain. After six months of FJI, most patients experienced moderate pain (47.2%), with mild pain reported by 30.6% of individuals. Severe pain was noted in 16.7% of cases, and only 5.6% of patients were completely pain-free (Table II).

Table II: Pre-injection and post-injection after six months based on Visual Analogue Score (VAS) and Oswestry Disability Index (ODI)

Variables	Pre-injection	Percentage (%)	Post-injection 6 months	Percentage (%)
Visual Analogue Score				
0: No pain	0	0	2	5.6
1-3: Mild pain	2	5.6	11	30.6
4-6: Moderate pain	20	55.6	17	47.2
7-10: Severe pain	14	38.9	6	16.7
Oswetry Disability Index				
Minimal disability	0	0	8	22.2
Moderate disability	14	38.9	8	22.2
Severe disability	15	41.7	15	41.7
Crippled	7	19.4	5	13.9

There was a significant correlation between percentage of ODI pre-injection and VAS of pre-injection ($p = 0.001$) by using Pearson Correlation test. Even though the p-value indicate a significant correlation, however the strength of correlation only recorded a moderate correlation (51.5%), positive and linear correlation. Another result obtained was between the percentage of ODI post-injection after six months and VAS of post-injection after six months. The correlation has shown a strong correlation (85.7%), positive and linear correlation between those two parameters. The p-value also indicate a significant correlation exists between percentage of ODI post-injection after six months and pain score of post-injection after six months ($p < 0.001$) (Table III).

ODI percentage score at a different time point (pre- and post- treatment) with adjusted BMI status showed a significant lowering in ODI scoring recorded in the normal weight category (21.25%) compared to the rests (10,22% in overweight, and 2.31% in obesity). In the paired T-test, only the normal weight category obtained a significant difference with a p-value of 0.006 (Table IV). Where from the perspective of analysing the functionality status outcome based on the Vitamin D status. It revealed a significant lowering of 38% in the optimal category, followed by the deficient and insufficient categories, which recorded 9.55% and 2.78% respectively. In the deficient and optimal categories showed a significant difference with both p-values obtained was less than 0.05 (Table IV).

Table III: Correlation between percentage of Oswestry Disability Index (ODI) pre-injection, pain score of pre-injection, percentage of ODI post-injection after 6 months, and pain score of post-injection after 6 months.

Pearson Correlation	% of ODI Pre-injection		VAS of Pre-injection		% of ODI Post-injection after 6 months		VAS of Post-injection after 6 months	
	Sig. (2-tailed)	Pearson Correlation	Sig. (2-tailed)	Pearson Correlation	Sig. (2-tailed)	Pearson Correlation	Sig. (2-tailed)	
% of ODI Pre-injection	1		0.515**	0.001	0.435**	0.008	0.352*	0.035
VAS of Pre-injection	0.515**	0.001	1		0.192	0.262	0.324	0.054
% of ODI Post-injection after 6 months	0.435**	0.008	0.192	0.262	1		0.857**	< 0.001
VAS of Post-injection after 6 months	0.352*	0.035	0.324	0.054	0.857**	< 0.001	1	

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table IV: Oswestry Disability Index (ODI) percentage score at a different time point (pre-injection and post-injection after 6 months) with adjusted body mass index (BMI) and vitamin D status.

Variables		Mean (SD) of ODI % score	t-stat	df	p-value*
Body mass index					
Normal weight	Pre-injection	50.25 (15.87)	3.937	7	0.006
	Post-injection 6 months	29.00 (23.52)			
Overweight	Pre-injection	39.89 (11.33)	1.376	8	0.206
	Post-injection 6 months	29.67 (21.41)			
Obesity	Pre-injection	49.42 (14.51)	0.568	18	0.577
	Post-injection 6 months	47.11 (16.45)			
Vitamin D status					
Deficient	Pre-injection	48.30 (12.88)	2.688	19	0.015
	Post-injection 6 months	38.75 (19.10)			
Insufficient	Pre-injection	43.71 (16.41)	0.473	13	0.644
	Post-injection 6 months	40.93 (24.38)			
Optimal	Pre-injection	61.00 (1.41)	19.000	1	0.033
	Post-injection 6 months	23.00 (4.24)			

SD: standard deviation
* Paired t-test

One-way ANOVA showed that there was no statistically significant difference between the mean difference of ODI percentage score with BMI groups (F (2,33) = 3.003, p = 0.063). However, result revealed that there was a statistically significant difference between the mean difference of ODI percentage score with vitamin D status (F (2,33) = 3.294, p = 0.049) (Table V). A Dunnett T3 post-hoc test used due to equal variance assumed assumption as the equal variance did not fit in the criteria in the homogeneity test. It showed that the deficient category has statistically lower by 28.45 as compared to optimal, meanwhile insufficient also showed a statistically lower percentage of ODI with 35.21 as compared to optimal. Both pair between deficient and insufficient towards optimal has shown a statistically significant (p<0.05) (Table VI).

Table V: Mean difference of Oswestry Disability Index (ODI) percentage of pre-injection and post-injection (6 months) with body mass index (BMI) category and vitamin D status.

Variables	Mean (SD)	95% Confidence Interval for Mean		F-stat	p-value*
		Lower Bound	Upper Bound		
Body mass index					
Normal weight	21.25 (15.27)	8.49	34.01		
Overweight	10.22 (22.29)	-6.91	27.35	3.003	0.063
Obesity	2.32 (17.76)	-6.24	10.88		
Vitamin D status					
Deficient	9.55 (15.89)	2.11	16.99		
Insufficient	2.79 (22.04)	-9.94	15.51	3.294	0.049
Optimal	38.00 (2.83)	12.59	63.41		

SD: standard deviation
* One-Way Repeated Measure ANOVA

Table VI: Multiple comparison post hoc analysis (Dunnett T3)

Vitamin D Status		Mean Difference (I-J)	p-value	95% Confidence Interval	
(I) Status	(J) Status			Lower Bound	Upper Bound
Deficient	Insufficient	6.76	0.697	-10.93	24.46
	Optimal	-28.45	<0.001	-39.74	-17.15
Insufficient	Deficient	-6.76	0.697	-24.46	10.93
	Optimal	-35.21	<0.001	-51.98	-18.45
Optimal	Deficient	28.45	<0.001	17.15	39.75
	Insufficient	35.21	<0.001	18.45	51.98

DISCUSSION

This is the first study analysing the correlation between the FJI treatment for patients with the diagnosis of lumbar FJA, the BMI and vitamin D serum status. It is important to acquire an accurate assessment of pain intensity and clinical outcome in observing the effectiveness of managing patients with LBP. We have adopted the numerical VAS for the pain intensity and ODI to determine the disability measure since they could be used to track the serial changes. Analysis of the study shows that during the first visit, most of the patients came with moderate pain (55.6%) during the first visit. Six months after lumbar FJI has shown that most of them were still categorised under moderate pain group (Table II). Assessment by using ODI scoring has shown almost similar trend as seen in the assessment using the pain score, with majority of patients (41.7%)

presented with severe disability before the treatment and most of them were still categorised under severe disability category (41.7%) after the procedure (Table II). Pearson correlation test shows that there was a statistically significant correlation between the ODI scoring and VAS (p = 0.001) (Table III). Our study aligns with existing literature, affirming that there is a notable impact of time on the functional outcomes in patients diagnosed with lumbar FJS who underwent a minimally invasive procedure, specifically percutaneous imaging-guided lumbar FJI. This finding is further substantiated by the outcomes of previous studies that utilised percutaneous imaging-guided FJI and reported excellent results (1,11,14,16,20,29,30,31,32,33).

The result of ODI scoring at different time point based on BMI category showed that there is a significant lowering of ODI score among the normal weight patients (21.3%). Only the normal weight group showed a statistically significant result after 6 months after treatment with p = 0.006 (Table IV). However, we found out that there was no correlation between the BMI and ODI scores using One-way ANOVA analysis (F (2.33) = 3.003, p = 0.063) (Table V). The failure to demonstrate the positive correlation between the BMI and the ODI scoring in our study may be affected by the small size of sample in this study. However, we noticed a good outcome after the treatment in the normal weight group as compared to the overweight and obese groups. We believe that in normal weight patients will have positive results after the treatment as compared to the overweight and obese patients. The possible effect of patients with BMI > 24 (overweight and obese categories) may cause FJA via several structural mechanism. This may lead to significant postural alterations that could impact joint loading. An elevation in BMI is associated with an increase in lumbosacral angles and biomechanical modifications within the lumbosacral spine. Consequently, this can contribute to heightened FJ degeneration, greater torque applied to the lumbar discs and joints, and an augmentation in shear forces, resulting in an overload on the spinal joints (34,35).

A significant difference of 38% observed for optimal category of vitamin D status (Table IV). We discovered in the deficient and optimal categories of vitamin D showed a significant difference with both p < 0.05 (Table IV). Further investigation was done to look in the correlation between the vitamin D categories and ODI score showed a statistically significant difference among all categories of vitamin D status with the treatment by using One-Way ANOVA test (F (2.33) - 3.294, p = 0.049) (Table V). Dunnett T3 post-hoc test further exploited and revealed that only the optimal category of vitamin D patients had shown good outcome after the treatment (Table VI). In the recent literature, hypovitaminosis D has shown to affect calcium metabolism, matrix ossification, osteoblastic activity, bone density, and bone remodelling adversely. It has shown to be an important factor leading to osteoporosis due to the disruption in calcium metabolism (36). Therefore, a person with osteoporotic vertebral body will sustain microfracture, which led to loss of vertebral body segmental height, which led to instability in FJs, and subsequently led to degenerative disc and joints and was further supported by recent studies that hypovitaminosis D has a positive correlation with LBP (37). Therefore, based on the evidence above, we believe that patients with hypovitaminosis D do not benefit from this treatment in contrary to the optimal vitamin D patients due to the degenerative changes of the joints.

Limitations

The study encountered several limitations. The follow-up period was limited to six months, which is shorter compared to other studies that typically have longer follow-ups. This short duration may lead to recall bias and makes it difficult to draw firm conclusions, especially when comparing our results with those of studies that had longer follow-ups. Although some studies have used a three- to six-month period for short-term outcomes (1,2,8), extending the follow-up to at least one year in future research would provide more clinically relevant data. While our sample size was calculated appropriately and is comparable to previous studies, future research should consider a larger sample size for more robust results. Additionally, further randomized controlled trials (RCTs) with greater methodological rigor are needed to explore the relationship between FJI and BMI categories. Even though the ODI is a widely validated assessment tool used in similar studies, it lacks certain psychometric properties important for biopsychosocial evaluation (14,26). Lastly, while participants did not undergo pre-intervention MRI, and we do not view this as a limitation, the necessity of pre-FJ intervention MRI remains a debated topic (1,4,6,12,16,19,20,21).

CONCLUSION

Patients diagnosed with lumbar FJA with normal BMI and optimal vitamin D status has a good clinical outcome six-month after FJI.

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REFERENCES

1. Manchikanti L, Knezevic E, Knezevic NN, Sanapati MR, Kaye AD, Abdi S, et al. Effectiveness of facet joint nerve blocks in managing chronic axial spinal

pain of facet joint origin: a systematic review and meta-analysis. Pain Physician. 2024;27(2):E169-206. Available from: https://pubmed.ncbi.nlm.nih.gov/38324785/. PMID: 38324785.
2. Ambrosio L, Vadala G, Russo F, Pascarella G, De Salvatore S, Papalia GF, et al. Interventional minimally invasive treatments for chronic low back pain caused by lumbar facet joint syndrome: a systematic review. Global Spine J. 2023;13(4):1163-79. doi: 10.1177/21925682221142264.
3. Liu M, Shaparin N, Nair S, Kim RS, Hascalovici JR. Chronic low back pain: the therapeutic benefits of diagnostic medial branch nerve blocks. Pain Physician. 2021;24(4):E521-8. Available from: https://pubmed.ncbi.nlm.nih.gov/34213878/. PMID: 34213878.
4. Manchikanti L, Kaye AD, Soin A, Albers SL, Beall D, Latchaw R, et al. Comprehensive evidence-based guidelines for facet joint interventions in the management of chronic spinal pain: American Society of Interventional Pain Physicians (ASIPP) Guidelines Facet Joint Interventions 2020 Guidelines. Pain Physician. 2020;23(3S):S1-127. Available from: https://pubmed.ncbi.nlm.nih.gov/32503359/. PMID 32503359.
5. Won HS, Yang M, Kim YD. Facet joint injections for management of low back pain: a clinically focused review. Anesth Pain Med (Seoul). 2020;15(1):8-18. doi: 10.17085/apm.2020.15.1.8.
6. Yoo YM, Kim KH. Facet joint disorders: from diagnosis to treatment. Korean J Pain. 2024;37(1):3-12. doi: 10.3344/kjp.23228.
7. Byvaltsev VA, Kalinin AA, Shepelev VV, Pestryakov YY, Biryuchkov MY, Jubaeva BA, et al. The relationship of radiographic parameters and morphological changes at various stages of degeneration of the lumbar facet joints: cadaver study. Global Spine J. 2024;14(1):195-203. doi: 10.1177/21925682221099471.
8. Said N, Amrhein TJ, Joshi AB, N NCN, Kranz PG. Facets of facet joint interventions. Skeletal Radiol. 2023;52(10):1873-86. doi: 10.1007/s00256-022-04184-5.
9. Wong MJ, Rajarathinam M. Ultrasound-guided axial facet joint interventions for chronic spinal pain: A narrative review. Can J Pain. 2023;7(2):2193617. doi: 10.1080/24740527.2023.2193617.
10. Acosta Julbe JI, Mandell JC, Ermann J, Isaac Z, Gottreich JR, Zampini JM, et al. Predictors of outcomes after lumbar intra-articular facet joint injections and medial branch blocks: a scoping review. Spine (Phila Pa 1976). 2023;48(20):1455-63. doi: 10.1097/BRS.0000000000004776.
11. Nisolle ML, Ghoundiwal D, Engelman E, El Founas W, Gouwy J, Guntz E, et al. Comparison of the effectiveness of ultrasound-guided versus fluoroscopy-guided medial lumbar bundle branch block on pain related to lumbar facet joints: a multicenter randomized controlled non-inferiority study. BMC Anesthesiol. 2023;23(1):76. doi: 10.1186/s12871-023-02029-9.
12. Du R, Xu G, Bai X, Li Z. Facet joint syndrome: pathophysiology, diagnosis, and treatment. J Pain Res. 2022;15:3689-710. doi: 10.2147/JPR.S389602.
13. Ghormly RK. Low back pain: with special reference to the articular facets, with presentation of an operative procedure. JAMA. 1933;101(23):1773-7. doi:10.1001/jama.1933.02740480005002.
14. Nisolle ML, Bourguignon A. Management of chronic low back pain: news on the lumbar medial branch block and the importance of the biopsychosocial model. Anaesthesiol Intensive Ther. 2023;55(5):382-3. doi: 10.5114/ait.2023.134272.
15. Kim BY, Concannon TA, Barboza LC, Khan TW. The role of diagnostic injections in spinal disorders: a narrative review. Diagnostics (Basel). 2021;11(12):2311. doi: 10.3390/diagnostics11122311.
16. Cohen SP, Bhaskar A, Bhatia A, Buvanendran A, Deer T, Garg S, et al. Consensus practice guidelines on interventions for lumbar facet joint pain from a multispecialty, international working group. Reg Anesth Pain Med. 2020;45(6):424–67. doi: 10.1136/rapm-2019-101243.
17. Revel M, Poiraudeau S, Auleley GR, Payan C, Denke A, Nguyen M, et al. Capacity of the clinical picture to characterize low back pain relieved by facet joint anesthesia. Proposed criteria to identify patients with painful facet joints. Spine (Phila Pa 1976). 1998;23(18):1972-77. doi:10.1097/00007632-199809150-00011.
18. Almeer G, Azzopardi C, Kho J, Gupta H, James SL, Botchu R. Anatomy and pathology of facet joint. J Orthop. 2020;22:109-17. doi: 10.1016/j.jor.2020.03.058.
19. Perolat R, Kastler A, Nicot B, Pellat JM, Tahon F, Attye A, et al. Facet joint syndrome: from diagnosis to interventional management. Insights Imaging. 2018;9(5):773-89. doi: 10.1007/s13244-018-0638-x.
20. Shin DA, Choo YJ, Chang MC. Spinal injections: a narrative review from a surgeon's perspective. Healthcare (Basel). 2023;11(16):2355. doi: 10.3390/healthcare11162355.
21. Little JW, Grieve T, Cantu J, Bogar WC, Heiser R, Miley H, et al. Reliability of human lumbar facet joint degeneration severity assessed by magnetic resonance imaging. J Manipulative Physiol Ther. 2020;43(1):43-9. doi: 10.1016/j.jmpt.2018.11.027.
22. Lilius G, Harilainen A, Laasonen EM, Myllynen P. Chronic unilateral low-back pain. Predictors of outcome of facet joint injections. Spine (Phila Pa 1976). 1990;15(8):780-2. Available from: https://pubmed.ncbi.nlm.nih.gov/2146756/. PMID: 2146756.

23. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The association between obesity and low back pain: a meta-analysis. Am J Epidemiol. 2010;171(2):135-54. doi: 10.1093/aje/kwp356.
24. e Silva AV, Lacativa PG, Russo LA, de Gregyrio LH, Pinheiro RA, Marinheiro LP. Association of back pain with hypovitaminosis D in postmenopausal women with low bone mass. BMC Musculoskelet Disord. 2013;14:184. doi: 10.1186/1471-2474-14-184.
25. Lodh M, Goswami B, Mahajan RD, Sen D, Jajodia N, Roy A. Assessment of Vitamin D status in patients of chronic low back pain of unknown etiology. Indian J Clin Biochem. 2015;30(2):174-9. doi: 10.1007/s12291-014-0435-3.
26. Lee CP, Fu TS, Liu CY, Hung CI. Psychometric evaluation of the Oswestry Disability Index in patients with chronic low back pain: factor and Mokken analyses. Health Qual Life Outcomes. 2017;15(1):192. doi: 10.1186/s12955-017-0768-8.
27. Annaswamy TM, Armstead C, Carlson L, Elkins NJ, Kocak D, Bierner SM. Intra-articular triamcinolone versus hyaluronate injections for low back pain with symptoms suggestive of lumbar zygapophyseal joint arthropathy: a pragmatic, double-blind randomized controlled trial. Am J Phys Med Rehabil. 2018;97(4):278-84. doi: 10.1097/PHM.0000000000000879.
28. Chuan Yen T, Mohler J, Dohm M, Laksari K, Najafi B, Toosizadeh N. The effect of pain relief on daily physical activity: in-home objective physical activity assessment in chronic low back pain patients after paravertebral spinal block. Sensors (Basel). 2018;18(9):3048. doi: 10.3390/s18093048.
29. Motawea AM, El Kholy MR, Ebied OM, Mousa WAEF, Abdullah MS. Imaging-guided facet joint injection technique for lower back pain management. Am J Health Res. 2015;3(2):52-6. doi: 10.11648/j.ajhr.20150302.11.
30. Peh WCG. Image-guided facet joint injection. Biomed Imaging Interv J. 2011;7(1):e4. doi: 10.2349/biij.7.1.e4.
31. Tan HK, Chew KM, Peh WCG. Percutaneous imaging-guided spinal facet joint injections. Tech Orthop. 2013;28(1):12-17. doi: 10.1097/BTO.0b013e3182897364.
32. Manchikanti L, Manchikanti KN, Manchukonda R, Cash KA, Damron KS, Pampati V, et al. Evaluation of lumbar facet joint nerve blocks in the management of chronic low back pain: preliminary report of a randomized, double-blind controlled trial: clinical trial NCT00355914. Pain Physician. 2007;10(3):425-40. Available from: https://pubmed.ncbi.nlm.nih.gov/17525777/. PMID: 17525777.
33. Manchikanti L, Pampati V, Bakhit CE, Rivera JJ, Beyer CD, Damron KS, et al. Effectiveness of lumbar facet joint nerve blocks in chronic low back pain: a randomized clinical trial. Pain Physician. 2001;4(1):101-17. Available from: https://pubmed.ncbi.nlm.nih.gov/16906173/. PMID: 61906173.
34. Dzefi-Tettey K, Edzie EKM, Mensah SK, Osei S, Piersson AD, Amedi MK, et al. Lumbar facet joint arthrosis on magnetic resonance imaging and its association with low back pain in a selected Ghanaian population. J Neurosci Rural Pract. 2023;14(4):681-5. doi: 10.25259/JNRP_94_2023.
35. Sheng B, Feng C, Zhang D, Spitler H, Shi L. Associations between obesity and spinal diseases: a medical expenditure panel study analysis. Int J Environ Res Public Health. 2017;14(2):183. doi: 10.3390/ijerph14020183.
36. Christodoulou S, Goula T, Ververidis A, Drosos G. Vitamin D and bone disease. Bio Med Res Int. 2013;2013:396541. doi: 10.1155/2013/396541.
37. Gokcek E, Kaydu A. Assessment of relationship between vitamin D deficiency and pain severity in patients with low back pain: a retrospective, observational study. Anesth Essays Res. 2018;12(3):680-4. doi: 10.4103/aer.AER_96_18.
38. Ross JJ, Ard KL. Septic arthritis of the spinal facet joint: review of 117 cases. Open Forum Infect Dis. 2024;11(3):ofae091. doi: 10.1093/ofid/ofae091.