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ORIGINAL ARTICLE

Comparison of ultrasound- and fluoroscopy-guided intra-articular corticosteroid injections for hip osteoarthritis

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SUMMARY

Objectives: This study aimed to evaluate the effectiveness of ultrasound (US)-guided and fluoroscopy (FL)-guided intra-articular steroid injections on pain and hip function. The study focused on patients with hip osteoarthritis (coxarthrosis) who were refractory to medical treatment.

Methods: In this retrospective study, 61 patients with stage ≥2 coxarthrosis and VAS ≥4 were evaluated. Patients received either US-guided (Group U) or FL-guided (Group F) corticosteroid injections. Visual analog scale (VAS), Harris Hip Score (HHS), and analgesic use were assessed at 1 week and at 1, 3, and 6 months post-treatment. Analgesic use was evaluated based on the number of days with analgesic consumption and was interpreted as increased, decreased, or unchanged compared to baseline.

Results: Both treatment methods provided significant improvements in VAS and HHS scores at all follow-up points across osteoarthritis stages ($p<0.05$). However, no statistically significant difference was found between the groups in terms of pain scores, functional outcomes, or analgesic use. While marked improvements were observed in stage 2 patients, the clinical effectiveness of the injections decreased as the disease stage progressed.

Conclusion: Both US-guided and FL-guided steroid injections resulted in significant pain reduction and improved functionality in patients with osteoarthritis. No clear superiority was observed between the two techniques. Treatment was most effective in patients at earlier stages of the disease, with efficacy declining as the disease advanced. Additionally, US is a safer imaging modality compared to FL, as it does not involve exposure to ionizing radiation.

Keywords: Coxarthrosis; fluoroscopy; hip osteoarthritis; intraarticular corticosteroid injection; ultrasonography.

Introduction

Osteoarthritis (OA) is the most common type of arthritis worldwide. It is associated with degenerative changes that develop either idiopathically or secondary to specific conditions that damage the articular surface.[1,2] The hip joint is one of the most frequently affected sites of OA, and the lifetime risk of developing symptomatic hip osteoarthritis is approximately 25%.[3,4] OA significantly impairs quality of life and imposes a substantial socioeconomic burden globally. With increasing life expectancy and rising obesity rates, its prevalence is expected to rise further in the coming decades.[5] Coxarthrosis involves structural alterations such as cartilage degeneration, osteophyte formation, ligament laxity, and synovial inflammation.[6] The most common symptom is hip pain localized in the groin region. The disease is characterized by pain accompanied by stiffness, restricted range of motion, and crepitus. Symptoms typically worsen after rest or intense physical activity and often limit walking and daily functioning.[1]

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Diagnosis is based on patient history, physical examination, and, most commonly, radiographic imaging.[7] Recently, the growing availability of US has contributed to a more detailed understanding of the disease. US is increasingly used as a valuable tool in both diagnostic and therapeutic contexts.[8]

Initial treatment of hip OA generally involves non-pharmacological interventions such as low-impact exercise, weight management, physical therapy, and lifestyle modifications. Pharmacologic management typically begins with paracetamol; non-steroidal anti-inflammatory drugs and, when necessary, short-term opioid analgesics may be added.[9] Interventional therapies prior to surgery include intra-articular injections of corticosteroids, hyaluronic acid, or platelet-rich plasma.[10]

Anatomically, the hip joint is a ball-and-socket synovial joint formed by the articulation of the femoral head and the acetabulum.[11] Intra-articular corticosteroid injections are widely utilized for short-term pain relief in patients with hip OA. However, due to the deep anatomical location of the hip joint, blind injections are associated with lower success rates and an increased risk of complications.[12] For this reason, image guidance is essential to improve procedural accuracy. According to the literature, the accuracy rate of US-guided injections ranges from 90% to 100%, while FL-guided procedures yield an accuracy of approximately 76%. US offers advantages such as the absence of ionizing radiation and real-time visualization of soft tissues, whereas FL allows confirmation of intra-articular needle placement using contrast agents.[13] Although computed tomography and magnetic resonance imaging offer high accuracy, their clinical use is limited due to cost, accessibility, and radiation exposure.[14]

This study aims to compare the effectiveness of corticosteroid injections into the femoroacetabular joint administered under US and FL guidance. The primary aim of this study was to determine whether there is a significant difference in pain reduction between US-guided and FL-guided intra-articular corticosteroid injections in hip osteoarthritis. The secondary aims were to assess the influence of disease stage on treatment efficacy, to evaluate functional outcomes over time, and to compare analgesic consumption trends during the 6-month follow-up period.

Evidence on the effectiveness of image-guided intra-articular injections in hip OA remains limited, and comparative data between US and FL techniques are particularly scarce in the literature. This study aims to address this gap and contribute to the comparative understanding of these two widely used image-guided injection modalities.

Material and Methods

Ethical approval for the study was obtained from the local ethics committee of a tertiary hospital (decision dated August 7, 2024; No. 198/2024). The study was conducted in accordance with the principles of the Declaration of Helsinki (2008).

A retrospective analysis was performed on the medical records of 61 patients aged ≥18 years who had hip osteoarthritis at stage ≥2 according to the Kellgren–Lawrence classification and VAS ≥4 despite prior medical treatment. These patients received image-guided intra-articular corticosteroid injections between June 2022 and June 2024. The primary aim of this study was to evaluate the efficacy of intra-articular corticosteroid injection (40mg triamcinolone acetonide) administered under ultrasonographic or fluoroscopic guidance. The choice of imaging guidance, either US or FL, was determined by the experience and discretion of the practitioners. US-guided procedures were performed exclusively by a single practitioner experienced in this technique, whereas FL-guided procedures were carried out by another practitioner with greater expertise in fluoroscopic guidance. This ensured that both techniques were executed by the most qualified professionals.

Patients were categorized into two groups:
- Group U (US-guided injections)
- Group F (FL-guided injections)

Changes in mean VAS scores, HHS, and the number of days analgesics were consumed were assessed at multiple time points: 1 week and 1, 3, and 6 months post-treatment. Pre-treatment and post-treatment outcomes were then compared. Analgesic use was evaluated based on the number of days with analgesic consumption; it was calculated on a weekly basis for the first week and on a monthly basis for subsequent follow-up points. The results were interpreted as increased, decreased, or unchanged compared to baseline.

Outcome Assessments

Pain was assessed using a 10-point Visual Analog Scale (VAS), where 0 represents no pain and 10 represents the worst imaginable pain. Functionality was assessed using the Harris Hip Score (HHS), which includes domains such as pain, function, absence of deformity, and range of motion (score range: 0–100). Analgesic consumption was recorded as the number of days the patient used any oral or parenteral analgesic at each follow-up interval. This was calculated on a weekly basis for the first week and on a monthly basis for the subsequent time points (1st, 3rd, and 6th months). The results were interpreted as increased, decreased, or unchanged compared to baseline.

The primary outcome was the change in VAS score over time.

Secondary outcomes included change in HHS, the impact of disease stage on clinical response, and analgesic use.

Procedures

US-Guided Injection

The patient was monitored and positioned in the supine position on the examination table. The intervention area was sterilized with povidone-iodine. A 22-gauge black-colored Quincke spinal needle was used to administer a total of 3 ml of 2% prilocaine and 1 ml (40 mg) of triamcinolone acetonide intra-articularly. The procedure was performed using a 1.5–6 MHz convex ultrasound probe (Toshiba TUS-A500, Toshiba Medical Systems, Japan). After initial placement over the femoral crease, the probe was moved medially and inferiorly to identify the femoral head and joint capsule. The joint space was visualized in the longitudinal axis, and the needle was inserted using an in-plane approach until intra-articular positioning was confirmed. The injections were documented using the same ultrasound device. Figure 1 presents the recorded image of an intracapsular hip injection in a patient enrolled in the study.

FL-Guided Injection

The patient was monitored and placed in the supine position on the operating table. The intervention area was sterilized with povidone-iodine. The hip joint was visualized using FL imaging, and a 22-gauge black-colored Quincke spinal needle was inserted into the joint capsule under fluoroscopic guidance. The needle was directed toward the junction of the superior femoral neck and femoral head, which is commonly preferred to ensure accurate intra-articular access. The correct positioning of the needle tip within the joint capsule was confirmed by the administration of contrast material. Once verified, a total of 3ml of 2% prilocaine and 1 ml (40 mg) of triamcinolone acetonide was injected intra-articularly. The injections were documented using an FL device. Figure 2 presents the recorded image of an intracapsular hip injection in a patient enrolled in the study.

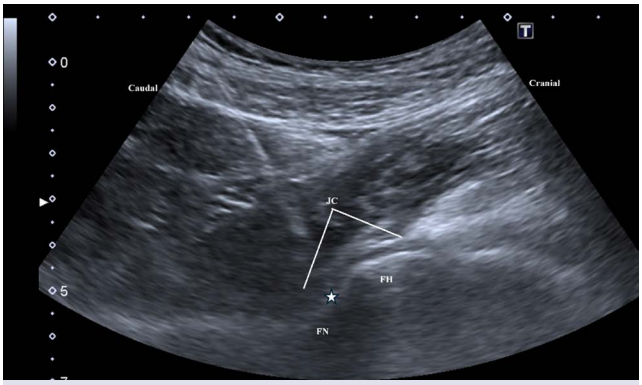

Figure 1. Ultrasound-guided intra-articular hip injection. The asterisk indicates the needle tip positioned within the joint capsule.

FH: Femoral head; FN: Femoral neck; JC: Joint capsule.

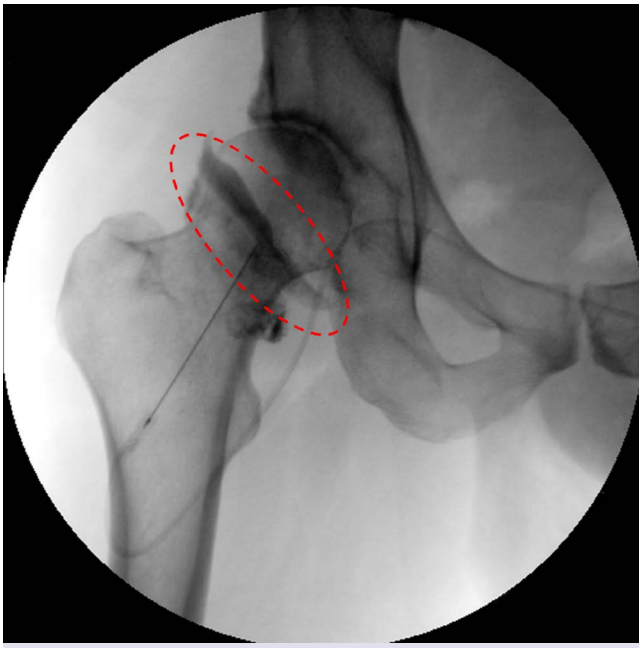

Figure 2. Fluoroscopy-guided intra-articular hip injection; the red dashed line indicates the distribution of contrast material within the joint capsule.

Table 1. Gender distribution across groups

	Group F n (%)	Group U n (%)	Total n (%)	p
Gender				1.000
Male	18 (64.3)	22 (66.7)	40 (65.6)	
Female	10 (35.7)	11 (33.3)	21 (34.4)	
Total	28 (100)	33 (100)	61 (100)	

Inclusion Criteria

Patients aged ≥18 years who were diagnosed with stage ≥2 coxarthrosis, continued to experience symptoms despite prior medical treatment, and received a single dose of intra-articular corticosteroid injection (40 mg triamcinolone acetonide) under US or FL guidance were included in the study.

Exclusion Criteria

Patients with incomplete clinical or follow-up data or those who underwent other interventional treatments (e.g., platelet-rich plasma therapy, physical therapy, hyaluronic acid injection, or radiofrequency ablation) or hip surgery during the follow-up period were excluded.

Statistical Analyses

The data were analyzed using SPSS 20. Normality of continuous variables was tested using the Shapiro–Wilk test. Results are presented as mean±standard deviation unless otherwise stated. The chi-square test, t-test, and repeated measures ANOVA were applied for the analyses. For post hoc comparisons following ANOVA, Bonferroni correction was used to adjust for multiple comparisons. A $p<0.05$ was considered statistically significant.

Results

A total of 94 patients with hip osteoarthritis were screened for inclusion in the study. Following exclusions during the initial assessment and follow-up period, 61 patients who met the inclusion criteria were included in the final analysis (Fig. 3).

Of the 61 patients, 28 (45.9%) were treated with FL-guided injections (Group F) and 33 (54.1%) with US-guided injections (Group U). There were 40 female patients (65.6%) and 21 male patients (34.4%), with no statistically significant difference in gender distribution between the groups ($p=1.000$; Table 1).

No significant difference in analgesic needs was observed between the groups at any time point ($p>0.05$; Table 2).

When patients were stratified by treatment type, significant differences in VAS values were observed over time in both strata and across all stages of coxarthrosis. It was observed that the clinical effect decreased as the stage of coxarthrosis increased, with the lowest treatment response found in patients at Stage 4 ($p<0.001$; Table 3).

No statistically significant difference was found when patients were stratified by stage and VAS values were compared within each group. Both groups showed a decrease in VAS scores over time, with Group U demonstrating a faster improvement, particularly in Stage 2. However, this difference diminished in the long term, and no significant advantage was observed between the treatment modalities in Stage 3 and Stage 4 patients (Table 4).

Table 2. Change in analgesic requirements within the group

		Change in analgesic requirement n (%)			
Group	**Time**	**Decreased**	**Unchanged**	**Increased**	**p**
F (n=28)	1st week	18 (64.3)	8 (28.6)	2 (7.1)	0.061
U (n=33)		16 (48.5)	17 (51.5)	0	
F	1st month	16 (57.1)	10 (35.7)	2 (7.1)	0.128
U		25 (75.8)	8 (24.2)	0	
F	3rd month	10 (35.7)	18 (64.3)	0	0.072
U		17 (51.5)	13 (39.4)	3 (9.1)	
F	6th month	5 (17.9)	21 (75)	2 (7.1)	0.225
U		9 (27.3)	18 (54.5)	6 (18.2)	

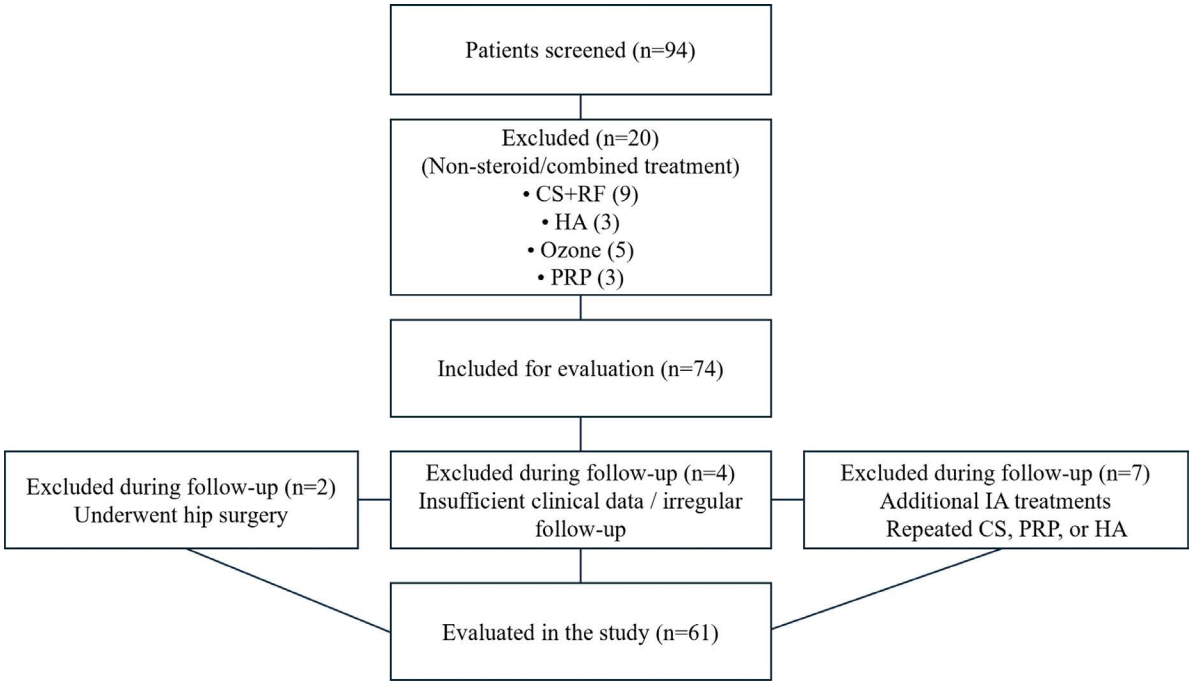

Figure 3. Flowchart illustrating the selection process and reasons for exclusion.

CS: Corticosteroid; RF: Radiofrequency; PRP: Platelet-rich plasma; HA: Hyaluronic acid.

Table 3. Comparison of VAS scores within treatment groups

Group	Hip osteoarthritis stage		VAS pre-treatment	VAS 1st week	VAS 1st month	VAS 3rd month	VAS 6th month	p-value and Partial eta2
F	2	Mean±SD	7.80±0.447	7.60±1.342	5.40±3.286	2.40±0.548	3.20±1.643	0.027 0.691
	3	Mean±SD	8.00±0.000	5.20±0.447	4.60±0.894	7.40±1.342	8.00±0.000	0.002 0.859
	4	Mean±SD	8.17±0.707	6.50±1.150	6.67±1.879	7.28±1.841	8.17±0.707	<0.001 0.396
U	2	Mean±SD	7.33±0.500	6.11±1.453	2.33±0.707	2.78±1.202	3.56±2.186	<0.001 0.822
	3	Mean±SD	7.25±0.463	5.38±1.506	3.13±0.835	4.50±2.390	6.63±1.188	<0.001 0.682
	4	Mean±SD	8.31±0.704	7.13±1.544	6.56±2.065	7.81±1.471	8.31±0.704	<0.001 0.376

VAS: Visual Analog Scale; SD: Standard deviation.

When patients were stratified by treatment type, significant changes in HHS values were observed throughout the treatment process, especially in early-stage disease. In Stage 2 patients, the HHS scores improved significantly up to the 6th month, whereas improvements were more limited in Stage 3 and Stage 4 patients. As the stage of coxarthrosis increased, the clinical response decreased, with the lowest response observed in Stage 4 patients (Table 5).

When patients were stratified by stage and HHS values were compared within groups, Group F had a higher initial score in Stage 2 (p=0.012), but no significant difference was found between the groups in post-treatment periods. No statistically significant difference was found between the two groups in Stage 3 and Stage 4, both at baseline and across all follow-up periods (Table 6). No adverse event was observed during or after the procedures.

Table 4. Comparison of VAS scores between treatment groups

Hip osteoarthritis stage and groups			VAS pre-treatment	VAS 1st week	VAS 1st month	VAS 3rd month	VAS 6th month
Stage 2	Group F	Mean±SD	7.80±0.447	7.60±1.342	5.40±3.286	2.40±0.548	3.20±1.643
	Group U	Mean±SD	7.33±0.500	6.11±1.453	2.33±0.707	2.78±1.202	3.56±2.186
p-value			0.109	0.084	0.105	0.437	0.758
Stage 3	Group F	Mean±SD	8.00±0.100	5.30±0.500	4.80±0.850	6.90±1.300	7.80±0.200
	Group U	Mean±SD	7.80±0.400	5.40±1.200	4.50±0.900	6.80±1.800	7.50±0.950
p-value			0.103	0.205	0.733	0.452	0.083
Stage 4	Group F	Mean±SD	8.17±0.707	6.50±1.150	6.67±1.879	7.28±1.841	8.17±0.707
	Group U	Mean±SD	8.31±0.704	7.13±1.544	6.56±2.065	7.81±1.471	8.31±0.704
p-value			0.552	0.187	0.879	0.360	0.552

VAS: Visual Analog Scale; SD: Standard deviation.

Table 5. Comparison of HHS scores within treatment groups

Group	Hip osteoarthritis stage		HHS pre-treatment	HHS 1st week	HHS 1st month	HHS 3rd month	HHS 6th month	p-value and Partial eta2
F	2	Mean±SD	60.00±0.000	63.60±12.740	72.00±15.652	83.00±4.472	78.40±10.479	0.003
								0.301
	3	Mean±SD	51.00±2.236	69.60±0.894	69.60±0.894	55.00±8.660	52.00±2.739	0.002
								0.872
	4	Mean±SD	36.39±9.971	44.33±12.663	45.56±17.226	42.22±16.199	37.22±8.613	<0.001
								0.364
U	2	Mean±SD	52.89±6.547	59.00±3.937	78.22±3.492	77.89±7.524	72.22±8.857	<0.001
								0.782
	3	Mean±SD	51.63±3.503	64.38±9.797	70.63±3.204	65.63±11.783	54.00±6.256	0.007
								0.568
	4	Mean±SD	35.00±8.367	42.25±13.026	46.31±15.709	39.00±14.329	33.69±8.882	<0.001
								0.382

HHS: Harris Hip score; SD: Standard deviation.

Discussion

This study compared the effects of US-guided and FL-guided intra-articular corticosteroid injections on pain control and functional improvement in hip OA. The results showed significant improvements in both VAS and HHS scores with both methods, although no significant superiority was observed between the groups. However, FL has several disadvantages compared to USG, such as the use of contrast agents, exposure to ionizing radiation, the need for radiation protection measures, and the requirement for additional personnel, such as a radiology technician.

In our study, no significant difference was observed between US-guided and FL-guided interventions in terms of gender distribution (p=1.000) (Table 1). This indicates that gender does not influence the choice of imaging modality. A systematic review on the prevalence of radiographic hip OA demonstrated that the average prevalence increases with age in both men and women.[15] In 1957, Kellgren and Lawrence introduced a widely used grading scale for the radiologic evaluation of OA.[16] Osteoarthritis has traditionally been assessed using conventional radiographs, which for many years were considered the gold standard for diagnosing the condition. However, in recent years, innovative imaging techniques

Table 6. Comparison of HHS values between treatment groups

Osteoarthritis stage and groups			HHS pre-treatment	HHS 1st week	HHS 1st month	HHS 3rd month	HHS 6th month
2	Group F	Mean±SD	60.00±0.000	63.60±12.740	72.00±15.652	83.00±4.472	78.40±10.479
	Group U	Mean±SD	52.89±6.547	59.00±3.937	78.22±3.492	77.89±7.524	72.22±8.857
p-value			0.012	0.471	0.428	0.194	0.263
3	Group F	Mean±SD	51.00±2.236	69.60±0.894	69.60±0.894	55.00±8.660	52.00±2.739
	Group U	Mean±SD	51.63±3.503	64.38±9.797	70.63±3.204	65.63±11.783	54.00±6.256
p-value			0.730	0.177	0.417	0.111	0.447
4	Group F	Mean±SD	36.39±9.971	44.33±12.663	45.56±17.226	42.22±16.199	37.22±8.613
	Group U	Mean±SD	35.00±8.367	42.25±13.026	46.31±15.709	39.00±14.329	33.69±8.882
p-value			0.665	0.640	0.895	0.546	0.248

HHS: Harris Hip Score; SD: Standard deviation.

such as ultrasonography have been introduced to provide a better understanding of the disease. This shift is primarily due to advancements in US technology and improvements in US equipment. Ultrasonography has proven to be a valuable imaging technique in both the diagnosis and treatment of hip joint osteoarthritis, significantly enhancing our understanding of the disease process.[17]

We used the Kellgren–Lawrence staging system to assess the patients in our study. Therefore, interventions performed without imaging devices, relying solely on anatomical landmarks, are less reliable compared to more superficial joints such as the knee. Additionally, the hip joint is located near critical neurovascular structures, and performing injections without imaging guidance may pose a risk of injury to the femoral artery, femoral nerve, and lateral femoral cutaneous nerve.[18] Leopold et al.[19] reported that hip injections performed using the anterior approach without imaging guidance had an accuracy rate of 60%. They also observed that 27% of these injections made contact with the femoral nerve and recommended the use of image-guided procedures to prevent serious complications.

The literature lacks studies comparing the accuracy or therapeutic efficacy of US and FL in hip intra-articular injections. In our study, injections were performed under either US or fluoroscopy guidance to enhance procedural safety and accuracy. Thus, the efficacy of treatment using US and FL techniques was examined. When we assessed the impact of US-guided and FL-guided injections on analgesic requirements and VAS scores, we found that the treatment was effective in reducing both the need for analgesics and VAS scores in patients with early-stage coxarthrosis. Especially in Stage 2 patients, long-term pain control was achieved, whereas in Stage 3 patients, the treatment was initially effective but pain levels increased again after the third month. In Stage 4 patients, the treatment provided partial improvement in the short term, but pain levels returned to baseline by the sixth month. These findings suggest that the treatment is more effective in patients with early-stage osteoarthritis, whereas it may be less effective for long-term pain management in advanced-stage patients (Table 2, 3).

Byrd et al.[20] conducted a study with 50 patients who underwent both US-guided and FL-guided hip intra-articular injections. The patients reported that US-guided injections were less painful and more comfortable compared to FL-guided injections. Since our patients received only one treatment technique, we were unable to make a direct comparison. However, US-guided injections are known to offer several advantages over FL-guided injections, including the absence of ionizing radiation, the ability to examine soft tissues, and no need for contrast media during the procedure.[21,22] US-guided injections can also be performed without the need for contrast material and in an office setting. In contrast, FL has several drawbacks, including the requirement for lead-equipped rooms and operating room conditions, the use of contrast material, and the risk of exposure to radioactive X-rays for both the patient and the

practitioner. Additionally, the ability of ultrasonography to visualize surrounding soft tissues in real time makes it a more detailed and advantageous option; however, it should be noted that the effectiveness of US-guided procedures is highly dependent on the experience of the practitioner.

Corticosteroids have a complex mechanism of action, exerting both immunosuppressive and anti-inflammatory effects. When injected intra-articularly, they may have both local and systemic effects. They work by modulating several pro-inflammatory cytokines involved in cartilage damage and degradation, effectively interrupting inflammatory and immune cascades.[23] Intra-articular corticosteroid injections in coxarthrosis contribute significantly to treatment by alleviating pain and increasing range of motion, improving functional ability, and reducing the need for analgesics. Studies evaluating the efficacy of these injections in coxarthrosis have shown notable reductions in pain levels and improvements in functional outcomes. Kullenberg et al.[5] reported that FL-guided injections of 80mg triamcinolone acetonide effectively reduced pain at rest and during weight-bearing, increased hip range of motion, and decreased the use of analgesics at both 3 and 12 weeks. Similarly, Qvistgaard et al.[24] demonstrated that US-guided methylprednisolone injections resulted in significant pain reduction on days 14 and 28; however, this benefit diminished after 3 months. Lambert et al.[25] reported that injections containing triamcinolone hexacetonide provided pain relief lasting up to 3 months and resulted in significant improvements in the Western Ontario and McMaster Universities Arthritis Index (WOMAC) scores. Similarly, Atchia et al.[26] demonstrated that US-guided injections of 120 mg methylprednisolone acetate effectively managed pain up to week 8. A review reported that corticosteroid injections are effective in coxarthrosis and that this effect may last up to 12 weeks.[27] Lai et al.[28] retrospectively examined 82 FL-guided intra-articular hip corticosteroid injections and reported that 19.5% of the injections showed no response, 47.6% provided short-term pain relief (≤2 weeks), and 32.9% resulted in sustained pain relief (>2 weeks). These studies demonstrate that intra-articular corticosteroid injections, whether administered under FL or US guidance, offer both short- and medium-term relief from symptoms and contribute to functional improvement.[24–28]

However, there is no comparative study that demonstrates the technical superiority of US-guided and FL-guided corticosteroid injections in coxarthrosis. Our study aimed to evaluate which technique offers more advantages in terms of clinical outcomes by comparing the efficacy and safety of these two methods. There was no statistically significant difference between Group F and Group U in terms of VAS and HHS scores ($p>0.05$). Clinically, an improvement in functional capacity and a reduction in pain levels were observed in both groups after treatment. However, it was observed that pain control and functional gains were not maintained in the long term in both groups, with values regressing to levels close to baseline. These findings suggest that the effectiveness of both methods is limited, particularly in advanced-stage patients (Table 4, 6).

In intra-articular hip injections, increasing the volume of the mixture, typically by adding a local anesthetic, may enhance the distribution of corticosteroids within the synovium. In a 2012 randomized controlled trial by Young et al.,[29] patients with coxarthrosis received intra-articular injections containing 1 ml of triamcinolone acetonide (40 mg) and 2 ml of local anesthetic, which were compared with injections containing the same combination plus 6ml of saline. All procedures were performed under fluoroscopic guidance. In the study, both groups showed significant improvement in the WOMAC Index, with improvements in pain, stiffness, and activities of daily living. However, no statistically significant difference was found between the 3 ml and 9 ml volumes. Therefore, the recommended injection volume is between 3 and 9 ml, as higher volumes do not offer any additional benefits over 3 ml. In our practice, we use a 4 ml injection volume (1 ml of triamcinolone acetonide+3 ml of 2% prilocaine) for our coxarthrosis patients. However, it is important to note that high concentrations of local anesthetics have been shown to be cytotoxic to chondrocytes, particularly with older molecules such as bupivacaine.[30] For this reason, we prefer prilocaine as our local anesthetic of choice.

Our data revealed that both techniques demonstrated similar efficacy and were not superior to each other in terms of changes in VAS, HHS, and analgesic requirements (Table 4–6). No complications or side effects were observed with either method. Furthermore, both techniques allowed for accurate visualization of the needle during injection.

Conclusion

The effects of intra-articular corticosteroid injections performed under US guidance and FL guidance on pain control and functional improvement in hip osteoarthritis were compared. Both methods showed similar levels of improvement in analgesic use, VAS, and HHS scores; however, no statistically significant difference was found between the groups. The FL method has certain disadvantages, such as the need for contrast material and radiation exposure, whereas US stands out as a safer method that allows real-time visualization of soft tissues. Although both methods are effective, especially in early-stage patients, long-term pain control remains limited in advanced stages.

Ethics Committee Approval: The Ankara Training and Research Hospital Ethics Committee granted approval for this study (date: 07.08.2024, number: 198/2024).

Informed Consent: Written informed consent for the procedures was obtained from all patients. Due to the retrospective nature of the study, additional informed consent was not required.

Conflict of Interest: The authors declare that there is no conflict of interest.

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Authorship Contributions: Concept – YK; Design – AM; Supervision – SAT; Resources – EY; Materials – İED; Data collection and/or processing – SG; Analysis and/or interpretation – EY; Literature search – İED; Writing – YK, AM; Critical review – SAT.

Peer-review: Externally peer-reviewed.

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ORIGINAL ARTICLE

Targeting dual pathways in refractory coccydynia: A comparative study of ganglion impar block alone versus combined with pericoccygeal injection

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SUMMARY

Objectives: Coccydynia is a complex and often refractory pain condition involving both sympathetic and somatic components. While ganglion impar block (GIB) is a well-established interventional technique for cases unresponsive to conservative treatment, pericoccygeal injection may offer additional benefits by targeting peripheral sensitization and anococcygeal nerve-mediated pain. This study aimed to evaluate and compare the clinical effectiveness of GIB alone versus GIB combined with pericoccygeal injection in patients with refractory coccydynia.

Methods: This retrospective cohort study included 60 patients aged 18–65 years treated at a tertiary pain clinic between June 2022 and June 2024. Patients received either GIB alone or GIB combined with pericoccygeal injection in a single session under fluoroscopic guidance. Pain severity and functional outcomes were assessed using the Numeric Rating Scale (NRS-11), Oswestry Disability Index (ODI), and Paris Functional Coccydynia Impact Questionnaire (PFCIQ) before the procedure and at 1 and 3 months post-intervention.

Results: Both groups demonstrated significant improvements in NRS-11, ODI, and PFCIQ scores at 1 and 3 months compared to baseline ($p<0.001$). The combination therapy group showed significantly greater reductions in NRS-11 and ODI scores at 1 month ($p=0.043$ and $p=0.036$, respectively), and in ODI scores at 3 months ($p=0.04$). Analgesic use declined prominently in both groups, and no major complications were reported.

Conclusion: A single-session combination of GIB and pericoccygeal injection appears to offer superior short-term pain relief and functional improvement compared to GIB alone in refractory coccydynia. Further prospective studies are needed.

Keywords: Coccydynia; fluoroscopy; pain management; somatic pain; spinal injections; sympathetic pain.

Introduction

Coccydynia, defined as pain in the sacrococcygeal region, is a clinically challenging condition because of its complex etiology and variable response to therapy. It is often triggered by trauma, predominantly affecting women and individuals with obesity; however, neoplasms, somatoform disorders, and idiopathic reasons can also play a role. Patients complain of coccyx discomfort that worsens when they sit or stand for extended periods, indicating the area's intricate innervation that includes both somatic and sympathetic pathways.[1,2] The anococcygeal nerve provides an extensive supply to the coccyx, a vestigial structure composed of fused vertebrae, and the ganglion impar modulates this supply, thereby increasing its significance in pain perception.[3]

The current management of coccydynia follows a stepwise algorithm, beginning with lifestyle modifications and conservative therapies, such as non-

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steroidal anti-inflammatory drugs (NSAIDs), pelvic floor exercises, and manual therapy techniques, including coccygeal massage and manipulation. Additional physical therapy options include thermal applications and extracorporeal shockwave therapy.[1,2,4] About 90% of patients respond well to conservative therapies; however, a significant portion of patients are resistant, requiring more sophisticated measures.[1,5,6] For resistant cases, interventional treatment options, particularly ganglion impar block (GIB), guided by fluoroscopy for precision, or some pericoccygeal injections using steroids or dextrose prolotherapy are preferred.[1,7] These approaches target both nociceptive and neuropathic components, offering relief where primary treatments fail. Nevertheless, optimal strategies remain under debate, with recent studies supporting multimodal interventions to address the condition's heterogeneity.[1,3,8]

The sympathetic chain's last node, known as Walther's ganglion or ganglion impar, is located variably anterior to the sacrococcygeal junction or first coccygeal vertebra. It integrates sympathetic and somatic inputs, contributing to coccygeal and perineal pain. GIB involves the use of local anesthetics by transdiscal or transsacrococcygeal techniques under fluoroscopic supervision, often in combination with neurolytic drugs such as phenol or ethyl alcohol. Conventional or pulsed radiofrequency ablation increases its usefulness.[9,10] Widely applied in coccydynia and tenesmus-related anorectal cancer pain, GIB's efficacy is well-documented, yet its limitations in addressing somatic pain components prompt exploration of adjunctive techniques.[11]

The aim for pericoccygeal injection is to create somatic blocking and lessen peripheral sensitization by targeting the anococcygeal nerve and adjacent tissues. Often administered posterior and lateral to the coccyx, it complements GIB by addressing local inflammation and nerve-mediated pain. Emerging evidence, particularly in postpartum coccydynia, suggests enhanced outcomes when combined with GIB, though its standalone role remains less defined.[9] By addressing both sympathetic and somatic pathways simultaneously, the combination of these methods may maximize pain relief—a theory that has not yet been thoroughly investigated.

To the best of our current understanding, the literature lacks comprehensive studies examining the therapeutic effects of pericoccygeal injections combined with GIB for the management of refractory coccydynia. This study aims to investigate and compare these effects in a single session for refractory coccydynia. The results of this study might improve pain treatment techniques by identifying an optimal interventional approach and guiding clinical decision-making with the development of targeted treatment protocols.

Materials and Methods

Study Design and Population

This retrospective study compared the effects of GIB alone versus GIB combined with pericoccygeal injection in coccydynia patients treated at a tertiary pain clinic that receives both direct patient admissions and referrals from other specialists. The study cohort was drawn from patients with a confirmed diagnosis of coccydynia persistent for at least 3 months as determined by history, clinical examination, and radiological imaging, who had undergone either GIB or GIB with pericoccygeal injection, and had complete medical records available for review between June 2022 and June 2024. All patients had failed conservative management, which included NSAIDs for at least 4 weeks, pelvic floor exercises and physical therapy, manual therapy techniques, and lifestyle modifications such as cushions and sitting modifications. Patients who had a recent intervention (within the past 6 months), morbid obesity (BMI>35 kg/m^2), severe comorbidities, skin infections, bleeding disorders, pregnancy, or incomplete records were excluded. A total of 60 patients aged 18–65 years who underwent either GIB or GIB with pericoccygeal injection were included. The sample size was determined using a power analysis (effect size: 0.84, power: 80%, error margin: 5%), based on previously published studies reporting significant differences in pain and functional outcomes following ganglion impar block interventions.[3,12,13] Accordingly, a minimum of 30 patients per group was required, and a total of 60 patients were enrolled.

Intervention

Treatment selection was based on clinical assessment by a single experienced pain medicine specialist (>5 years of experience) using the following approach:

Figure 1. A ganglion impar block performed between the first and second coccygeal vertebrae (Co1–Co2).

patients with predominantly deep, aching coccygeal pain suggesting primary sympathetic involvement received GIB alone, while patients presenting with both deep pain and superficial pericoccygeal tenderness, indicating combined sympathetic and somatic involvement, received combination therapy.

A standard procedure was applied to all patients by the same pain medicine specialist with over 5 years of experience, in a sterile operating room under fluoroscopic guidance and monitored conditions. The patients underwent noninvasive blood pressure monitoring, pulse oximetry, and a five-lead electrocardiogram, and intravenous access was established in the forearm before positioning for the intervention. The position used during the intervention was the prone position, with a pillow placed under the belly. The procedure area was disinfected with povidone-iodine and covered with a sterile drape. Anterior-posterior (AP) imaging was first performed with a C-arm scopy device, which was then placed in the lateral position.

The ganglion impar was accessed with a Quincke spinal needle, transsacrococcygeally (from between the first and second coccygeal vertebrae if sacrococcygeal access could not be achieved). Then, 1 mL of non-ionic contrast medium was administered, and fluoroscopic anterior-posterior and lateral imaging was performed to confirm the appropriate spread of contrast (Fig. 1). After this confirmation, 2 mL of 0.5% bupivacaine, 2 mL of saline, and 40 mg of methylprednisolone acetate were injected.

In the combination therapy group who underwent pericoccygeal injection in addition to impar block, following the same procedure, 5 mL of 0.25% bupivacaine and 20 mg of methylprednisolone were injected into the posterior pericoccygeal region while the needle was withdrawn, thus also targeting blockade of the anococcygeal nerve.

After the procedure, all patients were monitored and observed for at least two hours. Patients who had no additional complaints during follow-up visits were discharged.

Data Collection

Data were extracted from patient files following ethical approval. Recorded information included demographic details (age, sex), body mass index (BMI), symptom duration, comorbidities, prior medical treatments, procedure details, coccydynia etiology, and outcome measures.

Outcome Measures

Pain Assessment with the Numeric Rating Scale (NRS-11)

Pain levels were measured using the Numeric Rating Scale (NRS-11), a widely recognized tool for quantifying pain intensity. This scale ranges from 0 to 10, where 0 represents no pain and 10 signifies the worst imaginable pain. Patients were asked to rate their pain based on their subjective experience, providing a straightforward and reliable metric for assessing pain severity.[14,15] The NRS-11 was administered before the procedure and at follow-up intervals of 1 and 3 months post-procedure to track changes in pain levels over time, allowing for a clear evaluation of the intervention's effectiveness in reducing pain.

Oswestry Disability Index (ODI)

Functional disability was assessed using the Oswestry Disability Index (ODI), a validated questionnaire designed to evaluate the impact of pain on daily functioning. The ODI consists of 10 domains—pain intensity, lifting, self-care, walking, sitting, sexual function, standing, social life, sleep quality, and travel—each scored on a 0–5 scale. The total score

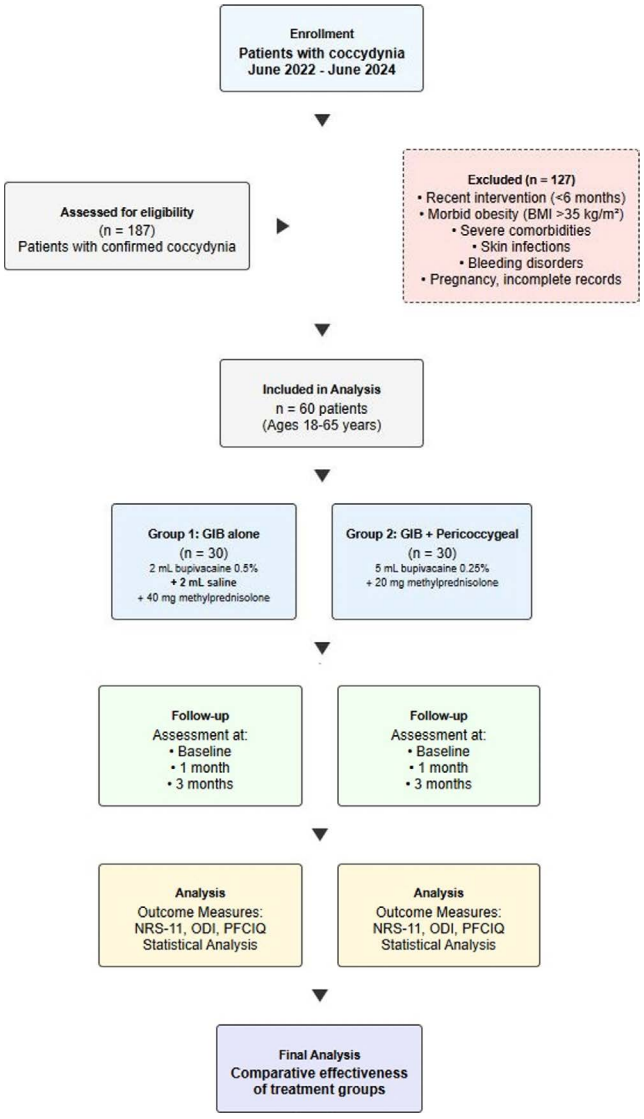

Figure 2. Study flowchart.

is expressed as a percentage (0–100%), with higher scores indicating greater disability. This comprehensive tool captures the multidimensional impact of pain on patients' lives.[16] ODI scores were collected pre-procedure and at 1 and 3 months post-procedure to monitor improvements in functional capacity following the intervention.

The Paris Functional Coccydynia Impact Questionnaire (PFCIQ)

To specifically address coccyx-related functional limitations, the Paris Functional Coccydynia Impact Questionnaire (PFCIQ) was employed. This targeted questionnaire evaluates the unique challenges associated with coccydynia, including difficulties with sitting, standing, or performing activities that exacerbate coccyx pain. The PFCIQ provides a detailed assessment of how coccyx-specific impairments affect

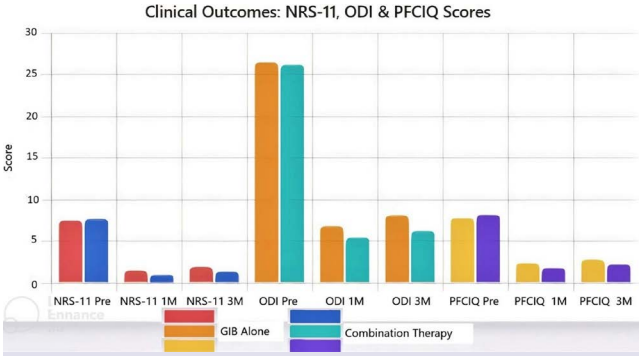

Figure 3. Comparison of clinical outcome scores between the ganglion impar block (GIB) alone group and the combination therapy group (GIB + pericoccygeal injection) at baseline, 1 month, and 3 months post-procedure. Bars represent mean scores for the Numeric Rating Scale (NRS-11), Oswestry Disability Index (ODI), and Paris Functional Coccydynia Impact Questionnaire (PFCIQ). Both groups demonstrated significant improvements in all outcome measures at follow-up. The combination therapy group showed lower NRS-11 and ODI scores at 1 month, and lower ODI scores at 3 months, compared to the GIB-alone group. PFCIQ scores improved in both groups without significant intergroup differences.

patients' quality of life and daily activities.[17] Like the other metrics, PFCIQ scores were recorded before the procedure and at 1 and 3 months post-procedure, enabling a focused evaluation of the intervention's impact on coccyx-related functional outcomes.

Ethical Considerations

The study was approved by the Institutional Review Board (IRB) on 26/09/2024 (ID: KAEK/2024.09.200). As it is a retrospective cohort study, no additional patient consent beyond routine clinical consent was required. Data collection occurred between October 1, 2024, and December 1, 2024. This study is registered at clinicaltrials.gov with the identifier NCT07060313. All procedures were conducted in compliance with the Declaration of Helsinki's ethical guidelines and any subsequent revisions.

The study flowchart is shown in Figure 2.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics Standard Concurrent User Version 26 (IBM Corp., Armonk, New York, USA) statistical software package. Descriptive statistics are presented as numbers (n), percentages (%), mean±standard deviation, median, minimum, and maximum. The normality of the distribution of data for the numerical variables was assessed using the Kolmogorov-Smirnov normality

Table 1. Demographic features

	Performed procedure		Test statistics	
	Ganglion impar block	Combination therapy	Test value	p
Gender, n (%)			0.085	0.771†
Female	21 (47.7)	23 (52.3)		
Male	9 (56.3)	7 (43.7)		
Side of pelvic pain, n (%)			0.476	0.788†
Bilateral	25 (50)	25 (50)		
Right	3 (42.9)	4 (57.1)		
Left	2 (66.7)	1 (33.3)		
Etiology, n (%)			2.715	0.257†
Trauma	22 (48.9)	23 (51.1)		
Idiopathic	8 (61.5)	5 (38.5)		
Others	0 (0)	2 (100)		
Age, (years)	46.6±12.49	43.43±15.57	0.878	0.384‡
	45 (24–78)	42 (19–78)		
BMI, (kg/m^2)	28.89±3,38	27.87±3.29	1.18	0.243‡
	29.25 (22–34.5)	27.55 (19.2–34.4)		
Duration of pain, (month)	2 (1–10)	2 (1–6)	418.5	0.621&
	2.63±2.29	2.13±1.25		

n: Number of patients, Numerical variables are presented as mean±standard deviation or median (minimum–maximum) values. †: Chi-Square test; ‡: Independent samples t test; &: Mann-Whitney U test.

test, and the homogeneity of variances was evaluated using Levene's test. The impar ganglion block and impar ganglion block + pericoccygeal injection groups were compared based on numerical variables using an independent samples t-test in cases of normal distribution, and a Mann-Whitney U test when the distribution was not normal. Chi-square tests were used to compare groups based on categorical variables, and the Friedman test was applied to analyze the median NRS-11, ODI, and PFCIQ scores during the follow-up period. Significance values have been adjusted by the Bonferroni correction for multiple tests. Statistical significance was set at $p<0.05$, and values were considered statistically significant.

Results

The study included data from 60 patients, comprising 44 females (73.3%) and 16 males (26.7%). The mean age of the participants was 45.03±14.09 years. Demographic characteristics are summarized in Table 1. No statistically significant differences were observed between the groups in terms of age, gender, BMI, duration of pain, etiology, or the side of pelvic pain (Table 1).

Both groups showed a significant improvement in NRS-11, ODI, and PFCIQ scores at the 1st and 3rd months compared to baseline values ($p<0.001$) (Table 2, 3).

Subgroup analysis revealed that while both groups experienced significant improvements from baseline at 1 and 3 months, the magnitude of change between the 1st and 3rd months within each group was not statistically significant. However, when comparing between groups, the combination therapy group demonstrated significantly greater improvement in NRS-11 and ODI scores at 1 month ($p=0.043$ and $p=0.036$, respectively), and in ODI scores at 3 months ($p=0.04$). No statistically significant differences were observed between the groups concerning the other variables ($p>0.05$) (Table 4).

No statistically significant difference was found between the two groups regarding analgesic use. However, while 58 patients (96.6%) required analgesic treatment before the procedure, only 9 patients (15%) continued to require analgesics at the third month post-procedure, indicating a substantial reduction in analgesic consumption (Table 5).

Table 2. Comparative analysis of the pre-procedure, post-procedure 1st and 3rd month NRS-11, ODI and PFCIQ in ganglion impar block group

	Mean (SD)	Median (min–max)	Test value*	p
NRS-11			2.971	**<0.001**
Pre-procedure	7.5 (0.82)	8 (6–9)[a]		
1st-month	1.47 (0.97)	2 (0–3)[b]		
3rd-month	1.9 (1.47)	2 (0–6)[bc]		
ODI			49.034	**<0.001**
Pre-procedure	26.5 (3.14)	26 (20–32)[a]		
1st-month	6.8 (2.52)	6 (3–12)[b]		
3rd-month	8.1 (3.54)	7.5 (4–17)[bc]		
PFCIQ			52.362	**<0.001**
Pre-procedure	7.8 (0.96)	8 (6–10)[a]		
1st-month	2.37 (1.03)	2 (0–4)[b]		
3rd-month	2.77 (1.63)	3 (0–8)[bc]		

*: Friedman test statistic; a–c: Values sharing the same letter within each column do not different significantly; NRS-11: Numeric Rating Scale -11; ODI: Oswestry Disability Index; PFCIQ: Paris Functional Coccydynia Impact Questionnaire; SD: Standard deviation; Min: Minimum; Max: Maximum.

Table 3. Comparative analysis of the pre-procedure, post-procedure 1st and 3rd month NRS-11, ODI and PFCIQ in combination therapy group

	Mean (SD)	Median (min–max)	Test value*	p
NRS-11			49.532	**<0.001**
Pre-procedure	7.67 (0.96)	8 (6–9)[a]		
1st-month	0.96 (0.92)	1 (0–3)[b]		
3rd-month	1.37 (0.99)	1 (0–4)[bc]		
ODI			46.991	**<0.001**
Pre-procedure	26.2 (2.96)	26 (20–32)[a]		
1st-month	5.47 (2.01)	5 (2–9)[b]		
3rd-month	6.23 (2.34)	6 (2–12)[bc]		
PFCIQ			50.296	**<0.001**
Pre-procedure	8.2 (0.96)	8 (6–10)[a]		
1st-month	1.8 (1.16)	2 (0–4)[b]		
3rd-month	2.23 (1.13)	2 (0–4)[bc]		

*: Friedman test statistic; a-c: Values sharing the same letter within each column do not different significantly; NRS-11: Numeric Rating Scale -11; ODI: Oswestry Disability Index; PFCIQ: Paris Functional Coccydynia Impact Questionnaire; SD: Standard deviation; Min: Minimum; Max: Maximum.

Throughout the study period, no major complications were reported or observed in either group. Key findings are presented in Figure 3.

Discussion

This study investigated the therapeutic efficacy of ganglion impar block (GIB) alone versus GIB combined with pericoccygeal injection for refractory coccydynia, demonstrating significant pain relief and functional improvement in both groups. The combination therapy group exhibited statistically significant improvements in pain and disability scores at 1 month and disability scores at 3 months compared to the GIB-alone group. These findings suggest that combining pericoccygeal injection with GIB may enhance short-term pain relief and functional outcomes, potentially by addressing both sympathetic and somatic pain pathways.[18]

Table 4. Pre-procedure, post-procedure 1st and 3rd-month NRS-11, ODI and PFCIQ scores on the procedures

	Ganglion impar block (n=30)		Combination therapy (n=30)		Test statistics	
	Mean (SD)	Median (min–max)	Mean (SD)	Median (min–max)	Test value*	p
NRS-11 pre-procedure	7.5 (0.82)	8 (6–9)	7.67 (0.96)	8 (6–9)	408	0.512
NRS-11 1st-month	1.47 (0.97)	2 (0–3)	0.96 (0.92)	1 (0–3)	319	**0.043**
NRS-11 3rd-month	1.9 (1.47)	2 (0–6)	1.37 (0.99)	1 (0–4)	366	0.197
ODI pre-procedure	26.5 (3.14)	26 (20–32)	26.2 (2.96)	26 (20–32)	438.5	0.864
ODI 1st-month	6.8 (2.52)	6 (3–12)	5.47 (2.01)	5 (2–9)	309.5	**0.036**
ODI 3rd-month	8.1 (3.54)	7.5 (4–17)	6.23 (2.34)	6 (2–12)	312.5	**0.041**
PFCIQ pre-procedure	7.8 (0.96)	8 (6–10)	8.2 (0.96)	8 (6–10)	348.5	0.114
PFCIQ 1st-month	2.37 (1.03)	2 (0–4)	1.8 (1.16)	2 (0–4)	334	0.075
PFCIQ 3rd-month	2.77 (1.63)	3 (0–8)	2.23 (1.13)	2 (0–4)	376.5	0.259

*: Mann Whitney U Test; NRS-11: Numeric Rating Scale -11; ODI: Oswestry Disability Index; PFCIQ: Paris Functional Coccydynia Impact Questionnaire; SD: Standard deviation; Min: Minimum; Max: Maximum.

Table 5. Comparative analysis of the pre-procedure, post-procedure 1st and 3rd month analgesic treatments on the procedures

	Ganglion impar block n (%)	Combination therapy n (%	Test value*	p
Pre-procedure			2.285	0.515
None	2 (100)	0 (0)		
Paracetamol	16 (47.1)	18 (52.9)		
NSAID	6 (54.5)	5 (45.5)		
Others	6 (46.2)	7 (53.8)		
1st-month			0.218	0.642
None	27 (49.1)	28 (50.9)		
Paracetamol	3 (60)	2 (40)		
NSAID	0	0		
Others	0	0		
3rd-month			0.353	0.838
None	25 (49)	26 (51)		
Paracetamol	3 (50)	3 (50)		
NSAID	2 (66.7)	1 (33.3)		
Others	0	0		

*: Chi-Square test; NSAID: Non-steroidal anti-inflammatory drugs.

These results align with recent literature supporting interventional approaches for coccydynia. A 2022 prospective randomized study by Sencan et al.[12] compared GIB with caudal epidural steroid injection, finding that while both methods initially improved pain, the effects of GIB seemed more pronounced at the six-month follow-up. A 2024 randomized trial by Genc Perdecioglu et al.[3] compared coccygeal nerve blockade to GIB, reporting significant pain reduction with both methods, though GIB showed slightly superior outcomes at 3 months. Our study extends these findings by demonstrating that the addition of pericoccygeal injection may further improve early outcomes, likely due to its targeting of the anococcy-

geal nerve, which modulates somatic pain. Similarly, a 2023 case series by Esmaeeli et al.[9] explored combined caudal epidural and paracoccygeal injections for postpartum coccydynia, noting significant pain relief at 1 month. The consistency of our findings with Esmaeeli et al.[9] supports the role of multimodal injections in addressing complex pain etiologies; however, our study's larger sample and standardized protocol support the reliability of these observations.

In contrast, a 2023 study by Swain et al.[10] reported that GIB alone achieved adequate pain control in idiopathic coccydynia, with no additional benefit from adjunctive techniques. The GIB's ability to block the sympathetic ganglionic pathways is reported to offer a systematic method of pain management, utilizing local anesthetics and steroids to address underlying inflammation.[19] Our results point to a discrepancy that may stem from differences in patient populations, as our cohort included diverse etiologies (traumatic, idiopathic, somatoform diseases, and others), potentially necessitating broader pain pathway targeting following recent reviews emphasizing the heterogeneity of coccydynia responses, advocating for tailored multimodal treatment strategies.[1,8]

Corticosteroid injections into the pericoccygeal region can reportedly provide temporary relief but often lack the comprehensive, consistent effectiveness seen with nerve blocks like GIB, particularly in patients with chronic pain mechanisms.[20,21] Additionally, pericoccygeal injections may involve more complications related to repeated interventions due to temporary relief, including risks of infection and variations in pain management outcomes.[22] By combining GIB and pericoccygeal injection in a single session, our intervention minimizes these concerns and may eliminate the need for recurrent treatments while increasing efficacy by simultaneously addressing the sympathetic and somatic pain pathways. The combination group's notable gains in NRS-11 and ODI scores at one month and three months indicate that this strategy might provide a stronger early response than GIB alone, potentially by more successfully addressing peripheral sensitization and local inflammation.[9,18]

The significant reduction in analgesic use (from 96.6% to 15% at 3 months) in both groups highlights the clinical relevance of these interventions. However, the lack of significant differences in PFCIQ scores between groups suggests that coccyx-specific functional limitations may be less responsive to the additional pericoccygeal injection, possibly due to the PFCIQ's focus on sitting and standing difficulties, which may be influenced by factors beyond pain intensity, such as pelvic floor dysfunction or biomechanical issues.[13,17]

Limitations

It is important to recognize a number of limitations in spite of these encouraging results. First, because treatment allocation was not randomized, the retrospective approach introduces potential selection bias and restricts conclusions about causality. Although the groups' baseline characteristics were similar, results could have been affected by unmeasured confounders such as psychological issues or previous treatment adherence. Second, the three-month follow-up period is quite brief, making it difficult to draw conclusions regarding long-term efficacy. According to earlier research, the effects of GIB may wear off after six months, requiring additional interventions.[12,21] In order to determine whether the combination therapy maintains its advantages over time, future research should extend the follow-up. Third, although the sample size was sufficient according to power analysis, it might not have been sufficiently large to identify variations in secondary outcomes such as analgesic use or PFCIQ scores. To validate these results and investigate subgroup effects, larger, prospective trials are required, especially in individuals with particular etiologies such as traumatic coccydynia or postpartum coccydynia.

When administered by qualified professionals, fluoroscopy-guided GIB and pericoccygeal injections are safe, as demonstrated by the lack of major complications in either group. However, the use of corticosteroids in both interventions raises concerns about potential side effects, including tissue atrophy or systemic absorption.[23] Alternative injectates for combination therapy that may provide regeneration advantages with less risk, including platelet-rich plasma or dextrose prolotherapy, could be the subject of future research.[7,24]

Clinically, our findings support the integration of pericoccygeal injection with GIB as a viable option for refractory coccydynia; however, the decision to pursue combination therapy should be individual-

ized, considering factors such as pain chronicity, etiology, and patient preferences. The development of standardized protocols for combined interventions, including optimal injectate volumes and concentrations, could further improve efficacy.

Conclusion

This study provides preliminary evidence that combining GIB with pericoccygeal injection offers superior short-term pain relief and functional improvement compared to GIB alone in refractory coccydynia. These results demonstrate the need to address the complexity of the problem by focusing on both the sympathetic and somatic pain pathways. Longer follow-up periods in future randomized controlled trials are necessary to confirm these findings, clarify the processes behind the advantages of the combination therapy, and determine its place in the treatment algorithm for coccydynia.

Ethics Committee Approval: The İstanbul Kanuni Sultan Süleyman Training and Research Hospital Ethics Committee granted approval for this study (date: 26.09.2024, number: KAEK/2024.09.200).

Informed Consent: As it is a retrospective cohort study, no additional patient consent beyond routine clinical consent was required.

Conflict of Interest: The authors declare that there is no conflict of interest.

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ORIGINAL ARTICLE

A comparative study of clonidine and dexmedetomidine as an adjuvant to levobupivacaine for caudal analgesia in children undergoing below umbilical surgeries: A randomized double-blind controlled trial

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SUMMARY

Objectives: Dexmedetomidine and clonidine have been studied separately as adjuvants with levobupivacaine, but there is no literature comparing the two drugs for caudal anesthesia in children. We compared the analgesic efficacy and adverse effects of clonidine and dexmedetomidine as adjuvants to levobupivacaine for caudal analgesia in children undergoing infraumbilical surgeries.

Methods: In this prospective randomized study, 100 pediatric patients (3 to 8 years) of either sex, scheduled for infraumbilical surgery, were randomly allocated to two equal groups in a double-blind manner. After induction of anesthesia using a standard technique, caudal anesthesia was administered using 0.2% levobupivacaine (1 ml/kg) with either 1 µg/kg dexmedetomidine (Group A) or 1 µg/kg clonidine (Group B). Hemodynamic parameters, motor block, degree of sedation, postoperative analgesia, use of rescue analgesics, and side effects were evaluated for 24 hours.

Results: The mean duration of analgesia in Group A (12.7±2.4 h) was higher than in Group B (10.6±2.2 h), which was statistically significant (p=0.000). The mean duration of sedation was higher in Group A, although it was statistically insignificant. Hemodynamic parameters were comparable in the two groups. No significant side effects were observed in the groups.

Conclusion: Dexmedetomidine (1 µg/kg) added to 0.2% levobupivacaine (1 ml/kg) for caudal block provides prolonged analgesia with better sedation scores when compared to clonidine (1 µg/kg) with 0.2% levobupivacaine (1 ml/kg) for below umbilical surgeries in pediatric patients, without increasing the incidence of adverse effects. Hence, we would recommend the use of 1 µg/kg dexmedetomidine as an adjuvant to 0.2% levobupivacaine.

Keywords: Analgesia; anesthesia; caudal; child; clonidine; dexmedetomidine; hemodynamics; levobupivacaine.

Introduction

Caudal analgesia, combined with general anesthesia, is the most common, safe, and reliable technique for analgesia in pediatric patients undergoing below umbilical surgeries. While excellent pain relief, minimal side effects, and high patient satisfaction are advantages, the short duration after a single injection is the main disadvantage.[1]

Caudal block can be practiced by a single-shot injection or as a continuous infusion through a caudal epidural catheter.[2] Levobupivacaine is equally efficacious as bupivacaine but has a superior pharmacokinetic profile, as it is much safer regarding reduced cardiotoxicity and neurotoxicity.[3]

Various adjuvants such as tramadol, ketamine, ephedrine, morphine, clonidine, fentanyl, and dexmedeto-

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midine with local anesthetics have been investigated to extend the duration of postoperative analgesia.[4,5]

Clonidine is a mixed alpha-1 and alpha-2 adrenoceptor agonist with a predominant alpha-2 action. It provides better perioperative hemodynamic stability and good quality intraoperative and prolonged postoperative analgesia with minimal side effects. Dexmedetomidine is a more potent sedative than clonidine, but patients remain easily aroused. This aspect, combined with the minimal influence on respiration, makes dexmedetomidine an interesting alternative to clonidine.[6]

Multiple studies have compared clonidine and dexmedetomidine with local anesthetics like bupivacaine and ropivacaine. There are studies comparing clonidine and dexmedetomidine separately with other adjuvants when added to levobupivacaine in the pediatric population. However, to our knowledge, there is a lack of data comparing clonidine and dexmedetomidine as adjuvants with levobupivacaine for caudal analgesia in pediatric patients. This study was designed to compare the analgesic efficacy and side effects of dexmedetomidine and clonidine when added to levobupivacaine for caudal analgesia in children, with the primary outcome as the duration of analgesia. The secondary outcomes were sedation scores, sedation time, hemodynamic parameters, pain scores in the first 24 hours, and complications in the two groups.

Materials and Methods

Ethics approval for this study was obtained from the Institutional Ethics Committee (F.1/IEC/CNBC/ 05/01/2020/4224), and the study was registered with the Clinical Trial Registry of India (CTRI/2020/06/025684). After obtaining written and informed consent from the patient's relatives, 100 American Society of Anesthesiologists physical status (ASA PS) 1 and 2 children aged 3 to 8 years, scheduled for elective below umbilical surgery, were prospectively enrolled in the study. The study was conducted in accordance with the Helsinki Declaration.

Patients with any history of developmental delay/mental retardation, spine and central nervous system anomalies, contraindications to regional anesthesia, history of allergy to drugs used in the study, known bleeding disorders, and infection at the injection site were excluded from the study.

The study population of 100 patients was randomly allocated into two groups by the draw of lots, with 50 patients in each group. The anesthesiologist who picked up the lots and prepared the drugs in a secluded place in a sterile manner was not a part of the study. The medication was handed over to and administered by another anesthesiologist blinded to the combination of drugs prepared in the syringe. The subjects, their parents or guardians, and the health care personnel providing direct patient care and assessing outcomes were blinded to the study.

In the operation theatre, a multi-parameter monitor was attached, and baseline values were recorded for arterial oxygen saturation (SpO_2), pulse rate (PR), respiratory rate (RR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and electrocardiogram (ECG). Anesthesia was induced with a standard inhalational technique using sevoflurane 8% with 100% O_2 in spontaneous ventilation. After securing a peripheral intravenous (i.v.) access, fentanyl 1µg/kg and propofol 2–3 mg/kg were injected. After that, the airway was secured with an appropriately sized laryngeal mask airway, and sevoflurane concentration was reduced to 2%, with O_2 and N_2O at 50% each for maintenance of anesthesia.

After that, patients were placed in a lateral position. Under all aseptic precautions, a single-dose caudal epidural injection was performed as per the group assigned using a 23-gauge hypodermic needle and the loss of resistance technique.

GROUP A received 0.2% levobupivacaine (1ml/kg) with 1µg/kg dexmedetomidine in 0.5 ml normal saline, and GROUP B received 0.2% levobupivacaine (1ml/kg) with 1µg/kg clonidine in 0.5 ml normal saline, with a maximum volume of 20 ml for both groups.

The time of the caudal block was recorded, and surgery was allowed to start 10 minutes after the caudal injection. No other analgesics, sedatives, or narcotics were used intraoperatively. Continuous monitoring of vital parameters was done intraoperatively. Vitals were recorded every 5 minutes for the first 20 minutes after performing the block and thereafter every 10 minutes until the completion of surgery. At the

end of the surgery, all anesthetic gases were discontinued, and the LMA was removed after adequate spontaneous breathing efforts were returned. The occurrence of intraoperative hypotension (fall in SBP >20% from baseline) and bradycardia (HR <60 bpm) was recorded and treated with a bolus of i.v. fluid and atropine (20 µg/kg every 2–5 minutes).

After surgery, patients were shifted to the Post Anesthesia Care Unit (PACU) for further observation and monitoring. Postoperatively, pain scores were assessed using the Wong-Baker pain scale (WBS), motor block using the Modified Bromage score (MBS), and the degree of sedation using Ramsay Agitation Sedation Score (RASS) were evaluated at 0 minutes, 30 minutes, 1 hour, 1.5 hours, 2 hours, 4 hours, and 8 hours. Duration of postoperative sedation was deemed from the time to extubation until the Ramsay sedation score was 2 or less. Motor block was evaluated until the MBS became '0'. The pain was assessed until the requirement of the first rescue analgesic (or 8 hours, whichever was longer), after which the study was considered over for that patient. All patients were also monitored for vital parameters, the occurrence of postoperative desaturation (SpO_2 <90%), hypotension (fall in SBP >20% from baseline), bradycardia (HR <60/minutes), postoperative nausea vomiting, urinary retention, and apnea. Patients complaining of pain at the surgical site or WBS of 4 or more were given i.v. paracetamol 15 mg/kg as a rescue analgesic. If the pain persisted after half an hour, syrup ibuprofen 6 mg/kg was given (after ensuring full recovery from anesthesia). The rescue analgesic requirement within one hour in the postoperative room was considered a failure of the caudal block, and the child was excluded from the study. Serious adverse events (if any) were to be managed per the protocol.

The primary outcome measure was the time to first use of rescue analgesic from arrival in the recovery room. The secondary outcome measures were pain scores, motor block, sedation scores, and adverse events such as postoperative nausea and vomiting (PONV), desaturation, urinary retention, and apnea.

Pain severity was measured using the WBS for 24 hours.[7] Postoperative sedation was evaluated on a 6-point RASS ranging from 1 to 6.[8] The duration of sedation was defined as the time from extubation until the RASS was 2 or less.

Statistical Analysis

The sample size was determined by using the time to requirement of the first rescue analgesic to compare the effectiveness of the study drugs between the two groups. Based on previous studies[9] to detect a difference of 1 hour in the time to the requirement of the first rescue analgesic (duration of analgesia) between the two groups, a sample size of 47 patients per group was considered necessary to detect statistical significance with an effect size of 0.67 at alpha 0.05 and power of 90%. So, we decided to recruit 50 patients in each group.

Statistical analysis was performed using the SPSS program for Windows, version 17.0 (SPSS, Chicago, Illinois). Continuous variables were presented as mean±SD, and categorical variables were presented as absolute numbers and percentages. Data was checked for normality before statistical analysis. Normally distributed continuous (quantitative) variables like duration of surgery and analgesia, hemodynamic parameters, age, weight, pain scores, and sedation scores were compared using the unpaired t-test. Categorical (qualitative) variables like gender and postoperative complications were analyzed using the chi-square test. Data that was not normally distributed, like Bromage score, was analyzed using the Whitney U test. A p-value of <0.05 was considered statistically significant.

Results

This randomized comparative double-blind trial was performed on 100 children (50 in each group) once they satisfied the inclusion criteria and informed consent was obtained. 120 patients were assessed for eligibility, out of which 8 were excluded as their parents declined to participate, 12 were excluded based on exclusion criteria, and finally, 100 were recruited for the study. All recruited patients received the allocated intervention and completed the study (Fig. 1). Subject characteristics and intraoperative clinical profiles were comparable among the study groups (Table 1).

The two groups showed no statistically significant differences in hemodynamic parameters (PR, SBP, and DBP) (Fig. 2, 3). The SpO_2 at baseline or over the intraoperative and postoperative period was comparable between the groups.

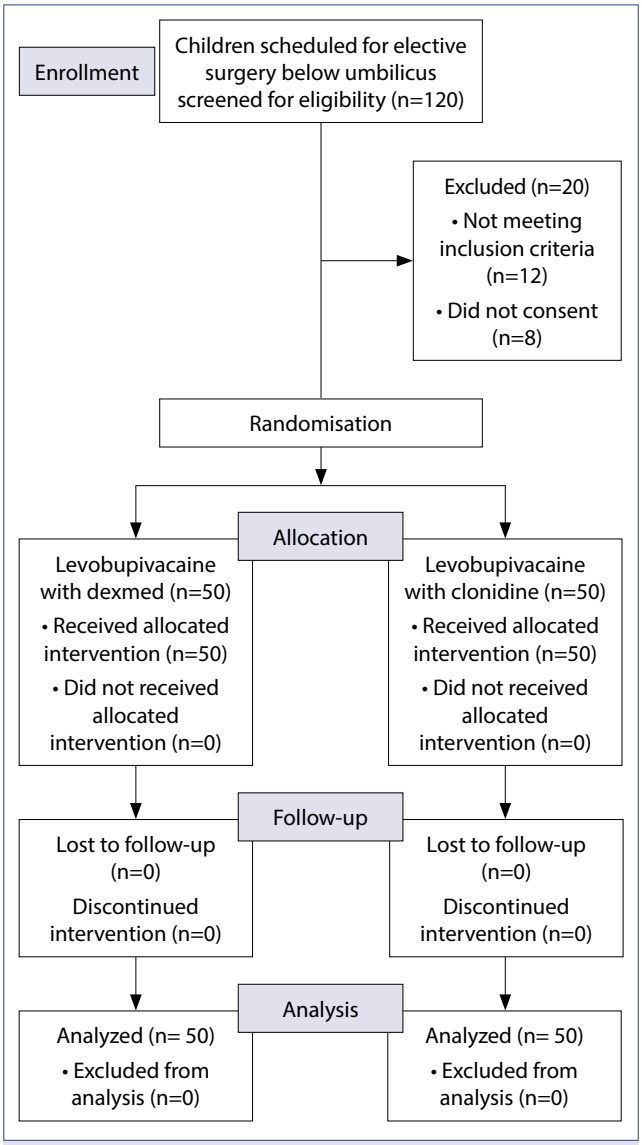

Figure 1. Consort diagram.

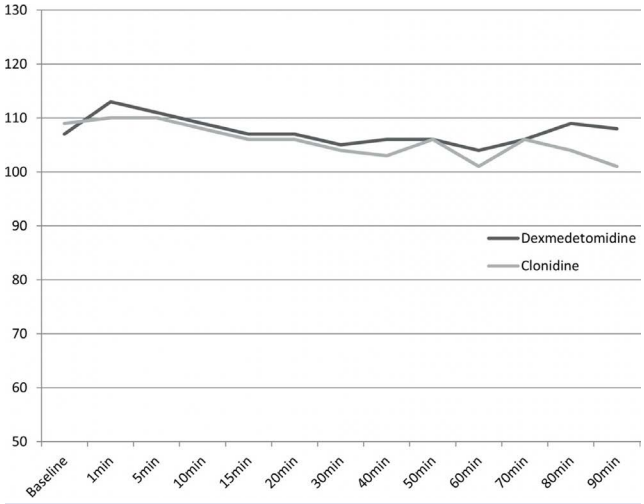

Figure 2. Figure comparing the mean intra-operative heart rates between patients in the dexmedetomidine and clonidine groups over time.

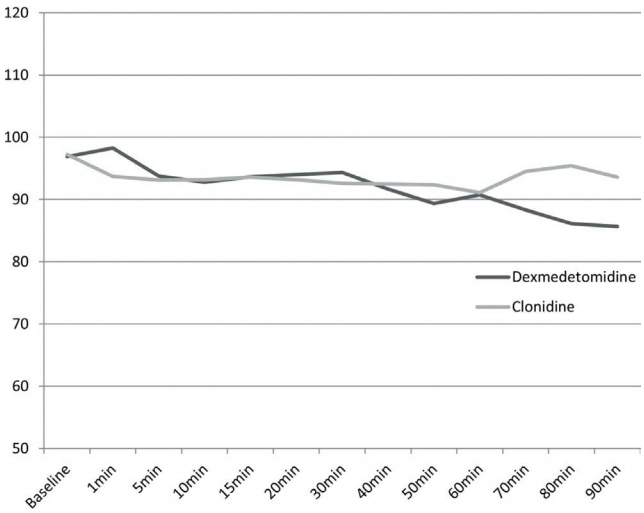

Figure 3. Figure comparing the mean intra-operative systolic blood pressures between patients in the dexmedetomidine and clonidine groups over time.

The mean duration of analgesia in the dexmedetomidine group was significantly higher (12.70±2.41 h) than for clonidine (10.64±2.23 h); p=0.001 (Table 1).

In both groups, the number of patients requiring i.v. fluid boluses for hypotension at 15 minutes (3 vs. 4), 20 minutes (4 vs. 4), and 30 minutes (2 vs. 1) in the intraoperative period were similar in Groups A and B, respectively.

The mean pain score assessed by the Wong-Baker pain scale was not statistically significant during the first four hours of the postoperative period, but it was lower in Group A compared to Group B at 4 hours (2.50±0.50 vs. 2.92±0.27; p<0.001) and 8 hours (2.80±0.40 vs. 2.93±0.25; p=0.05). The pain scores remained comparable at the rest of the time points during the 24-hour postoperative observation period.

The comparison showed no statistically significant differences in the mean Modified Bromage Scale scores between the two groups during the immediate postoperative period (0 minutes and 30 minutes; p=0.84 and 0.28). However, at 1 and 1.5 hours, the scores were significantly higher in the clonidine group (p<0.001) (Table 2).

A comparison of the mean Ramsay Sedation Score revealed no statistically significant differences between the two groups during the immediate postoperative period. The mean duration of sedation was longer in the dexmedetomidine group than in the clonidine group (128.60±72.06 vs. 117±73.05 minutes). However, the difference was statistically insignificant (p=0.42). PONV was observed in 3 pa-

Table 1. Demographic data, mean duration of analgesia and sedation, and incidence of PONV

	Group A (dexmedetomidine) Mean (SD)	Group B (clonidine) Mean (SD)	p
Age (years)	5.3 (1.52)	5.6 (1.74)	0.360
Weight (kg)	13.63 (6.87)	13.55 (6.03)	0.948
Height (inches)	46.14 (6.26)	45.59 (5.91)	0.654
Gender (M/F)	40/10	32/18	0.075
Duration of surgery (minutes)	56.80 (15.31)	59.40 (17.66)	0.433
Duration of analgesia (hours)	12.70 (2.41)	10.64 (2.23)	0.0001*
Mean duration of sedation (minutes)	128.60 (72.06)	117 (73.05)	0.426
PONV, n (%)	3 (6%)	4 (8%)	0.70

*: Statistically significant (p<0.05); PONV: Postoperative nausea and vomiting; SD: Standard deviation; M: Male; F: Female.

Table 2. Modified Bromage Scale scores and Wong-Baker Scale scores over time

	Group A (dexmedetomidine)	Group B (clonidine)	p
Modified Bromage Scale, Median (Min–Max)			
0 hr	1 (0–1)	1 (0–1)	0.84
0.5 hr	0 (0–1)	0 (0–1)	0.28
1 hr	0 (0–1)	0 (0–1)	0.78
1.5 hr	0 (0–1)	0 (0–1)	0.77
Wong-Baker Scale, Mean (SD)			
0 hr	2.48 (0.5)	2.52 (0.50)	0.69
0.5 hr	2.44 (0.5)	2.52 (0.50)	0.42
1 hr	2.54 (0.50)	2.64 (0.53)	0.33
1.5 hr	2.50 (0.51)	2.48 (0.50)	0.84
2 hr	2.52 (0.50)	2.40 (0.49)	0.23
4 hr	2.5 (0.50)	2.9 (0.27)	0.00*
8 hr	2.8 (0.40)	2.93 (0.25)	0.05

*: Statistically significant (p<0.05); SD: Standard deviation; Min: Minimum; Max: Maximum.

tients in Group A and 4 in Group B (p=0.70). None of the patients in any group experienced hypotension, bradycardia, respiratory depression, desaturation, apnea, or urinary retention in the postoperative period (Table 1).

Discussion

Caudal dexmedetomidine and clonidine have been studied separately with levobupivacaine in children, where they have been shown to increase the duration of postoperative analgesia.[10–12] We compared the analgesic efficacy of clonidine and dexmedetomidine as adjuvants to 0.2% levobupivacaine in children undergoing infraumbilical surgeries.

Armitage's formula for caudal block recommends bupivacaine 0.5 ml/kg for a lumbosacral block, 1 ml/kg for a thoracolumbar block, and 1.25 ml/kg for a mid-thoracic block. Since we had patients undergoing all types of below umbilical surgeries requiring blockade of thoracolumbar dermatomes (up to T10) for our study, a volume of 1 ml/kg was chosen.[13]

Ivani et al.[14] studied levobupivacaine in various concentrations of 0.125%, 0.2%, and 0.25%. They observed a dose-response relationship both with regard to the median duration of postoperative analgesia (0.125%, 60 min; 0.20%, 118 min; and 0.25%, 158 min) and the number of patients with evidence of early postoperative motor blockade (0.125%, 0

patients; 0.20%, 4 patients; and 0.25%, 8 patients). Though the 0.125% concentration was associated with significantly less early motor blockade, it resulted in a shorter duration of postoperative analgesia. Based on these results, we used 0.2% levobupivacaine for caudal blockade in children.

The main finding of the present study is that a caudal injection of a combination of levobupivacaine with dexmedetomidine 1 µg/kg significantly provides a longer duration of postoperative analgesia compared to levobupivacaine with clonidine 1 µg/kg. This difference in the duration of analgesia can be attributed to the more selective action of dexmedetomidine on alpha-2a adrenoceptors responsible for the hypnotic and analgesic effects of these drugs.[15]

The findings of our study were similar to the study conducted by Jinjil et al.[16] and Mavuri et al.,[17] who studied the analgesic efficacy of caudal clonidine (1 µg/kg) and dexmedetomidine (1 µg/kg) as adjuvants to 0.2% ropivacaine in pediatric patients. They also found that the duration of postoperative analgesia was significantly longer in the dexmedetomidine group compared to the clonidine group. Previous studies by Al Maghawry et al.,[18] Ahuja et al.,[19] and Nasr and Abdelhamid[20] have demonstrated attenuated neuroendocrine stress responses by adding clonidine and dexmedetomidine to the local anesthetic for caudal block. The serum cortisol levels were decreased in the clonidine and dexmedetomidine groups compared to control, with the lowest levels reported in the dexmedetomidine group, further reiterating its more potent analgesic effect.[18]

The mean pain score assessed by the Wong-Baker pain scale was not significantly different during the first 4 hours postoperatively, but it was lower in Group A at 4 hours and 8 hours compared to Group B. This may be due to improved and more prolonged analgesia with dexmedetomidine than clonidine. Al Maghawry et al.[18] similarly reported a comparable pain score between clonidine and dexmedetomidine groups until postoperative 6 hours, after which the scores were significantly lower in the dexmedetomidine group.

We found a higher duration of sedation in the patients who received dexmedetomidine (128.60±72.06 minutes) than those who received clonidine (117.00±73.05 minutes), although the difference was not statistically significant. In the present study, 72% of the patients in the dexmedetomidine group had Ramsay scores of 3 or 4 at the end of 90 minutes compared to 54% in the clonidine group. The longer duration of sedation and better sedation scores at 90 minutes in the dexmedetomidine group can be attributed to its more selective and potent agonist action on supraspinal alpha-2a receptors mediating hypnosis. Similar studies conducted by Mavuri et al.[17] and Reddy and Gangadharaiah showed a significantly prolonged duration of sedation with clonidine and dexmedetomidine compared to plain ropivacaine, with dexmedetomidine documenting the most extended duration of sedation.

Both the groups were also compared for motor blockade postoperatively using the Modified Bromage score.

Immediately after arrival in the recovery room, 46% of patients in Group A and 48% in Group B had a Modified Bromage score of 0, which increased to 74% of patients in Group A and 64% in Group B at 30 minutes. At 120 minutes and beyond, none of the patients showed residual motor blockade, and the score among all patients was 0. So, the p-value could not be calculated. Ivani et al.[21] reported 25% motor block at wake-up following levobupivacaine 0.2% caudal anesthesia compared with 16% with 0.2% ropivacaine. Gupta et al.[22] reported 60% motor block at wake-up following 0.2% bupivacaine compared with 0.25% levobupivacaine, but in both groups, the incidence decreased to less than 7% at 3 hours.

Clonidine and dexmedetomidine are alpha-2 agonists that induce sympatholysis by stimulation of the prejunctional inhibitory alpha-2 receptors, with subsequent decrease in norepinephrine release and are known to cause adverse effects such as hypotension and bradycardia due to an uninhibited increase in parasympathetic tone.[23] In our study, hemodynamic parameters were comparable in both groups at various intervals. However, 4 cases in each group required i.v. fluid boluses, and the parameters returned to normal within 20 to 30 minutes of the caudal injection. El Shamaa et al.[5] studied dexmedetomidine's effect with bupivacaine in the caudal

block and found no significant changes in the hemodynamics with dexmedetomidine compared to bupivacaine alone.

There was a significantly higher mean pulse rate during the first 2 hours in the postoperative period in the clonidine group compared to the dexmedetomidine group. However, the patients were comfortable and pain-free during this interval. This observation during a particular interval can be due to better analgesia and sedation provided by dexmedetomidine.

The groups had no significant difference in the incidence of nausea, vomiting, or urinary retention. No episodes of clinically significant respiratory depression or desaturation were identified. A similar conclusion was drawn from the studies conducted by Gupta and Pratap[22] and Neogi et al.[23] They all observed that adding caudal clonidine and dexmedetomidine in similar doses significantly prolonged the duration of analgesia without an increase in the incidence of adverse effects.[24]

Conclusion

Dexmedetomidine (1 µg/kg), when added to levobupivacaine (0.2%), provides a longer duration of analgesia with better sedation scores as compared to clonidine (1 µg/kg) for below umbilical surgeries in pediatric patients, without increasing the incidence of adverse effects.

Ethics Committee Approval: The Chacha Nehru Bal Chikitsalya Children Hospital Ethics Committee granted approval for this study (date: 05.05.2020, number: F.1/IEC/CNBC/05/01/2020/4224).

Informed Consent: A consent form was obtained from each patient before participating in the study.

Conflict of Interest: The authors declare that there is no conflict of interest.

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ORIGINAL ARTICLE

Does central sensitization affect responses to genicular radiofrequency and intra-articular injection in elderly knee osteoarthritis patients?

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SUMMARY

Objectives: This study aimed to evaluate the effect of central sensitization level on treatment response in individuals older than 65 years who underwent genicular nerve radiofrequency and intra-articular injection treatments for knee osteoarthritis (OA).

Methods: In this retrospective cohort study, 37 patients were divided into two groups according to the Central Sensitization Inventory (CSI) score (CSI<40 and CSI≥40). All patients underwent genicular nerve radiofrequency ablation and intra-articular injection. Pain (NRS), functionality (WOMAC), walking capacity (6MWT), sleep quality (PSQI), and satisfaction levels were evaluated at baseline and at 1 and 3 months following the procedure. Variance and regression analyses were used for statistical evaluation.

Results: Significant clinical improvements were observed in all patient groups for the evaluated parameters (p<0.001). However, variance analysis for pain (F=22.566, p<0.001), function (F=15.283, p<0.001), sleep quality (t=−3.87, p<0.001), and walking capacity (F=13.301, p=0.001) showed lower scores in the CSI≥40 group compared with the CSI<40 group. Regression analysis confirmed lower responses in CSI≥40 patients: pain (β=−2.1; 95% CI: −3.1 to −1.1; p<0.001), function (β=−4.6; 95% CI: −7.2 to −2.0; p=0.001), walking (β=−24.6; 95% CI: −40.7 to −2.8; p=0.026), and sleep (β=−1.9; 95% CI: −2.9 to −0.9; p=0.001).

Conclusion: The presence of central sensitization significantly limits the clinical response to genicular radiofrequency ablation and intra-articular injection treatments in older patients with OA. Routine use of screening tools such as CSI in treatment planning may guide more effective and personalized approaches.

Keywords: Central nervous system sensitization; elderly; knee; osteoarthritis; radiofrequency ablation.

Introduction

Knee osteoarthritis (OA) is a common cause of chronic pain and is frequently seen in older individuals.[1] Traditional treatment methods include anti-inflammatory drugs, physical therapy applications, and intra-articular injections, which focus on the peripheral nature of OA.[2] However, studies indicate that the pain mechanism associated with OA is more complex.[3] An important component of this complexity is central sensitization, which is characterized by hypersensitivity to non-painful stimuli, enlargement of pain areas, and decreased pain thresholds.[4] In a large number of patients with knee OA, there is a discrepancy between radiological findings and pain intensity, which suggests that the associated pain cannot be explained by local pathology alone.[5] Clinical and neurophysiological studies show that patients with knee OA often have widespread hyperalgesia and impaired pain inhibition.[6] One of the widely used and validated tools for the clinical assessment of central sensitization is the Central Sensitization Inventory (CSI).[7] The CSI groups patients with knee OA according to their symptom profiles and stands out as an important scale, especially for determining the response to interventional or conservative treatments.[8,9] Scores of 40 and higher indicate the presence of central sensitization.[10] Studies

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indicate that patients with high CSI scores benefit less from physical therapy, surgery, or medication.[11–13] Intra-articular injections and genicular nerve radiofrequency treatments (RFT) are minimally invasive pain treatment options that are effective and reliable for the management of knee OA.[14] However, the effect of these treatments on specific parameters, such as functionality and walking capacity, in elderly patients with central sensitization is not yet clear.[15] Our hypothesis is that increased central sensitization might impair the effectiveness of minimally invasive pain treatments, similar to its effects on other conservative treatments. In this context, we are the first to subgroup older patients (age ≥65 years) with knee OA according to CSI scores. Thus, we aimed to evaluate the effects of the combination of intra-articular injection and genicular nerve conventional RFT on pain scores, functionality, sleep quality, walking capacity, and patient satisfaction.

Materials and Methods

Study Design and Patient Selection

Ethical approval was obtained from the local ethics committee for this retrospective cohort study (date: 29.04.2025; number: 418). Data from patients who presented to our outpatient pain clinic with knee pain between October 1, 2024, and April 10, 2025, were investigated. The inclusion criteria were: (i) age ≥65 years, (ii) satisfying the American College of Rheumatology (ACR) osteoarthritis criteria.[16] (iii) having undergone intra-articular injection and genicular nerve RFT for pain management, (iv) being class III–IV according to the Kellgren–Lawrence classification system, (v) having complete follow-up scales, and (vi) having knee pain for at least 3 months. Patients with incomplete file data, additional diseases that could lead to central sensitization (e.g., fibromyalgia, irritable bowel disease, migraine), inflammatory joint disease, previous knee surgery, or those who did not have regular outpatient clinic follow-ups were excluded. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data Collection

As part of the study, the CSI, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the Pittsburgh Sleep Quality Index (PSQI) follow-up scales were recorded as self-reports from the patients. Other follow-up scales included the 6-Minute Walk Test (6MWT) distance measurement, the Numerical Rating Scale (NRS), and a short satisfaction survey (i.e., satisfied, not satisfied, or undecided), which were recorded in manuscript form by the researchers. All scale data (except patient satisfaction) were recorded at the first application and at months 1 and 3 post-treatment. Patient satisfaction was recorded at 3 months post-treatment. All assessment scales used in the study are part of our routine outpatient clinic follow-up. In addition, age, pain duration, body mass index (BMI), and gender data were recorded. Demographic data, medical history, and scale data screening were performed using the Hospital Information Management System (HBYS) and the researchers' manuscript data. Data analyses were performed by assigning the participants to two groups: those with central sensitization (CSI score ≥40) and those without central sensitization (CSI score <40). In accordance with patient ethics committee policies, patients' personal data were anonymized before analysis.

Intra-articular Injections and Genicular Nerve Radiofrequency Ablation Procedure

Before intra-articular injection and genicular branch RFT applications, a detailed medical history focusing on symptoms was obtained from all patients, and a physical examination was performed. Imaging techniques (e.g., X-ray or MRI, if necessary) were reviewed, and when differential diagnosis was required, appropriate tests (e.g., blood tests, cytology, fluid culture) were requested. Informed consent was obtained from patients who were suitable for interventional procedures. In addition, all patients were asked to undergo the necessary blood tests (e.g., complete blood count, activated partial thromboplastin time, international normalized ratio, and hepatitis and HIV serology) before the procedure. After standard monitoring in the operating room environment, all patients were administered minimal sedation (midazolam 0.05–0.1mg/kg) intravenously by the anesthesia team. The procedure area was prepared with an iodine-based solution, and sterile surgical draping was applied. Local infiltration was then performed on the skin of the treatment area with 2% prilocaine. All

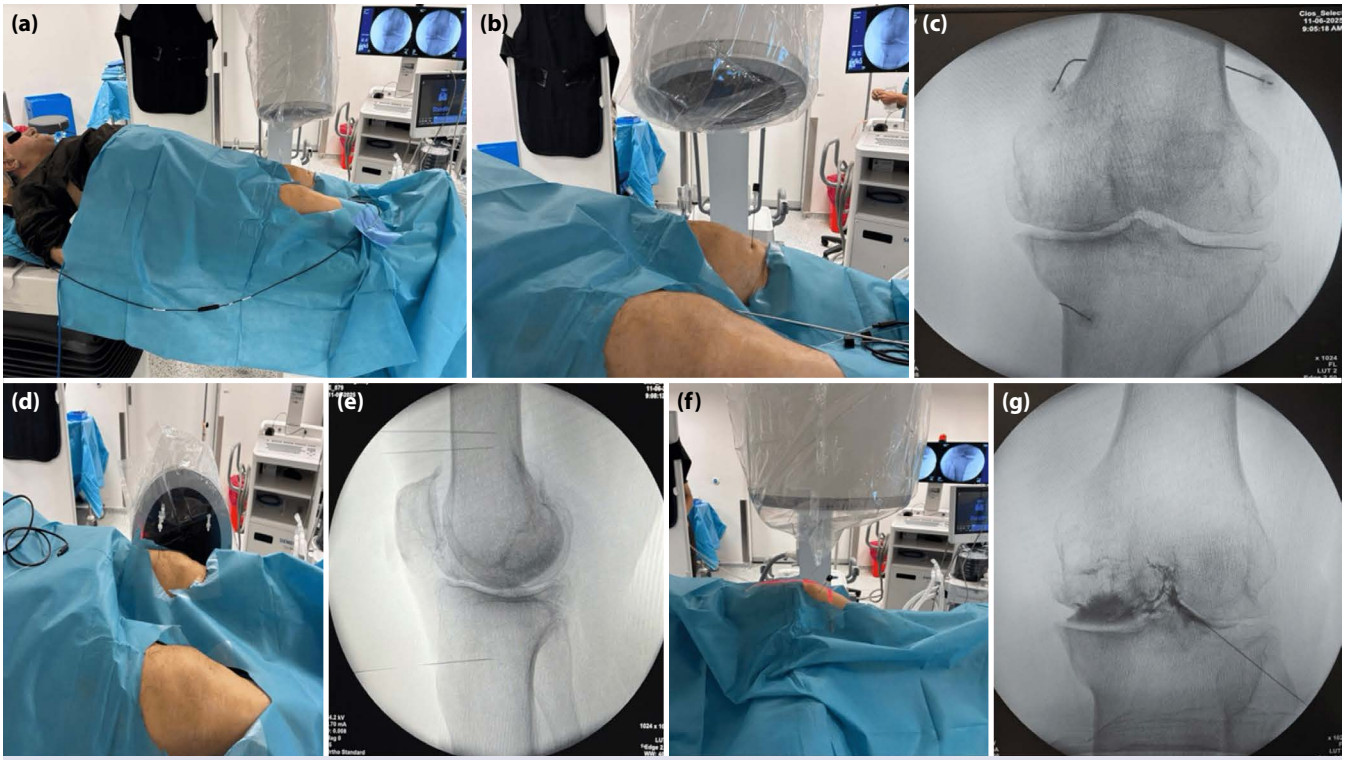

Figure 1. The fluoroscopic guidance stages of radiofrequency ablation of the genicular branches of the knee (superior lateral, superior medial, inferior medial genicular nerves) and intra-articular knee block via the anterolateral approach are presented for each image. **(a)** Patient positioning and anteroposterior fluoroscopic imaging, **(b)** Positioning of radiofrequency cannulas, **(c)** Anteroposterior fluoroscopic view of the cannulas, **(d)** Lateral positioning of the cannulas, **(e)** Lateral fluoroscopic view of the cannulas and needle placement, **(f)** Needle placement via the anterolateral approach, **(g)** Fluoroscopic imaging of intra-articular contrast medium distribution. Note: Patient permission was obtained.

procedures were performed under fluoroscopy (GE OEC 9900 C-Arm, GE Healthcare, USA). For radiofrequency ablation of the genicular branches (i.e., superior lateral, superior medial, and inferior medial), needle positioning was confirmed by anteroposterior and lateral fluoroscopic imaging. RFT was performed using a 22G×10cm×10mm active motor RF hybrid cannula (Diros Technology Inc., Canada) and an RF generator (Kimberly-Clark Pain Management Generator Version 4.0, Halyard Health, Alpharetta, GA, USA). The presence of paresthesia with sensory stimulation (≤0.5mA, 50Hz) and the absence of motor stimulation (1mA, 2Hz) were confirmed. Conventional ablation was performed on all branches at 90°C for 60 seconds. For the intra-articular procedure, the knee was flexed to 90°. A 22G spinal needle was advanced using an anterolateral approach, and intra-articular placement was confirmed with contrast imaging. A mixture of 5–10ml containing 0.5% bupivacaine (2.5ml), 16mg dexamethasone, and 0.9% saline was injected. All pain procedures were performed by a specialist in accordance with the standard protocol (Fig. 1).

Statistical Analyses

Data analysis was performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics included mean, standard deviation, minimum, and maximum values. Normal distribution of continuous variables was assessed using skewness and kurtosis values, and parametric tests were applied to normally distributed data.[17,18] An independent samples t-test was used for comparisons between two independent groups, and a dependent samples t-test was used for within-group comparisons over time. Repeated measures ANOVA was applied for three or more measurements. Categorical variables were analyzed using the chi-square test. For comparisons according to CSI score (<40 versus ≥40), time and group interactions were tested using two-way ANOVA. The effect of CSI score on clinical parameters was evaluated using linear regression analysis. The significance level was set at $p<0.05$. Post hoc power analysis, based on the smallest effect size (time×group interaction for 6MWT; $\eta^2=0.111$; Cohen's $f=0.353$), was conducted using repeated-

Table 1. Demographic characteristics by CSI groups

Variables	CSI<40 (N=19)	CSI≥40 (N=18)	Total (n=37)	p
Gender (male/female)	8 / 11	7 / 11	15 / 22	**0.842†**
Age (years)	70.95±6.14	74.28±6.85	72.57±6.62	**0.128***
Body Mass Index (kg/m^2)	27.17±3.24	29.77±5.15	28.43±4.42	**0.079***
Pain duration (months)	11.05±7.99	26.67±13.37	18.65±13.38	**<0.001***

Table 1 shows the demographic and clinical characteristics of the study participants categorized by CSI score groups. Participants were grouped into CSI<40 and CSI≥40 categories. The demographic variables include age, gender distribution, BMI: body mass index, and pain duration (in months). Mean±standard deviation is reported for continuous variables. CSI: Central Sensitization Inventory; † : Pearson's Chi-square test, *: Independent samples T-test.

Table 2. Comparison of clinical outcomes by CSI groups

Outcome measure	Timepoint	CSI<40 (n=19) Mean±SD	CSI≥40 (n=18) Mean±SD	p*
NRS	Baseline	7.58±0.84	8.00±0.59	**0.086**
NRS	Month 1	3.74±1.85	6.33±1.33	**<0.001**
NRS	Month 3	4.47±2.04	7.00±1.33	**<0.001**
WOMAC	Baseline	42.16±6.54	50.28±11.17	**0.012**
WOMAC	Month 1	30.82±6.93	43.52±10.58	**<0.001**
WOMAC	Month 3	32.47±7.08	44.98±9.97	**<0.001**
6MWT	Baseline	361.16±61.32	301.50±65.49	**0.007**
6MWT	Month 1	425.79±65.57	344.39±55.53	**<0.001**
6MWT	Month 3	422.95±68.44	338.67±70.25	**0.001**
PSQI	Baseline	8.11±1.59	6.83±1.15	**0.008**
PSQI	Month 3	4.26±1.82	4.89±1.13	**0.213**

The variables include the Numerical Rating Scale (NRS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), 6-Minute Walk Test (6MWT), and Pittsburgh Sleep Quality Index (PSQI), measured at baseline, post-treatment follow-up 1 month and follow-up 3 month where available. Values are expressed as mean±standard deviation. Patients with higher CSI scores demonstrated significantly worse pain, function, and sleep outcomes at multiple time points. This table highlights the potential influence of central sensitization on treatment response and recovery trajectory. *: An independent samples t-test was used to compare the groups; SD: Standard deviation; CSI: Central Sensitization Inventory.

measures ANOVA (within–between interaction) in G*Power. With α=0.05, three measurements, a repeated measures correlation of 0.5, nonsphericity correction ε=1, and n=37, the calculated power was approximately 99.8%.

Results

Within the scope of the study, data from 37 patients who met the inclusion criteria and did not meet the exclusion criteria were analyzed. The demographic data of the participants are summarized in Table 1. Eighteen participants were in the central sensitization group (CSI≥40) with a mean CSI score of 51.6±7.76, while 19 participants without central sensitization (CSI<40) had a mean score of 32.8±4.1 ($p<0.05$). The relationships between the participants' demographic variables and CSI scores were evaluated. No significant differences were found between the two CSI groups in terms of gender distribution, age, or BMI ($p>0.05$). However, pain duration was significantly longer in the CSI≥40 group ($p<0.001$).

The baseline, month 1, and month 3 NRS, WOMAC, 6MWT, and PSQI values are presented in Table 2. Repeated measures ANOVA revealed significant improvements in NRS, WOMAC, and 6MWT scores over time in both groups ($p<0.001$). In two-way ANOVA, these improvements were more pronounced in the CSI<40 group ($p<0.001$). Paired samples t-test showed that PSQI scores decreased in both groups, while independent samples t-test demonstrated that this decrease was more evident in the CSI<40 group ($p<0.001$). One-way ANOVA showed that both base-

Table 3. Time, group, and interaction effects for clinical outcomes in CSI < 40 vs. CSI ≥40 groups

Outcome measure	Effect type	Test (F or t)	p	η^2	Post-hoc power (1-β)
NRS	Time effect (all participants)	F=64.313	<0.001*	**0.648**	**>99%‡**
	CSI<40 vs CSI≥40	F=22.566	<0.001†	**0.392**	**>99%‡**
	Time×group interaction	F=12.686	<0.001†	**0.266**	**>99%‡**
WOMAC	Time effect (all participants)	F=149.783	<0.001*	**0.811**	**>99%‡**
	CSI<40 vs CSI≥40	F=15.283	<0.001†	**0.304**	**>99%‡**
	Time×group interaction	F=10.721	<0.001†	**0.234**	**>99%‡**
6MWT	Time effect (all participants)	F=85.786	<0.001*	**0.710**	**>99%‡**
	CSI<40 vs CSI≥40	F=13.301	0.001†	**0.275**	**>99%‡**
	Time×group interaction	F=4.353	0.017†	**0.111**	**>99%‡**
Satisfaction level	CSI<40 vs CSI≥40	F=6.640	0.004**	**0.281**	**>99%‡**
PSQI	Time effect (all participants)	t=10.032	<0.001***	NA	**>99%§**
	CSI<40 vs CSI≥40	t=-3.87	<0.001****	NA	**>99%§**

Table 3 evaluates the effects of time, group (CSI<40 and CSI≥40), and time×group interaction across all time points (baseline, 1 month, and 3 months) for the Numerical Rating Scale (NRS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the 6-Minute Walk Test (6MWT). Repeated-measures ANOVA and two-way ANOVA analyses were used for these outcomes. For statistically significant findings, the partial eta squared (η^2) value represents the effect size. For the Pittsburgh Sleep Quality Index (PSQI), paired samples t-tests and independent samples t-tests were used. Satisfaction Level was assessed using a 3-point Likert scale (Satisfied / Undecided / Not Satisfied) at the 3rd month. Group differences were analyzed using one-way ANOVA. NA: Not applicable; *: Repeated-measures ANOVA; †: Two-way ANOVA; **: One-way ANOVA; ***: Paired samples t-test; ****: Independent samples t-test; ‡: Repeated-measures ANOVA (within-between interaction); post-hoc power analysis based on observed η^2; §: Paired and independent samples t-tests (post-hoc power calculated based on observed Cohen's d values)

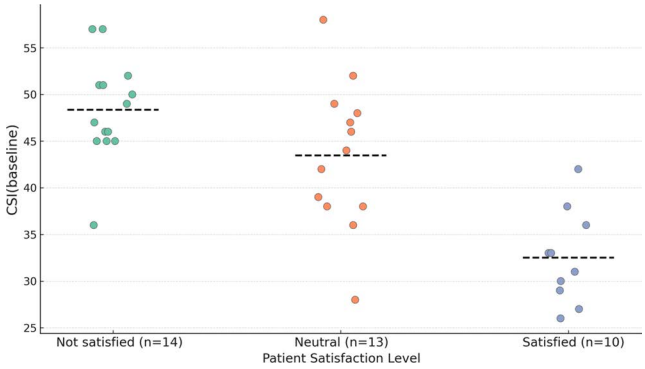

Figure 2. Each dot represents an individual patient. Dots are presented in three groups according to their level of satisfaction: "Not satisfied" (n=14), "Undecided" (n=13), and "Satisfied" (n=10). Black dashed lines indicate the mean baseline CSI score for each group. As patient satisfaction increases, a decreasing trend is observed in baseline CSI scores.

line and 3-month CSI scores were higher in dissatisfied and undecided participants (p=0.004). All statistical results and the corresponding post hoc power analyses for the 37 patients are presented in Table 3. The 3-month post-procedure patient satisfaction levels according to baseline CSI values are shown in Figure 2. Paired samples t-test demonstrated a significant decrease in CSI scores after treatment in both groups compared with baseline (CSI<40: t=3.15, p=0.006 versus CSI≥40: t=5.05, p<0.001).

For linear regression analysis, the pre-treatment CSI score was used as the independent variable, and ΔNRS, ΔWOMAC, Δ6MWT distance, and ΔPSQI scores were used as dependent variables (Δ: pre-treatment to month 1 change). The decreases in ΔNRS, ΔWOMAC, and ΔPSQI scores and the increase in Δ6MWT distance were significantly greater in the CSI<40 group than in the CSI≥40 group (p<0.05). Table 4 presents the regression analysis results. These findings suggest that the response to interventional treatment may be less effective in individuals with high CSI scores, particularly in terms of pain, functionality, and sleep, and that the increase in walking distance may be related to the CSI score.

None of the patients reported any complications during the follow-up period.

Discussion

This study investigated how central sensitization influences the response to intra-articular injections and genicular nerve RFT in elderly patients (age≥65 years) with knee OA. Both patients with central sensitization (CSI≥40) and those without (CSI<40) showed statistically significant improvements in

Table 4. Multivariate linear regression analysis for predictors of treatment response based on baseline CSI (≥40 vs <40)

Outcome measure	β coefficient (β)	95% CI	p	R^2 / adjusted R^2
Δ NRS (pain score change)	-2.105	**-3.14 to -1.07**	<0.001	0.309
Δ WOMAC (function score change)	-4.581	**-7.20 to -1.97**	0.001	R^2=0.244
Δ 6MWT (walking distance change, meters)	-24.62	**2.75 to 40.74**	0.026	Adjusted R^2=0.108
Δ PSQI (sleep quality score change)	-1.898	**-2.91 to -0.89**	0.001	R^2=0.275

CSI: Central Sensitization Inventory; Δ: difference between pre-treatment and 1st month scores; NRS: Numeric Rating Scale; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; 6MWT: Six-Minute Walk Test; PSQI: Pittsburgh Sleep Quality Index. β coefficients represent the estimated change in the outcome variable associated with having a baseline CSI ≥40 compared to <40, after adjusting for covariates. 95% confidence intervals (CI) are presented for each β coefficient. R^2 indicates the proportion of variance explained by the model. Adjusted R^2 was used where appropriate. All regression models were statistically significant (overall model p<0.05), explaining 10.8% to 30.9% of the variance.

pain (by NRS score), function (by WOMAC score), sleep quality (by PSQI score), and walking distance (by 6MWT distance). However, this effect was lower in patients with central sensitization, in line with our hypothesis. Furthermore, regression analysis found that central sensitization was predictive of therapeutic outcomes. We focused on two main points in discussing our findings: the effect of central sensitization on knee osteoarthritis treatment and the effect of interventional treatments in older patients with knee osteoarthritis.

Central sensitization describes a pain experience not fully explained by peripheral joint pathology and can significantly affect treatment response in knee OA. Kim et al.[12,18] explored the effect of central sensitization on treatment response, showing that patients with high central sensitization had significantly worse pain, functionality, and satisfaction levels after total knee arthroplasty. Carlesso et al.[6] also reported that pain patterns were closely related to central sensitization in studies evaluating quantitative sensory testing and CSI scores together in patients with knee OA. Campbell et al.[19] showed a decrease in sleep quality in patients with knee osteoarthritis and high central sensitization using CSI and PSQI scores. Additionally, Arendt-Nielsen et al.[20] found that patients with knee osteoarthritis who had central sensitization experienced more widespread pain sensitivity, weaker pain control, and longer-lasting pain.

Yüzügüldü et al.[11] reported that high CSI values negatively affected the response to physical therapy. Our research shows that individuals with a CSI score of 40 and higher had a significantly longer duration of pain and a poorer treatment response, which is consistent with these mechanistic foundations. Studies to date have generally focused on the effects of central sensitization on surgical and physical therapy modalities for knee OA. However, no study has examined the combined effects of genicular radiofrequency and intra-articular injection on pain, function, walking distance, or sleep quality in patients with central sensitization.

In chronic knee OA, inflammatory and neuropathic pain components are often present together.[6] Genicular RFT targets the neuropathic component, whereas intra-articular steroid injections target the inflammatory component. Yilmaz et al.[21] showed in their randomized study that combinations of genicular block and intra-articular injection treatments were superior to single injections. Recent meta-analyses report that genicular RFT has a longer-lasting effect on pain and functionality.[22,23] Based on this information, we often prefer this combination treatment in patients with advanced-stage OA to achieve a more effective and long-lasting clinical response. Central sensitization could limit treatment response not only to surgery but also to minimally invasive interventional pain treatments. Lluch Girbés et al.[24] emphasized that the presence of central sensitization in patients with OA might limit the response to classical treatments and that patients should therefore be grouped in advance using criteria such as CSI. Our findings underscore the significance of including central sensitization scales in routine clinical evaluation processes when planning interventional treatment.

Our regression analysis results showed that high CSI scores are associated with poor clinical outcomes. Easily administered self-report scales such

as the CSI could help identify patients who are less likely to respond to treatment, facilitating the development of more personalized and multimodal treatment approaches. It should be noted that midazolam and steroids administered during the procedure might have affected central sensitization in our study. Animal and human studies have shown that midazolam can affect central sensitization.[25,26] However, these studies have mostly evaluated the effects of high doses or effects occurring shortly after administration. It is unlikely that the low and single dose of midazolam affected central sensitization throughout the follow-up period in our study. In addition, studies on steroids have shown that their effect on central sensitization is limited.[27,28] This supports our findings regarding steroid use. Furthermore, since both treatments were applied equally to both CSI<40 and CSI≥40 groups, the observed differences depend on the CSI score, and there was no confounding effect of the drugs.

Although there is limited research directly evaluating intra-articular injection and genicular radiofrequency in older patients with knee OA, many studies have included populations with similar age ranges to ours.[29–31] These studies generally focus on the efficacy and safety of treatment. Ma et al.[32] reported that ultrasound-guided genicular RFT in older patients with OA provided substantial improvement in pain relief and functionality. However, their study evaluated patients aged 50 years and older based on NRS and WOMAC scores. Unlike the study by Ma et al.,[32] we evaluated genicular radiofrequency results in patients aged 65 years and older. We assessed multiple parameters, including pain, function, sleep, and walking distance. In addition, our study focused on the evaluation of central sensitization as a parameter predicting treatment response.

Studies directly examining the clinical effects of central sensitization in older individuals with OA are limited. Tavares et al.[15] reported that the response to conservative treatment and functional gains are reduced due to deterioration of descending pain inhibitory systems in older patients with knee OA. Cruz-Almeida et al.[33] reported that differences in psychological profile and central pain processing in older patients affect pain intensity independently of the peripheral location of pain. The main finding of our study, namely the inadequate treatment response observed in the CSI≥40 group, is consistent with these published findings. The fact that improvement in sleep quality was less in the group with central sensitization suggests that this sensitization status affects not only pain but also a wider range of quality-of-life parameters. Petersen et al.[5] reported that central pain sensitivity increases with age in patients with osteoarthritis and that this effect is more pronounced than in healthy individuals. Additionally, neuropathic comorbidities frequently seen in older individuals could make the experience of pain more complex.

A striking aspect of our findings is the limited response observed in patient satisfaction. Although treatment follow-up parameters improved significantly, patients did not always report this positively. The satisfaction level was significantly low, especially in those with central sensitization, indicating that central sensitization affects pain perception not only at the physical level but also at emotional and cognitive levels. Central sensitization is not merely a neurophysiological phenomenon; it is a dynamic process involving psychosocial factors such as depression, anxiety, and somatic complaints.[34,35] In this context, psychological parameters might have affected patient satisfaction. However, Rehm et al.[36] emphasized that central sensitization is more closely related to pain intensity and reported that the effect of psychosocial factors might be limited. In retrospect, a study evaluating comorbidities, medication use, and psychosocial factors together in older patients could help clarify the relationship between central sensitization and patient satisfaction.

This study is a multidimensional investigation that evaluates the effects of central sensitization on the response to intra-articular injection and genicular nerve RFT in older patients with knee OA. Combining objective and subjective scales improves the clinical validity of the findings. In addition, CSI-based grouping indicates that treatment responses depend on both age and the level of central sensitization. These findings suggest that central mechanisms should also be taken into consideration in the pain management of older individuals.

This study has some limitations. The retrospective design limits the ability to establish a causal relationship. The single-center structure and specific inclusion criteria might have limited the generalizability of the results despite sufficient statistical power. Although comorbidities such as fibromyalgia, irritable bowel syndrome, migraine, and temporomandibular dysfunction that affect central sensitization were excluded, factors common in older people such as anxiety, depression, and medication use were not evaluated, which could limit the interpretation of CSI scores as a purely neurophysiological indicator. In addition, advanced measurements such as neuropathic pain scales, psychological assessment tools, and neurophysiological tests were not included in the study. These limitations underscore the need for future prospective, multicenter studies that also account for psychosomatic factors and medication use.

Conclusion

This study shows that central sensitization has a significant effect on multiple clinical parameters such as pain, functionality, sleep, and walking in older patients undergoing interventional treatment for knee osteoarthritis. The limited response to treatment in individuals with high CSI scores suggests that central sensitization could negatively affect recovery. These findings highlight the importance of complementary strategies targeting not only peripheral but also central pain mechanisms in older individuals. In addition, screening tools such as the CSI could help guide personalized treatment planning.

Ethics Committee Approval: The Kayseri City Hospital Ethics Committee granted approval for this study (date: 29.04.2025, number: 418).

Informed Consent: Informed consent was obtained from patients who were suitable for interventional procedures.

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ORIGINAL ARTICLE

Comparing perichondrial M-TAPA and subcostal OSTAP blocks in laparoscopic hernia repair: A randomized, non-inferiority trial

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SUMMARY

Objectives: The modified thoracoabdominal nerves block through the perichondrial approach (M-TAPA) and the oblique subcostal transversus abdominis plane block (OSTAP) provide effective analgesia management after abdominal surgeries. There are limited studies comparing these two blocks in the literature. We aimed to compare M-TAPA and OSTAP in patients who underwent laparoscopic inguinal hernia repair.

Methods: Patients with ASA status I–II, aged between 18 and 65 years, scheduled for elective TAPP under general anesthesia were included in the study. The patients were randomized into two groups: Group M-TAPA (n=30) and Group OSTAP (n=30). Blocks were performed using a total of 60 ml of 0.25% bupivacaine (30 ml per side). Postoperatively, all patients were routinely prescribed intravenous ibuprofen 400 mg three times a day. If a patient's NRS score was ≥4 at any time, a dose of 100 mg intravenous tramadol was administered for rescue analgesia.

Results: The duration of the block procedure was significantly longer in the OSTAP group. The need for rescue analgesia and opioid consumption were similar between the groups. In the first two postoperative hours, static and dynamic NRS scores were lower in the M-TAPA group than in the OSTAP group. There were no differences between the groups in terms of the rate of adverse events. Patient satisfaction (Likert scale) was higher in the M-TAPA group.

Conclusion: The M-TAPA block is not inferior to the OSTAP block following laparoscopic inguinal hernia repair surgery. Moreover, the M-TAPA block may be an alternative option to the OSTAP block, as it is easy to apply.

Keywords: Laparoscopic inguinal hernia; M-TAPA block; OSTAP block; postoperative analgesia.

Introduction

Laparoscopic inguinal hernia repair is a common surgical procedure worldwide, known for its advantages of reduced recovery time and lower postoperative complication rates compared to open surgery.[1] The transabdominal preperitoneal (TAPP) inguinal hernia repair method is a surgical technique used to repair inguinal hernias.[2] The TAPP procedure is a type of laparoscopic and minimally invasive surgery in which small incisions are made in the abdomen to allow the insertion of laparoscopic instruments and a camera. Carbon dioxide is used to inflate the abdomen for the operation. Smaller incisions cause less pain and result in quicker recovery compared to open surgery.[1,2] However, managing postoperative pain remains a significant challenge impacting patient recovery and satisfaction.[3] Inadequately managed pain leads to prolonged hospital stays, delayed return to normal daily activities, and increased healthcare costs.[4] Pain management strategies have evolved, with a growing emphasis on multimodal analgesia to minimize opioid use and its associated side effects.[4,5] In this context, regional anesthesia

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techniques, particularly nerve blocks and interfascial plane blocks, have become increasingly popular due to their efficacy in providing targeted pain relief.

The modified thoracoabdominal nerves block through the perichondrial approach (M-TAPA) and the oblique subcostal transversus abdominis plane block (OSTAP) are two techniques that have shown promise in managing postoperative pain after abdominal surgeries. M-TAPA is a novel technique based on a perichondrial approach that targets the medial and lateral branches of the thoracoabdominal nerves.[6] OSTAP is a modification of the classical TAP block. It is performed using a subcostal approach from the costal margin to the iliac crest along the transversus abdominis plane, targeting the medial branches of the thoracoabdominal nerves.[7] The effectiveness of these two interfascial plane block techniques in reducing postoperative pain while minimizing opioid consumption after surgery has been explored in various surgical contexts.

Despite their growing popularity, there is a paucity of literature directly comparing the efficacy of M-TAPA and OSTAP blocks, particularly in the context of laparoscopic inguinal hernia repair. This study aims to fill this gap by conducting a randomized controlled trial to compare these two techniques in terms of postoperative analgesia management, opioid consumption, patient satisfaction (Likert scale), and potential side effects of opioid analgesics. The primary outcome of the study was a comparison of the groups' postoperative second-hour Numeric Rating Scale (NRS) scores at rest. The secondary outcomes were comparisons of the groups' Likert scale scores, all NRS scores other than the second hour, the need for rescue analgesics, opioid consumption, duration of block procedures, and incidence of side effects recorded 24 hours postoperatively. The hypothesis was that M-TAPA and OSTAP blocks would have similar analgesic efficacy levels following laparoscopic inguinal hernia repair surgery.

Material and Methods

Study Design and Participants

This study was a randomized, prospective analysis involving 60 patients aged between 18 and 65 years, classified as ASA I–II, and scheduled for elective laparoscopic inguinal hernia repair surgery. After receiving ethical approval from our university's Ethics Board (06.07.2022, no. 610), the study registration was recorded on ClinicalTrials.gov (NCT05476510). This study was conducted in accordance with the principles of the Declaration of Helsinki.

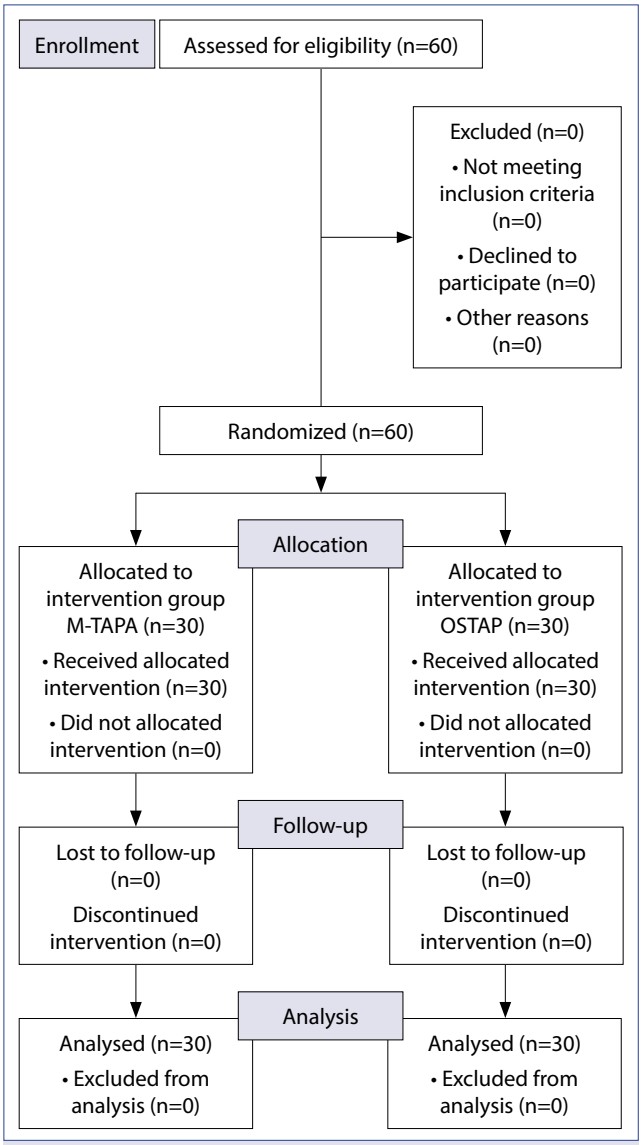

Figure 1. Consort flow diagram of the study.

Written informed consent was obtained from all participants. The CONSORT flow diagram was used for patient enrollment (Fig. 1). The study was conducted between August 2022 and July 2023 at Medipol Mega University Hospital. Patients with a history of bleeding diathesis, allergy or sensitivity to local anesthetics and opioids, infection at the block site, alcohol or drug dependency, allergy to the study drugs, pregnancy or lactation, anticoagulant therapy, or those who did not consent to participate in the study were excluded.

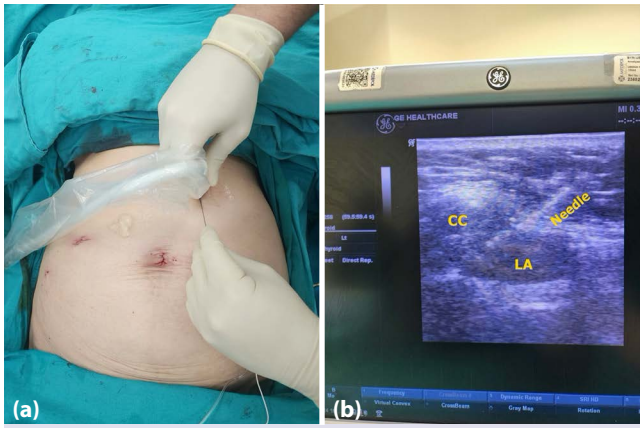

Figure 2. (a) Patient and probe position during M-TAPA. **(b)** Sonographic visualization of M-TAPA. Chondrium and LA spread are seen.

CC: Costochondrium; LA: Local anesthetic.

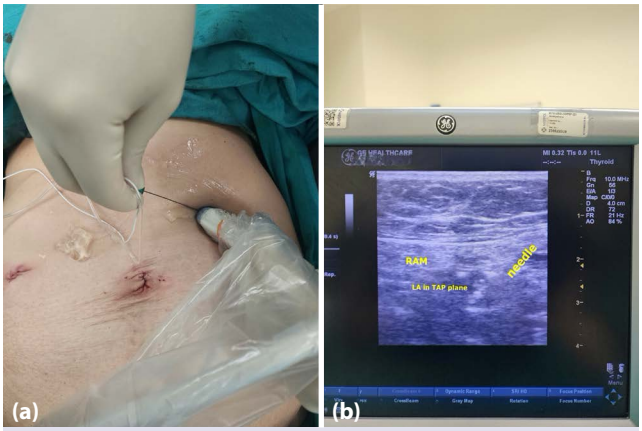

Figure 3. (a) Patient and probe position during OSTAP. **(b)** Sonographic visualization of OSTAP in the subcostal area at the initial level of the block. Local anesthetic is seen in the transversus abdominis plane.

RAM: Rectus abdominis muscle; LA; Local anesthetic; TAP: Transversus abdominis plane.

General Anesthesia

Patients received premedication with 2 mg midazolam intravenously before entering the operating room. Monitoring included electrocardiography, noninvasive arterial blood pressure, and peripheral oxygen saturation (SpO_2). General anesthesia was performed using the same protocol in all groups: an intravenous dose of 2–2.5 mg/kg propofol, 1.5 µg/kg fentanyl, and 0.6 mg/kg rocuronium. After intubation, mechanical ventilation settings were adjusted to maintain EtCO2 levels between 30 and 35 mmHg. Anesthesia maintenance was achieved with 1–2% sevoflurane in an O_2/fresh air mixture and a remifentanil infusion of 50 µg/h. Postoperative nausea and vomiting prophylaxis was provided with 4 mg ondansetron administered intravenously. All patients received 400 mg ibuprofen and 100 mg tramadol as a single IV bolus dose for postoperative multimodal analgesia management 20 minutes before the end of surgery. All patients underwent laparoscopic inguinal hernia repair with the same TAPP procedure performed by the same surgical team.

Randomization and Outcomes

Participants were randomly assigned into two groups of 30 patients each using computer-generated randomization: Group M-TAPA and Group OSTAP. The need for rescue analgesia and side effects (nausea/vomiting/itching) were evaluated as "yes" or "no."

Regional Anesthesia Technique

Under general anesthesia and before extubation, all blocks were performed in the supine position under ultrasound guidance. A high-frequency linear ultrasound probe (11–12 MHz), covered with a sterile sheath, was used with an 80-mm block needle (Braun 360°).

M-TAPA Procedure

The probe was placed on the chondrium corresponding to the midclavicular line at the level of the ninth–tenth ribs. Using the in-plane technique, the transducer was slightly tilted and the costochondral angle was visualized. An 80-mm block needle was inserted and advanced to a position just below the chondrium between the transversus abdominis muscle and the oblique muscle (Fig. 2a). Five ml of saline was administered to confirm the correct site. Then, 30 ml of 0.25% bupivacaine was injected (Fig. 2b). The same procedure was performed on the contralateral side (total 60 ml).

OSTAP Procedure

For the OSTAP block, the transducer was placed in an oblique plane in the subcostal region from the xiphoid to the iliac crest while the patient was in the supine position. A 150-mm block needle was first inserted between the transversus abdominis and rectus abdominis muscles, advancing in the interfascial plane toward the iliac crest (Fig. 3a). Five ml of isotonic saline was administered for confirmation. Subsequently, 30 ml of 0.25% bupivacaine was administered throughout the oblique subcostal line on each side (60 ml in total) (Fig. 3b).

Postoperative Pain Assessment and Analgesia Management Protocol

Pain intensity was evaluated using the NRS, where 0 indicates no pain and 10 represents the most severe pain. The NRS scores were recorded at rest and during mobilization at 1, 2, 4, 8, 16, and 24 hours postoperatively. The use of analgesic drugs, their quantities, postoperative opioid requirements, side effects (nausea, vomiting, itching), duration of block procedures, and patient satisfaction were all measured using a seven-point Likert scale. The duration of the block procedure was defined as the time from visualization of anatomical structures with ultrasound until administration of the local anesthetic. The duration of surgery referred to the time from the first incision to complete suturing and skin closure.

Postoperatively, all patients in both groups were routinely administered 400 mg ibuprofen intravenously three times a day. If a patient's NRS score was ≥4 at any time, an intravenous dose of 100 mg tramadol was administered as rescue analgesia. The postoperative patient assessment was conducted by a pain nurse anesthetist who was blinded to the study. The participants and the surgical team were aware of group allocation.

Sample Size and Statistical Analysis

The sample size of the study was calculated using the G*Power program (v.3.1.9). The primary aim of this study was to compare postoperative 2nd-hour NRS scores at rest. In the preliminary study, which included eight patients in each group, the 2nd-hour NRS score was 2.50 in the OSTAP group and 1.40 in the M-TAPA group. Standard deviations were 1.85 and 0.8, respectively. Considering α error 0.05 and β error 0.05, the number of patients to be included in each group was determined as 25 with 95% power. Taking into account a potential dropout rate of 10%, 60 subjects were planned for the study.

Statistical analyses were performed using IBM SPSS Statistics for Windows (Version 22.0; IBM Corp., Armonk, NY, USA) and the R statistical software package (v.4.0.2; R Foundation for Statistical Computing, Vienna, Austria). We calculated the 95% CI of the median differences in NRS scores using the Hodges–Lehmann estimator. As our hypothesis was a non-inferior NRS score in patients receiving M-TAPA block 2 hours after surgery compared with those receiving OSTAP, a non-inferiority study design was used, and an acceptable non-inferiority margin was defined as 1.0 according to a previous study.[8] The Shapiro–Wilk test was used to analyze data distribution. Continuous variables were expressed as mean±standard deviation and median (25th–75th percentiles). The Pearson chi-square test was used to compare categorical data between groups. Student's t-test was used for normally distributed continuous variables. In our study, the statistical significance threshold value was $p<0.05$.

Results

The study included 60 patients, who were equally divided into the M-TAPA (n=30) and OSTAP (n=30) groups. The patients' demographic data and surgical details are presented in Table 1. There were no significant differences between the two groups in terms of age, sex, ASA classification, height, weight, or type of surgery (unilateral/bilateral). The duration of surgery was not significantly different between the groups (M-TAPA: 64.9±8.6 min; OSTAP: 68.6±7.9 min; p=0.090). However, the duration of anesthesia was significantly longer in the OSTAP group (M-TAPA: 81.8±9.8 min; OSTAP: 89.8±4.9 min; p=0.001). Similarly, the duration of the block procedure was significantly longer in the OSTAP group (M-TAPA: 9.3±1.3 min; OSTAP: 15±2.8 min; p=0.001). The longer anesthesia duration in the OSTAP group was related to the longer block procedure time.

Table 2 summarizes the patients' postoperative opioid consumption and use of rescue analgesia. No significant differences were observed in tramadol doses between the two groups (p=0.725). Similarly, the requirement for rescue analgesia was comparable between the groups (M-TAPA: 7/23; OSTAP: 8/22; p=0.766).

The comparison of static and dynamic NRS assessments between the groups is detailed in Table 3. The M-TAPA and OSTAP groups were not superior to each other in terms of overall NRS scores. In the first postoperative hour at rest, patients in the M-TAPA group had significantly lower NRS scores compared to those in the OSTAP group (M-TAPA: 1[1–2]; OSTAP: 2[1–2]; p=0.008). Similar patterns were observed in the second (p=0.009) and sixteenth hours (p=0.032). However, no significant differences were noted at other time points. Regarding pain during movement,

Table 1. Comparison of demographic data, duration times of surgery and anesthesia, and duration of block procedure between groups

	Group M-TAPA (n=30)	Group OSTAP (n=30)	p
Age	44.6±8.1	47.9±9.1	*0.136*
Gender (M/F)	19/11	17/13	*0.791†*
ASA (I/II)	18/12	19/11	*0.791†*
Height (cm)	167.5±6.6	170.1±9.8	*0.248*
Weight (kg)	78.8±11.2	77.1±10.7	*0.551*
Type of surgery (unilaterally/bilaterally)	12/18	13/17	*0.598†*
Duration of surgery (min)	64.9±8.6	68.6±7.9	*0.090*
Duration of anesthesia (min)	81.8±9.8	89.8±4.9	***0.001***
Duration of block procedure (min)	9.3±1.3	15±2.8	***0.001***

Values are expressed mean±standard deviation or number; P value is obtained with t-test (mean±SD); †: P value is obtained with Pearson's χ^2 test (n); p values were italicized and values that are written in bold represent statistical significance. ASA: American Society of Anesthesiologist; M: Male; F: Female; cm: Centimeter; kg: Kilogram; min: Minutes; M-TAPA: Modified Thoracoabdominal Nerves Block Through the Perichondrial Approach; OSTAP: Oblique Subcostal Transversus Abdominis Plane Block.

Table 2. The comparison of postoperative opioid (tramadol) consumption and the incidence of need for rescue analgesia between groups

	Group M-TAPA (n=30)	Group OSTAP (n=30)	p
Tramadol dose (mg)	0 (0–0)	0 (0–100)	*0.725*
Rescue analgesia (Y/N)	7/23	8/22	*0.766†*

Data are expressed as median; P value is obtained with Mann-Whitney U test median (percentiles 25–75); †: P value is obtained with Pearson's χ^2 test (n); p values were italicized and values that are written in bold represent statistical significance; Y: Yes (indicates the number of the patients that used rescue analgesia); N: No; Mg: Milligram; M-TAPA: Modified Thoracoabdominal Nerves Block Through the Perichondrial Approach; OSTAP: Oblique Subcostal Transversus Abdominis Plane Block.

significant differences were observed between the groups in the first (M-TAPA: 2[1–2]; OSTAP: 2[2–3]; p=0.023) and second hours (p=0.032).

Figure 4 demonstrates the non-inferiority of the M-TAPA group (95% CI of the median differences in postoperative NRS scores).

The rates of adverse events and patient satisfaction are shown in Table 4. There were no significant differences between the groups in terms of adverse event rates. Patient satisfaction, measured using a Likert scale, was slightly higher in the M-TAPA group (M-TAPA: 7[6–7]; OSTAP: 6[6–7]; p=0.183).

Discussion

Our non-inferiority study yielded noteworthy findings regarding the efficacy of M-TAPA in laparoscopic TAPP inguinal hernia repair surgery. The M-TAPA group exhibited superior outcomes in terms of pain management and patient satisfaction, as assessed by NRS scores and the Likert scale. According to our results, NRS scores in the first 2 postoperative hours were lower in the M-TAPA group than in the OSTAP group. Likert scale scores were higher in the M-TAPA group than in the OSTAP group at the 24th postoperative hour.

Pain management after TAPP inguinal hernia repair surgery is an important issue. Although it is a minimally invasive procedure, patients may experience severe postoperative pain.[3–5] Effective analgesia management provides many benefits, including early recovery, early mobilization, and early discharge in the postoperative period.[5] Pain after TAPP surgery may be caused by various factors, such as peritoneal stretching due to intraperitoneal gas insufflation, dissection and mesh placement for hernia repair, and inflammatory mediators.[9] Several regional analgesia techniques are used for postoperative pain management following TAPP inguinal hernia surgery.

Table 3. Comparison of the average Numerical Rating Scale scores between groups

	Group M-TAPA (n=30)	Group OSTAP (n=30)	p	Difference in NRS‡	
				Median	95% CI
Static					
1st hour	1 (1–2)	2 (1–2)	***0.008***	***-1***	***-1 to -1***
2nd hour	1 (1–2)	2 (1–2)	***0.009***	***0***	***-1- 0***
4th hour	1 (1–2)	1 (1–2)	*0.193*	*-1*	*-1- 0*
8th hour	1 (1–2)	1 (1–2)	*0.980*	*0*	*-1- 0*
16th hour	1 (1–1)	1 (1–2)	***0.032***	***0***	***-1- 0***
24th hour	1 (1–2)	1 (1–2)	*0.192*	*0*	*-1 -1*
Dynamic					
1st hour	2 (1–2)	2 (2–3)	***0.023***	***0***	***-1- 0***
2nd hour	2 (1–2)	2 (2–3)	***0.032***	***0***	***-1- 0***
4th hour	1 (1–2)	2 (2–2)	*0.080*	*0*	***-1- 0***
8th hour	2 (1–2)	2 (1–2)	*0.338*	*0*	*-1 -1*
16th hour	1 (1–2)	2 (1–2)	*0.084*	*-1*	***-1- 0***
24th hour	2 (1–2)	2 (1–2)	*0.806*	*0*	*-1 -1*

Data are expressed as median (percentiles 25–75). Difference of NRS=NRS of M-TAPA minus NRS of OSTAP; p values were italicized and values that are written in bold represent statistical significance. Wilcoxon rank-sumtest used to compare medians between the groups. ‡: Hodges–Lehman estimator used to calculate 95% CI of the median differences. NRS: Numerical Rating Scale; M-TAPA: Modified Thoracoabdominal Nerves Block Through the Perichondrial Approach; OSTAP: Oblique Subcostal Transversus Abdominis Plane Block; CI: Confidence interval.

Table 4. Comparison of the incidence of side effects and patient satisfaction (Likert) between groups

	M-TAPA (n=30)	OSTAP (n=30)	p
Nausea (Y/N)	5/25	6/24	*0.739*
Vomiting (Y/N)	3/27	4/26	*1*
Itching (Y/N)	4/26	5/25	*0.718*
Likert Scale	7 (6–7)	6 (6–7)	***0.183†***

P value is obtained with Pearson's χ^2 test (n); †: P value is obtained with Mann-Whitney U test median (percentiles 25–75). P values were italicized and values that are written in bold represent statistical significance; Y: Yes; N: No; M-TAPA: Modified Thoracoabdominal Nerves Block Through the Perichondrial Approach; OSTAP: Oblique Subcostal Transversus Abdominis Plane Block.

The thoracoabdominal nerves (T7–T12 and L1) innervate the abdomen. Cutaneous nerve branches enter the transversus abdominis plane (TAP) after separation from the thoracic nerves.[10,11] Therefore, the anterior and lateral branches may be blocked within the TAP. The TAP is located between the transversus abdominis muscle and the internal oblique muscle.[10] Local anesthetic is administered into this area during the M-TAPA block just below the chondrium at the level of the ninth–tenth rib.[6] This costal margin corresponds to the attachment points of three abdominal muscles and represents the origin of the TAP. The internal oblique muscle attaches to the costal cartilage from below, and the transversus abdominis muscle attaches from the inner aspect.[12,13] Injecting local anesthetic between these two muscles, corresponding to the TAP plane, results in consistent spread of the anesthetic. Thus, M-TAPA provides a sensory blockade from T7 to L1. Injection of local anesthetic just below the tenth rib provides multilevel thoracoabdominal blockade through the endothoracic fascia.[14,15] The extensive dermatomal coverage, including T12 and L1, may be related to the cranial needle direction during the M-TAPA block.[15,16]

Aikawa et al.[16] evaluated the dermatomal coverage of the M-TAPA block in patients undergoing gynecological laparoscopic surgery in their prospective observational study. They reported that the T8–T11 dermatomes were the most commonly covered dermatomes both anteriorly and laterally with M-TAPA. Laparoscopic inguinal hernia repair surgery mainly involves lower dermatomal levels between T10 and

L1, particularly in cases with mesh placement, which may be associated with increased pain. In addition, trocar insertion points are generally between T8 and T10 for this surgery. The more the needle is directed cranially during the M-TAPA block, the greater the dermatomal involvement extending to the lower abdomen. This is because local anesthetic administered just below the costal cartilage causes multilevel sensory blockade via the endothoracic fascia.

Ohgoshi et al.[17] conducted a study on the effectiveness of M-TAPA, including anatomical analysis in cadavers and dermatome analysis in healthy volunteers. They dissected the anatomical areas where M-TAPA spread in cadavers and investigated the clinical correlation of this anatomical spread by performing dermatome analysis in healthy volunteers. They emphasized that the space between the endothoracic fascia, diaphragm, and costodiaphragmatic recess observed in cadaver dissections plays a critical role in the mechanism of M-TAPA. They stated that the greater the spread in this area, that is, the more the block needle advances cranially under the rib, the wider the distal area of effect of M-TAPA. They reported that dermatomal coverage in healthy volunteers extended down to T12. We believe that this spread pattern may further increase the distribution of local anesthetic as far as L1 due to increased intraabdominal pressure during laparoscopic surgery.

Bilge et al.[8] compared M-TAPA and OSTAP in patients who underwent laparoscopic cholecystectomy surgery. They reported that M-TAPA was superior to OSTAP in terms of pain scores, opioid consumption, and sensory blockade levels. According to their results, M-TAPA provided extensive dermatomal involvement from T4 to T12/L1. Furthermore, they reported that dermatomal coverage was wider in the midclavicular region than in the midaxillary area. In our study, pain scores in the first two postoperative hours were lower in the M-TAPA group than in the OSTAP group. Alver et al.[18] performed a study in patients who underwent laparoscopic inguinal hernia surgery, comparing M-TAPA with a control group. They reported that the M-TAPA group was superior to the control group in terms of pain scores, opioid consumption, and Quality of Recovery-40 scores at 24 hours postoperatively. In addition, there are studies indicating that the M-TAPA block is effective in laparoscopic cholecystectomy surgery.[19,20] Tanaka et al.[12] conducted a study in open gynecological surgery and performed a cadaveric evaluation of the efficacy of M-TAPA. They reported low pain scores, and anesthetized dermatome levels in patients ranged between T6 and T12, mainly in the innervated anterior branches. According to the results of their cadaveric study, dye spread between T8 and T11. In a cadaveric evaluation performed by Ciftci et al.,[13] dye spread between T4 and T12. In general, results from cadaveric and clinical studies may differ. Tanaka et al.[12] reported that there might be more cranial spread up to T7 due to pneumoperitoneum during laparoscopic surgeries, intraoperative positioning, and increased intraabdominal pressure.[11] Additionally, studies have indicated that M-TAPA provides abdominal dermatomal coverage in both the anterior and lateral abdominal regions.[16,21]

OSTAP is a modification of the oblique subcostal TAP block developed by Hebbard et al.[7] Unlike other TAP block methods, a much longer needle (150–200 mm) and a larger volume of local anesthetic are required.[10] The oblique subcostal line runs from the xiphoid to the anterior part of the iliac crest. The OSTAP block potentially covers the T6–L1 nerves and provides both upper and lower abdominal analgesia. However, OSTAP is technically more challenging than other TAP block techniques.[10] Filling a long fascial plane with a larger volume of local anesthetic using a long needle can be difficult. In our study, we compared the duration of the block procedure between the groups. The duration was significantly shorter in the M-TAPA group (9.3±1.3 min) than in the OSTAP group (15±2.8 min). This finding indicates that the M-TAPA block is easier to perform than the OSTAP block. The advantages of the M-TAPA block compared with the OSTAP block are that it requires a lower volume of local anesthetic and is easier to perform. However, there may be inter-practitioner differences, and further studies are needed.

It has been reported that OSTAP provides effective analgesia after several abdominal surgeries.[22–24] In our study, opioid consumption was low and similar in both the M-TAPA and OSTAP groups. Pain scores were also similar, although scores in the first two postoperative hours were lower in the M-TAPA group. In addition, we used 30 ml of local anesthetic for the blocks. While volumes greater than 30 ml are

often required for the OSTAP block, 30 ml may be sufficient for M-TAPA. The difference in pain scores in the first two hours in our study may therefore be related to this volume difference. Additionally, the Likert patient satisfaction score was higher in the M-TAPA group than in the OSTAP group. This difference may be attributable to lower pain scores in the early postoperative period.

In our study, 30 ml of local anesthetic was administered for both the M-TAPA and OSTAP blocks. NRS scores in the first two postoperative hours were lower in the M-TAPA group, whereas opioid consumption was similar between the groups. Notably, the block procedure duration was longer in the OSTAP group. The M-TAPA block may be preferred over the OSTAP block because a lower volume is sufficient and it is easier to apply.

Another important issue in our study is the use of a relatively high volume of local anesthetic (60 ml of 0.25% bupivacaine, totaling 150 mg) and the importance of discussing the risk of local anesthetic systemic toxicity (LAST). While the total dose of 150 mg of bupivacaine is below the commonly cited maximum single dose of 2 mg/kg (or an absolute maximum of 175 mg), the potential for systemic absorption and toxicity remains an important consideration in any regional anesthesia technique. In this study, all blocks were performed under ultrasound guidance to ensure correct needle placement and to minimize the risk of intravascular injection. Furthermore, no clinical signs or symptoms of LAST, such as neurological or cardiovascular disturbances, were observed in any of the patients postoperatively. Nevertheless, the use of large volumes of local anesthetic remains a point of discussion, and future studies could explore the efficacy of these blocks with lower volumes or concentrations of local anesthetics to further enhance the safety profile.

Limitations

Our study has several limitations. We used a volume of 30 ml for each block. Different results may be achieved with different or larger volumes. The number of participants was also limited. Finally, we did not evaluate the sensory blockade. We only used pain scores and opioid consumption to assess the efficacy of the blocks.

Conclusion

In conclusion, the M-TAPA block provided comparable analgesia to the OSTAP block after laparoscopic inguinal hernia repair surgery. The M-TAPA block may be a useful alternative to the OSTAP block, as it is easy to perform.

Ethics Committee Approval: The İstanbul Medipol Non-Interventional Clinical Research Ethics Committee granted approval for this study (date: 06.07.2022, number: 610).

Clinical Trial Registration: This study was registered at ClinicalTrials.gov (Identifier: NCT05476510).

Informed Consent: Written informed consent was obtained from the participants.

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CASE REPORT

Radiologic and pathologic evaluation for a large schwannoma of the sciatic nerve: A neglected cause of sciatica

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SUMMARY

Schwannomas are benign tumors originating from the peripheral nerve sheath. Although they rarely involve the sciatic nerve, their presence may result in sciatica, a condition characterized by pain radiating along the course of the sciatic nerve from the buttock or gluteal region. Despite being an uncommon cause of sciatica, sciatic nerve schwannomas present diagnostic challenges and management complexities. Their occurrence within the sciatic nerve is frequently overlooked, underscoring the need for accurate diagnosis and individualized therapeutic strategies. Surgical intervention is the primary treatment modality for sciatic nerve schwannomas and is associated with highly favorable outcomes when an appropriate surgical approach is employed. In this report, we present a case of chronic sciatica caused by a large schwannoma. Our aim is to emphasize the critical role of comprehensive imaging techniques and meticulous pathological evaluation in achieving an accurate diagnosis and guiding effective treatment planning in such cases.

Keywords: Buttock pain; neurilemma; neurofibroma; sciatica; ultrasound.

Introduction

Schwannomas, originating from Schwann cells within the peripheral nervous system, are benign tumors.[1] Among adults, they are the most prevalent tumors affecting the peripheral nerve sheath.[2] Sciatica refers to pain radiating through the buttock, posterior thigh, and leg along the course of the sciatic nerve and its branches.[3] Although the sciatic nerve is the largest nerve in the human body, schwannomas arising from this nerve are exceptionally rare and represent an uncommon cause of sciatica.[1,2] The tendency to prioritize more common etiologies of sciatica may hinder the accurate diagnosis and effective management of sciatic nerve schwannomas.[1,3]

To address this diagnostic challenge, ultrasonography has emerged as a pivotal and valuable diagnostic tool, complementing patient history and physical examination.[2,4] In this context, we present a case report of chronic sciatica caused by a large schwannoma, emphasizing the advantages of various imaging modalities in achieving accurate diagnosis and guiding optimal management strategies.

Case Report

A 37-year-old female patient presented with exacerbated right hip pain aggravated by prolonged sitting and standing. The pain originated in the right buttock and radiated down the posterior thigh and calf, extending to the foot. Additionally, the patient reported generalized numbness and tingling throughout the entire foot. These symptoms had persisted for 1–2 years but had intensified notably over the preceding three months. The patient denied any family history of cancer, pre-existing medical conditions, or trauma to the affected area. She had previously received diagnoses of lumbar disc

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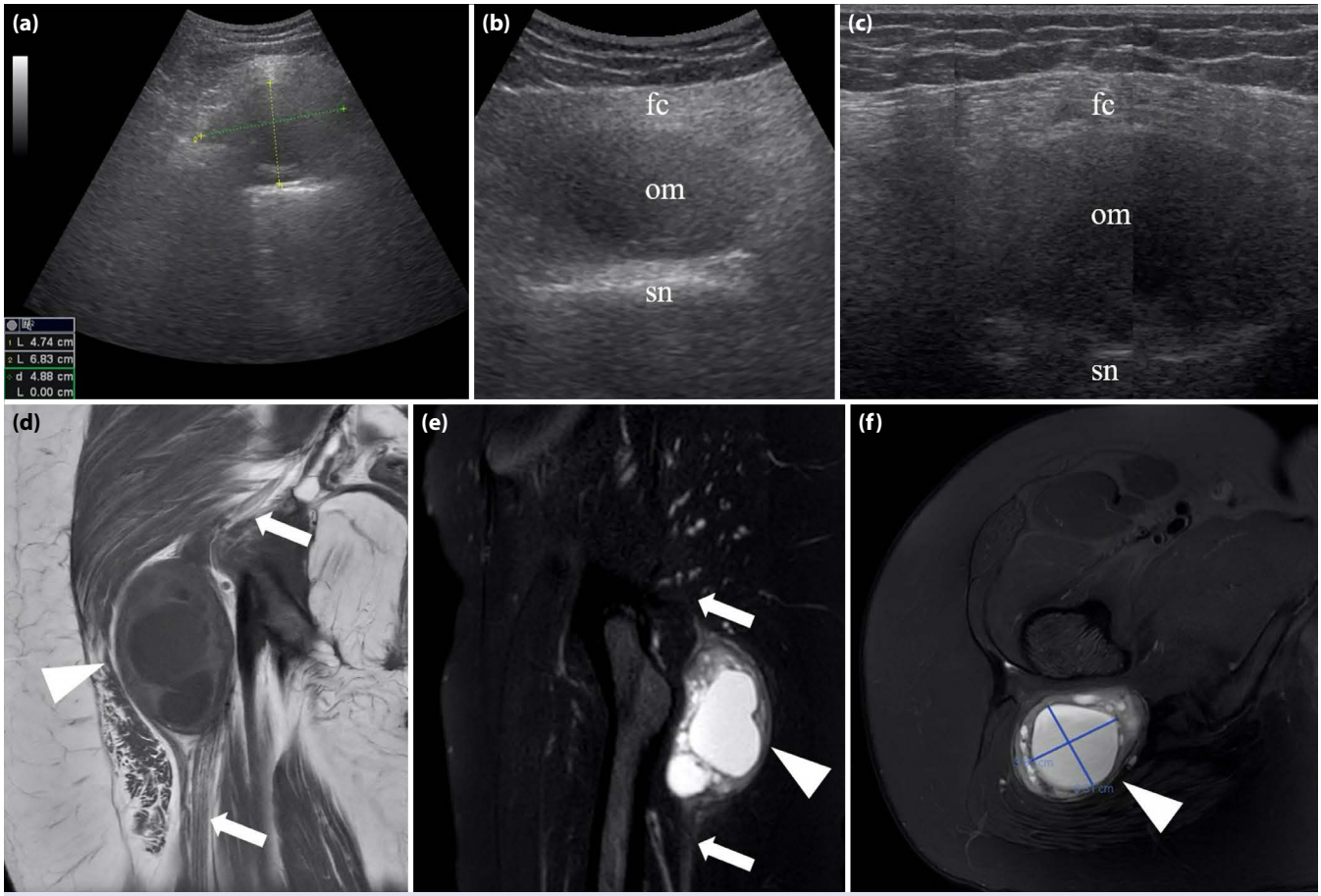

Figure 1. Axial ultrasound imaging with a convex probe **(a, b)** and a linear probe **(c)** demonstrates a hypoechoic oval mass adjacent to the sciatic nerve with its hyperechoic fibrillar capsule. Coronal T1-weighted **(d)**, sagittal T2-weighted **(e)**, axial T2-weighted **(f)** MRI sequences of a well-defined encapsulated peripheral nerve sheath tumor between gluteal and adductor muscles in the posterior upper third of the thigh.

White arrowheads: Schwannoma; White arrows: Sciatic nerve; fc: Fibrous capsule; om: Oval mass; sn: Sciatic nerve.

herniation, myofascial pain syndrome, and piriformis syndrome during earlier medical evaluations. Although she initially responded to nonsteroidal anti-inflammatory drugs (NSAIDs), their efficacy had diminished over time.

On physical examination, pressure applied to the posterolateral region of the right hip elicited pain and paresthesia. Although the Tinel sign was positive, no palpable mass was detected in the affected area. Neurological examination, including assessment of lower extremity range of motion, muscle strength, sensation, and deep tendon reflexes, revealed no significant abnormalities.

Using a convex probe, ultrasonographic evaluation of the right posterior thigh demonstrated an oval cystic mass located adjacent to the sciatic nerve. The well-defined, encapsulated mass measured 4.74 cm×6.83 cm (Fig. 1a, b), showed no significant increase in Doppler signal, and appeared as a hypoechoic encapsulated lesion with a central hypoechoic area. Due to the size of the mass and the anatomical characteristics of the examination region, a linear probe was insufficient for comprehensive evaluation, necessitating acquisition of multiple images to better delineate the encapsulated and well-demarcated structure (Fig. 1c).

Subsequent magnetic resonance imaging (MRI) revealed a 6.8 cm×4.4 cm encapsulated peripheral nerve sheath tumor with a cystic-mucoid component distal to the sciatic notch, located between the gluteal and adductor muscles (Fig. 1d). Diffusion-weighted imaging (Fig. 1e, f) demonstrated mild diffusion restriction in areas excluding the cystic-mucoid component.

An ultrasound-guided biopsy confirmed the diagnosis of schwannoma (Fig. 2). As atypical neurofibro-

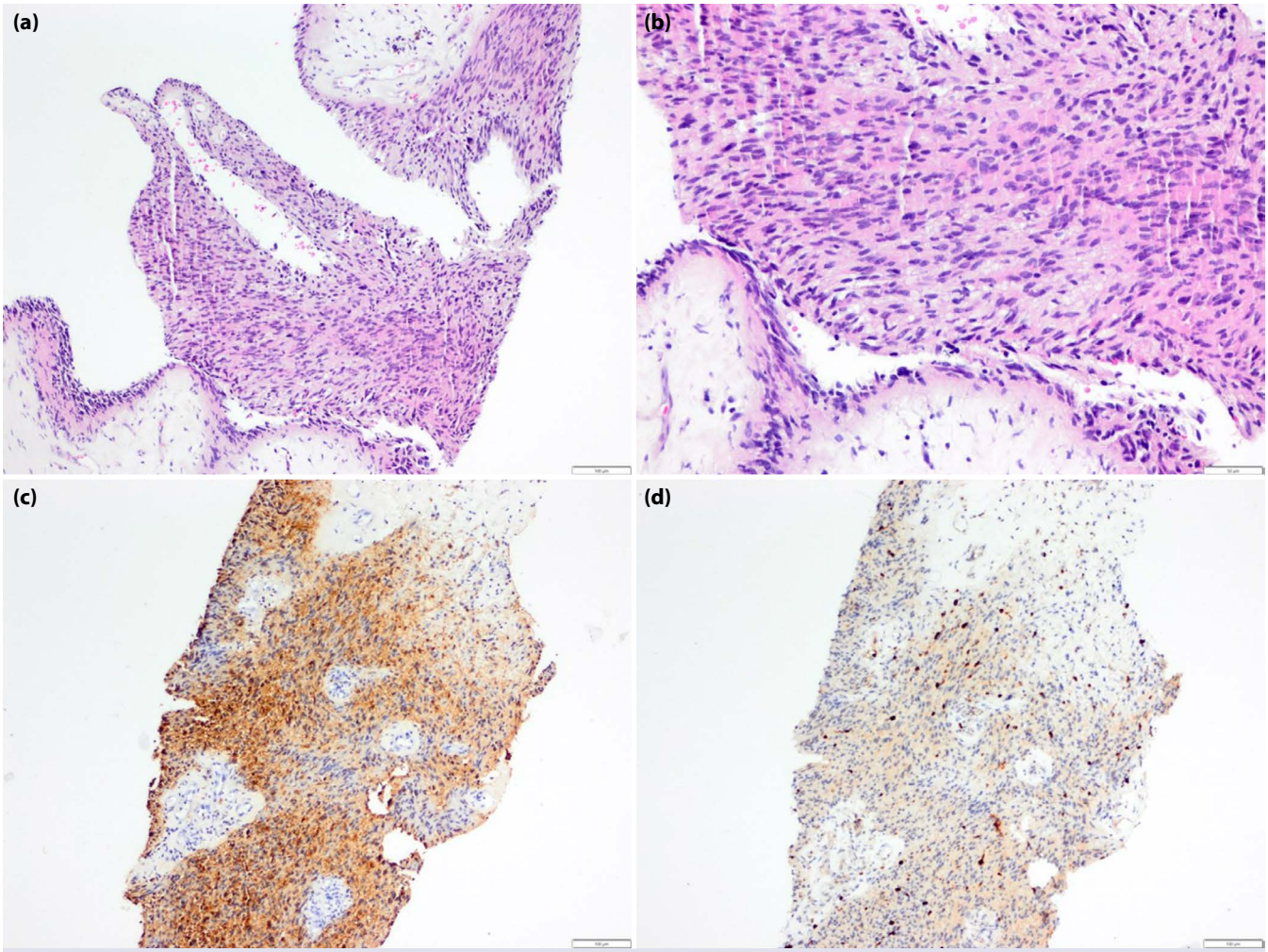

Figure 2. Histopathology showing hypocellular, edematous and cystic areas among hypercellular regions. No necrosis and mitosis are detected. At the top right and in the middle of the picture, Verocay bodies are seen, consisting of two nuclear palisade regions and the nuclear region between them **(a)**. Neoplastic cells have ovoid-spindled nuclei, fine chromatin, eosinophilic and vacuolated cytoplasm. Some of the cells have prominent nucleoli, enlarged and hyperchromatic nuclei **(b)**. Neoplastic cells are diffuse positive with S100 immunohistochemical staining **(c)**. Immunohistochemically, Ki67 proliferation index is up to 5–10% at focal areas **(d)**.

matous neoplasia could not be definitively excluded, conservative excision of the mass was recommended by the pathology department. The patient was subsequently referred to the neurosurgery department for planned surgical excision. Written informed consent was obtained from the patient for publication of this case report and the accompanying images.

Discussion

The differential diagnosis of sciatica includes lumbar disc herniation with nerve compression, degenerative spinal conditions, facet syndrome, spinal tumors, biceps femoris strain or hematoma, sciatic neuritis, piriformis syndrome, pelvic tumors, endometriosis, and peripheral nerve sheath tumors.[1,3,5] In addition, numerous other conditions may present with clinical features similar to sciatica.[3,5] Lumbar disc herniation and degenerative spinal disease are typically the primary considerations in patients presenting with sciatic symptoms.[3] Alongside these common etiologies, piriformis syndrome represents a notable entity that is reported to be both overdiagnosed and underdiagnosed according to different perspectives in the literature.[6,7] This syndrome involves compression of the sciatic nerve and its branches by the piriformis muscle and underscores the importance of ultrasonography in both its diagnosis and management.[8] Ultrasonography not only guides diagnostic injections, which are important in confirming piriformis syndrome, but also facilitates detection of masses exerting pressure on the sciatic nerve or abnormalities within the nerve itself.[9] Moreover, it enables evaluation of the musculature and adjacent tissues in the symptomatic region.[9,10]

In our patient's clinical history, exacerbation of pain during prolonged sitting and the localized origin of pain prompted ultrasonographic evaluation. Identification of a cystic, oval mass adjacent to the sciatic nerve subsequently led to the diagnosis of schwannoma based on its well-defined borders and absence of central necrosis. In contrast to schwannomas, neurofibromas are malignant peripheral nerve sheath tumors characterized by larger size, irregular margins, central necrosis, and infiltrative growth into surrounding tissues.[1,11] Notably, power Doppler ultrasonography is not reliable for differentiating schwannomas from neurofibromas.[2,4]

Magnetic resonance imaging (MRI) is considered the gold standard imaging modality for the diagnosis of schwannomas. These lesions typically appear as well-circumscribed oval masses that are isointense on T1-weighted images (Fig. 1d) and hyperintense on T2-weighted images (Fig. 1e, f), causing expansion along the course of the sciatic nerve.[1] Although MRI provides comprehensive anatomical detail and is valuable for surgical planning, ultrasonography plays a crucial role in alleviating patient concerns regarding diagnosis and facilitating biopsy procedures required for definitive confirmation. Furthermore, intraoperative use of ultrasonography may enhance surgical accuracy and improve clinical outcomes.[1] Despite the relatively large size of the mass in our case, its encapsulated structure, well-defined margins, and absence of central necrosis allowed for a preliminary diagnosis of a benign peripheral nerve sheath tumor. A review of 23 case reports published over the last 15 years indicates that while some sciatic nerve schwannomas may reach sizes of 9, 11, or even 15 cm, most cases typically measure between 3–5 cm.[1] Nevertheless, pathological confirmation remains essential for the definitive diagnosis of peripheral nerve sheath tumors, given the inherent limitations of imaging modalities.[1,12] Although the risk of malignant transformation in schwannomas is low, at approximately 5%, complete surgical excision remains the most appropriate treatment approach for peripheral nerve sheath tumors.[1,2]

The schwannoma in our case was located in the upper one-third of the sciatic nerve, as reported in approximately half of the cases in the literature.[1] Almost all reported cases present with sciatic pain, and our case is consistent with the literature in this respect. While the presence of Tinel's sign is in accordance with previous reports, the absence of a palpable mass—despite the lesion measuring approximately 9cm—distinguishes our case from others.[1] A palpable mass was not detected in cases reported by Kralick et al.[13] (3.5 cm), Haspolat et al.[14] (4 cm), Mansukhani et al.[15] (2.5 cm), Munakomi et al.[16] (3 cm), Guedes et al.[5] (3 cm), and Telera et al.[1] (3 cm). In this regard, the absence of a palpable mass despite the large size of the lesion suggests that sciatic schwannomas may be difficult to diagnose without imaging, even as they increase in size.

Although the duration of symptoms varies widely in the literature, ranging from 1 to 120 months, the onset of symptoms in our patient was consistent with the commonly reported duration of approximately two years.[1] The relationship between tumor size and time to diagnosis remains unclear.[1] For example, the 9 cm mass reported by Godkin et al.[17] was diagnosed within 8 months, whereas the 8.5 cm mass described by Blanchard et al.[18] was diagnosed after 84 months. Factors other than tumor size, such as geographic location, access to healthcare facilities, and diagnostic approaches, likely contribute to these variations.

When sciatic schwannomas reported in the literature are evaluated collectively, it should be noted that Tinel's sign may be absent, a palpable mass may not be detected, and the condition may be confused with a wide range of other diagnoses.[1] The most effective way to overcome these diagnostic challenges is to consider schwannoma in the differential diagnosis and to proceed with ultrasonography as the initial imaging modality, followed by MRI for definitive evaluation. Subsequent pathological examination and surgical excision form the basis of optimal treatment management.[1,2,12]

Discussion

Sciatic nerve schwannomas, although rare, should be considered in cases of persistent, unexplained sciatica. The limitations of physical examination during the diagnostic phase, together with restricted access to advanced imaging modalities such as MRI, underscore the importance of ultrasonographic evaluation as an accessible and valuable diagnostic tool.

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

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CASE REPORT

Complex regional pain syndrome should be aggressively treated as soon as it is diagnosed

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SUMMARY

Complex regional pain syndrome is a chronic pain condition characterized by regional pain without a dermatomal distribution. The primary goal of treatment is to alleviate pain and restore function in the affected limb. Multimodal therapeutic methods are adopted, including stellate ganglion block, with favorable outcomes such as pain score reduction and increased mobility in affected patients. This case presentation aims to describe the importance of early stellate ganglion block in the management of CRPS.

Keywords: Complex regional pain syndrome; stellate ganglion blockage; ultrasound.

Introduction

Complex regional pain syndrome (CRPS) is a chronic pain condition that presents with regional pain without a dermatomal distribution. It is characterized by symptoms of varying severity, including skin changes, autonomic dysfunction, abnormal sensorimotor changes, and trophic changes.[1] There are two subcategories of CRPS: CRPS type I, in which no nerve lesion is present, and CRPS type II, which is characterized by the presence of a coexisting nerve lesion. CRPS type I, which is the more common form, often develops after trauma or surgery.[2–4] The primary goal of treatment is to alleviate pain and restore function in the affected limb. Although the progression of the disease may vary and there is no conclusive evidence that it can be modified through treatment, therapy should not be postponed, as patients with a more chronic course tend to have a poorer prognosis. While conservative treatment may be sufficient for acute CRPS cases, chronic CRPS is recognized as a complex and challenging biopsychosocial syndrome. Managing chronic CRPS necessitates a comprehensive multidisciplinary approach encompassing medical, psychological, physical, and occupational therapies.[5]

In the existing literature, numerous studies have investigated the pharmacological management of CRPS, including the use of nonsteroidal anti-inflammatory drugs, glucocorticoids, bisphosphonates, calcitonin, vitamin C, opioids, anticonvulsants (such as gabapentin and pregabalin), free radical scavengers, and vasoactive mediators. Physical and occupational therapy, either alone or in conjunction with medical therapy, are recognized as initial treatment options for CRPS, with the objective of addressing kinesiophobia. While initiation of physiotherapy in the early stages of the disease has been shown to confer greater benefits, it may also yield positive outcomes in cases of chronic CRPS.[6]

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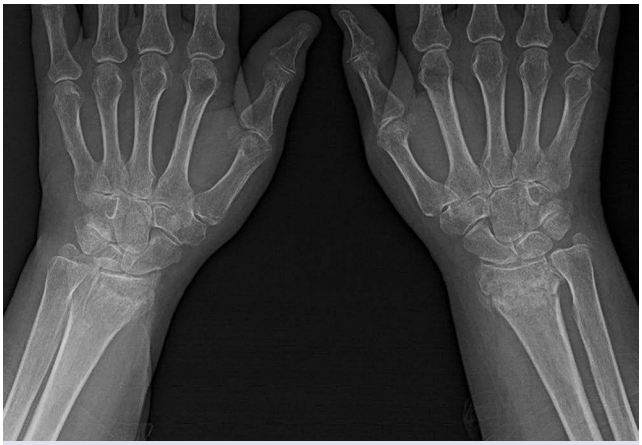

Figure 1. Direct graphy showing healed fracture, patchy osteopeniae and mild soft tissue swelling.

Interventional modalities, such as stellate ganglion block (SGB) for upper extremity CRPS and lumbar sympathetic block (LSB) for lower extremity CRPS, have been shown to yield favorable outcomes. Sympathetic blockade can also be achieved via local anesthetic administration in the epidural space. In addition, spinal cord stimulation and dorsal root ganglion stimulation are viable therapeutic options for CRPS when conservative measures have failed to provide satisfactory results.[7] In this case report, we present the treatment of a patient who developed CRPS following a fracture using a stellate ganglion block.

Case Report

A 57-year-old woman sustained a fracture of the distal radius in her right forearm after slipping on ice. Her arm was immobilized in a cast for six weeks, during which time the fracture healed uneventfully. However, at the end of the six-week period, she began to develop pain in her right hand and wrist. Radiographic evaluation confirmed appropriate fracture healing. When evaluated two months after the initial injury, she complained of widespread pain and swelling in her hand and wrist. Radiographic examination revealed uneven reduction in bone density (osteopenia) and mild soft tissue swelling (Fig. 1).

She had difficulty making a full fist with her right hand, with limited joint extension. Her fingers were flexed at rest. She exhibited increased sensitivity to touch, along with marked temperature sensitivity, perceiving both hot and cold sensations. The most severe pain was elicited by joint compression, particularly in the finger joints. She reported a pain intensity of 7/10 on the VAS, described as sharp,

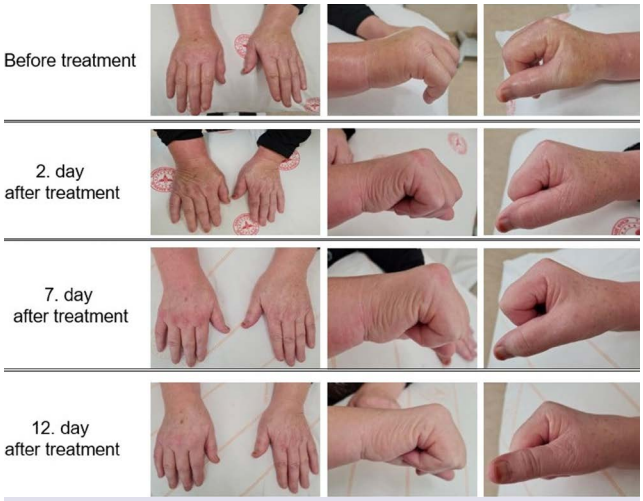

Figure 2. The image showing the recovery process of a patient diagnosed with CRPS before and after treatment. Note that the edema and gloss of the right hand decrease with treatment.

heavy, and shock-like, accompanied by warmth and numbness in the right hand. Laboratory findings were within normal limits, including the CRP level (CRP=0.6 mg/L).

After excluding cellulitis, infection, osteomyelitis, and rheumatic diseases, a diagnosis of CRPS was established. Due to the patient's advanced age and to avoid potential side effects, oral steroid therapy was not considered. The patient was initiated on physical therapy in combination with a stellate ganglion block to alleviate symptoms and prevent disease progression. Marked clinical improvement was observed within two weeks, and hand function normalized (Fig. 2).

The stellate ganglion block was performed as follows. The patient was placed in the supine position with the head slightly turned to the contralateral side of the injection site. The skin over the injection site at the C7 level was prepared with an antiseptic solution. An ultrasound probe was positioned perpendicular to the long axis of the neck at the level of the C7 vertebra. After identification of the thyroid gland, carotid artery, and sternocleidomastoid muscle, the probe was moved laterally to visualize the scalene muscle. Using an in-plane approach, the needle was advanced from lateral to medial at a 45-degree angle, passing through the scalene muscle. The injection was administered into the sympathetic trunk region anterior to the longus colli muscle (Fig. 3). Correct needle placement was confirmed

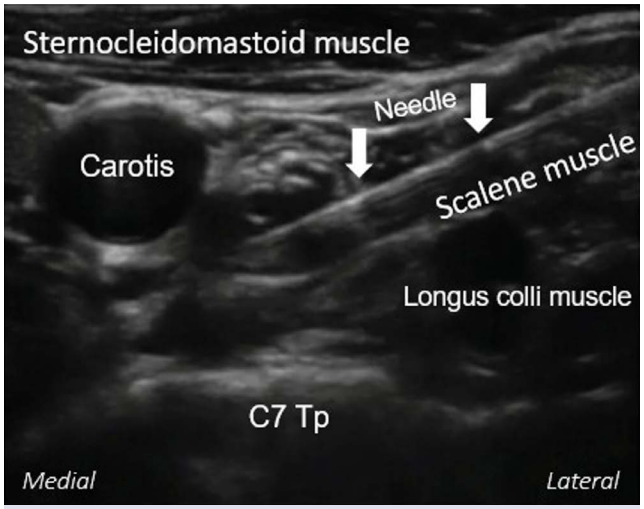

Figure 3. Ultrasound-guided stellate ganglion blockage.

by visualization of local anesthetic spread around the ganglion under real-time ultrasound guidance. Following confirmation, a mixture of local anesthetic and steroid was injected to achieve pain relief and reduce inflammation. The patient was monitored for immediate complications, including respiratory distress or hematoma formation.

Written informed consent was obtained from the patient included in this case for publication of her clinical data.

Discussion

There are several treatment options available for complex regional pain syndrome (CRPS). Treatment modalities include physical therapy; medications such as pain relievers, corticosteroids, and anticonvulsants; sympathetic nerve blocks; graded motor imagery; and cognitive behavioral therapy. New treatments are continuously being developed and evaluated; however, the current level of evidence is generally low to moderate.[8–10] Some of the more recent treatment options for CRPS include the following.

Ketamine is a potent anesthetic and analgesic agent that has been shown to be effective in the treatment of CRPS. It is most commonly administered via intravenous infusion. Ketamine exerts its effects through multiple pathways, with its primary mechanism being noncompetitive antagonism at the phencyclidine-binding site of N-methyl-D-aspartate receptors in the central nervous system. Inhibition of these receptors results in reduced neuronal excitability and pain transmission.[8]

Calmare therapy, also known as scrambler therapy, is a noninvasive technique that uses an external device to stimulate peripheral nerves and reduce pain signals. Theoretically, calmare therapy delivers "non-pain information" to the central nervous system via surface C fibers through electrodes placed in a dermatomal distribution pattern individualized for each treatment session. This process replaces aberrant "pain information" with synthetic "non-pain information."[10]

Virtual reality–based therapies have been explored in patients with CRPS to reduce pain-related anxiety and kinesiophobia and to support graded motor imagery. However, current evidence is derived mainly from small experimental or feasibility studies.[9–11]

Neuromodulation involves the application of electrical or magnetic stimulation to disrupt pain signaling pathways and provide analgesia. These interventions are categorized as noninvasive or invasive and are typically reserved for patients who do not respond adequately to long-term conservative treatments. Invasive neuromodulation techniques include peripheral nerve stimulation, dorsal root ganglion stimulation, spinal cord stimulation, motor cortex stimulation, and deep brain stimulation. The most commonly used noninvasive modalities include transcutaneous electrical nerve stimulation, transcranial direct current stimulation, and repetitive transcranial magnetic stimulation.[11]

Immunomodulation represents another emerging therapeutic strategy. Immunomodulatory agents exert their effects by altering the expression and activity of key inflammatory mediators, including cytokines, neuropeptides, eicosanoids, and amino acids. Given the potential role of inflammation in the pathophysiology of CRPS, immunomodulatory therapies may offer clinical benefit for selected patients.[9]

It should be noted that treatment efficacy varies among individuals, and an optimal management strategy for CRPS often requires a multimodal approach combining several therapeutic modalities. Treatment planning should be individualized and guided by clinical evaluation.

Sympathetic nerve blocks, including stellate ganglion block, are interventional procedures used in the

management of CRPS, sympathetic dystrophy, and posttraumatic stress disorder. These procedures involve injection of a local anesthetic into the stellate ganglion, a sympathetic nerve structure in the cervical region that regulates functions such as vascular tone and pain modulation. By blocking sympathetic outflow to the affected limb, these interventions can reduce pain and improve functional mobility.[11]

Once CRPS is diagnosed, prompt and aggressive treatment is essential. The condition can significantly impair quality of life, contribute to depression, and lead to loss of work capacity due to chronic pain. Therefore, accessible and effective treatment modalities should be implemented in combination. In this report, we emphasized the importance of early intervention in a patient who developed CRPS following a fracture. In conclusion, while the diagnosis of CRPS may be relatively straightforward, its treatment remains challenging. Early and aggressive multimodal management is critical to prevent disease progression. Stellate ganglion block is a valuable therapeutic option that may accelerate recovery, shorten the duration of physical therapy, and facilitate an earlier return to work.

Conclusion

Early diagnosis and prompt initiation of a multimodal treatment approach are essential to prevent the progression of complex regional pain syndrome and to improve functional outcomes. Stellate ganglion block, particularly when integrated early into a multidisciplinary rehabilitation program, appears to be an effective intervention for achieving rapid pain relief and restoring limb mobility.

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: Written informed consent was obtained from the patient included in this case for publication of her clinical data.

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CASE REPORT

A rare cause of back pain in children: Notalgia paresthetica

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SUMMARY

Notalgia paresthetica (NP) is a rare sensory neuropathy and is not a well-known condition. As a result, the diagnosis is often overlooked, and back pain may be the initial presenting symptom. Back pain is a common locomotor system complaint in children. Here, we present a 15-year-old female patient who experienced back pain, itching, and tingling for the past 4 months and was diagnosed with NP. Recognition of NP as a rare cause of back pain in children is important for initiating targeted therapy. Considering NP in the differential diagnosis of children presenting with back pain allows early diagnosis and treatment and helps prevent pain from becoming chronic.

Keywords: Back pain; children; neuropathy; notalgia paresthetica.

Introduction

Notalgia paresthetica (NP) is a sensory neuropathy generally characterized by back pain, hyperpigmentation, pruritus, and paresthesia or hyperesthesia of the skin around the scapula.[1] The disease is progressive and involves periodic episodes of inflammation and remission. It is usually unilateral and may persist for months or even years after onset.[1] A careful medical history and proper physical examination are generally sufficient for diagnosis.[2] NP is primarily a disease of adulthood and is rarely seen in children.[3] Although there is no definitive cure for NP, various treatment options have been reported to alleviate disease-related symptoms. To the best of our knowledge, there are no reported pediatric cases of NP in the literature that are not associated with MEN 2A. The aim of this case presentation is to draw attention to NP as a rare cause of back pain that may also occur in children.

Case Report

A 15-year-old female patient presented with gradually increasing back pain, tingling, and itching in the dorsal region for four months. She had been examined several times by a family physician because of back pain, and an analgesic had been prescribed approximately three months earlier. The patient reported that her pain decreased temporarily after analgesic treatment but subsequently recurred. As her complaints persisted, she was referred to an orthopedist. No pathology was detected on plain radiography or magnetic resonance imaging (MRI), and she was subsequently referred to a physiotherapy clinic. Written informed consent was obtained from the patient.

The patient was right-handed, and the only notable finding in her medical history was carrying a heavy backpack. The pain was localized to the left side and was not accompanied by neck or low back pain. The pain decreased at night and with heat application; however, heat increased the severity of itching. Tingling was present throughout the day, increased at night, and decreased with heat. On physical examination, a unilateral 3×5cm hyperpigmented skin lesion with indistinct borders was observed at the inferomedial border of the left scapula, lateral to the thoracic spine. Cervical and thoracic joint ranges of motion were full, and thoracic kyphosis was mildly

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increased. Except for hypoesthesia in the hyperpigmented area, the neurological examination was normal. Systemic examination findings and laboratory results were within normal limits. Cervical and thoracic radiographs revealed only a slight increase in thoracic kyphosis, and cervical and thoracic MRI findings were normal.

The diagnosis was established following consultation with a dermatologist. Initially, an analgesic (paracetamol 1500 mg/day) and a topical anesthetic (lidocaine pomade) were prescribed. The patient was enrolled in a physiotherapy program that included postural correction exercises, paraspinal muscle strengthening, scapular strengthening, and pectoral muscle stretching exercises. Education on proper techniques for carrying heavy loads was also provided. As the patient's pain did not decrease sufficiently at the follow-up examination after ten days, the analgesic was discontinued and a nonsteroidal anti-inflammatory drug (NSAID) (nimesulide 200mg/day) was initiated.

At the subsequent follow-up visit, her complaints had decreased. Back pain was mild and intermittent, and no medication was required. Continuation of the exercise program was recommended. Dermatological follow-up was advised, as no change was observed in the skin lesion.

Discussion

In this case report, we present a 15-year-old female patient with NP. Her main symptoms were back pain, tingling, and itching in the dorsal region for four months. Although back pain is a common complaint, fewer than 100 cases of NP have been described in the literature.[4] This may be because the disease is not well recognized and is generally considered benign. The interval between symptom onset and diagnosis is often remarkably long, and some patients are not diagnosed until more than 20 years after symptom onset.[5] In our case, this interval was approximately four months.

The diagnosis of NP is usually based on clinical findings.[2–4] Medical history and physical examination constitute the cornerstone of diagnosis, and the associated skin lesion is typically characteristic. Relevant laboratory investigations should be performed to exclude MEN 2A.[6] Imaging modalities such as X-ray, computed tomography, or MRI are not always required for the diagnosis of NP.[2,4] In our patient, although the skin lesion was typical and located in a characteristic region, it had not been previously evaluated by a dermatologist, which likely contributed to a delay in diagnosis. The most frequently reported neurological finding in NP is hypoesthesia localized to the center of the lesion, as observed in our patient.

Treatment of NP is mainly symptomatic unless an underlying cause can be identified and addressed. Appropriate treatment during childhood or adolescence may reduce the risk of pain becoming chronic and persisting into adulthood.[4,7] Identifying and eliminating factors that may predispose children and adolescents to chronic pain later in life is therefore crucial.[4] Topical local anesthetics and capsaicin have been used in the treatment of NP.[8] Topical local anesthetics are thought to exert their effects by stabilizing neural membranes. In more severe cases, paravertebral nerve blockade may be performed and can result in long-term remission.[9] Additionally, topical antipruritic agents as well as topical or intralesional corticosteroids may be beneficial.[10] Paracetamol and NSAIDs can be used for pain management.[11] Physiotherapy also plays an important role in addressing both pain and functional impairment.[12]

Consistent with recommendations in the literature, we successfully treated our patient using simple analgesics (paracetamol and NSAIDs), topical local anesthetics, and a structured physiotherapy program. We conclude that the limited number of NP cases reported in the literature may reflect that NP is an underrecognized medical condition. Diagnosis is frequently delayed, and symptoms may persist for months or even years. Early recognition of NP is essential to initiate appropriate targeted therapy.

Conclusion

Considering NP in the differential diagnosis of children presenting with back pain allows early diagnosis and treatment and prevents the chronification of pain. Early intervention also helps avoid restrictions in activities of daily living, improves quality of life, and prevents unnecessary healthcare costs. Furthermore, patients and their families should be informed about the potential risk of developing MEN 2A in the future.

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: A written informed consent was obtained from the patient and her family.

Conflict of Interest: The author declare that there is no conflict of interest.

Financial Disclosure: The author declared that this study has received no financial support.

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The underdiagnosed issue in anterior hip painful conditions: A myofascial perspective to the sartorius muscle and dry needling protocol

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To the Editor,

One of the causes of anterior hip pain is overuse or injury to the muscles or tendons. Muscles located in front of the hip, including the sartorius, iliopsoas, rectus femoris, and adductor longus muscles, play a role in this issue.[1] Considered one of the longest muscles in the human body, the sartorius originates from the anterior superior iliac spine (ASIS) and inserts into the pes anserine region of the proximal tibia. It plays a role in facilitating both hip and knee flexion.[2] As is known, soft tissue problems such as bursitis, tendinitis, and fasciitis can cause myofascial pain in the muscles, and myofascial trigger points can play a role in the development of osteoarthritis by causing pain and physical function limitation.[3] There are many publications in the literature about pes anserine bursitis, which is characterized by inflammation at the attachment site of the sartorius, gracilis, and semitendinosus muscles and is associated with the overuse of these muscles.[4] However, in our literature review, we did not find any publication specifically addressing myofascial pain occurring in the more proximal region of the sartorius muscle. Considering all these factors, we think that myofascial evaluation of the sartorius muscle may be ignored in individuals presenting with anterior hip pain.

Myofascial pain syndrome is characterized by the presence of a nodule in the muscle fibers that is painful when pressed or spontaneously, causing both local and referred pain. When evaluating patients, it is imperative to consider that myofascial pain syndrome is a significant contributor to musculoskeletal pain and requires the development of a targeted treatment approach. In the treatment of myofascial pain syndrome, non-invasive treatment methods such as manual therapy, ultrasound, laser therapy, transcutaneous electrical stimulation, as well as invasive treatment methods such as dry needling, local anesthetic injections, and botulinum toxin applications are used.[5]

The myofascial trigger point of the sartorius muscle can cause referred pain along the muscle and medial to the knee (Fig. 1a). When these trigger points are treated, a dramatic improvement in the patient's pain complaint can be observed. Dry needling, one of the treatment methods, is performed in the supine position. Considering the superficial anatomical structure of this muscle, dry needling should be performed with a 0.14x15 mm sterile acupuncture needle. The needle should be inserted parallel to the skin from lateral to craniomedial direction using the pincer palpation technique (Fig. 1b).

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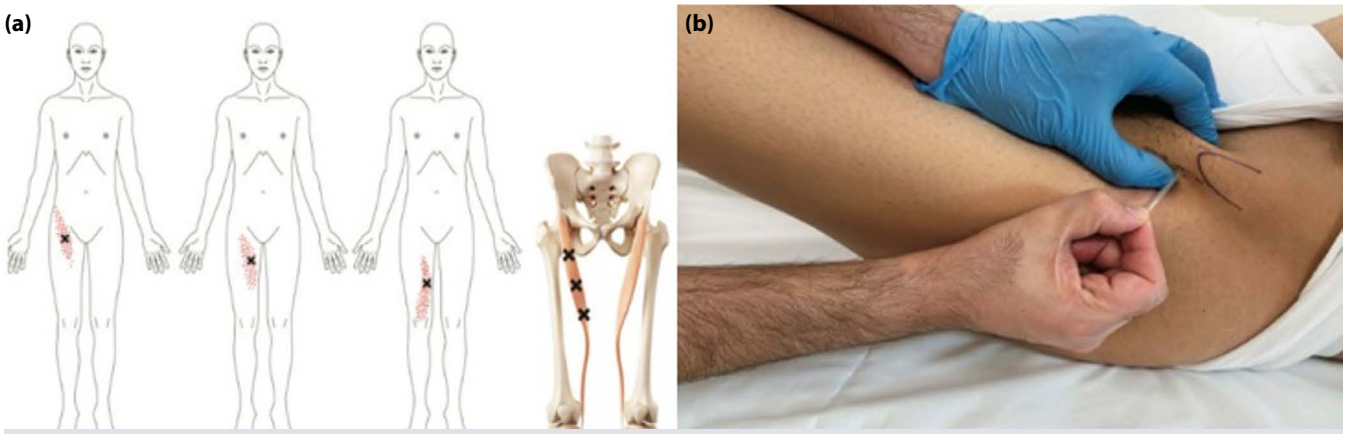

Figure 1. (a) Referred pain area of sartorius muscles trigger point, **(b)** dry needling technique with pincer palpation.

The purpose of this article is to draw attention to the fact that although the sartorius muscle is often associated with pes anserine bursitis in the literature, myofascial pain arising from the trigger point of this muscle can cause pain in the anterior part of the hip. In the differential diagnosis of a patient presenting with anterior hip pain, myofascial pain of the sartorius muscle should be taken into consideration, as well as joint and extra-articular causes. Applying dry needling therapy to trigger points of the sartorius muscle may be therapeutic in these patients.

Informed Consent: Written informed consents were obtained from patients who participated in this study.

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The role of interfascial plane blocks in chronic pain treatment: A brief report of three cases

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To the Editor,

Nowadays, chronic pain is a significant problem that affects the majority of society.[1] Ultrasound (US)-guided nerve block techniques are an essential component of the multimodal approach to chronic pain management. US-guided fascial plane blocks have gained popularity in daily anesthesia and pain medicine practice. They may be performed for chronic pain management alone or as an adjuvant to a multimodal approach. The fascial system in the body may have an important role in the development of chronic pain. As it contains numerous mechano- and chemoreceptors, the interfascial planes participate in the regulation of force transmission, sensory functions, and wound healing. Dysfunctions in proprioception, myofascial pain, and muscle cramps are related to the deep fascia because of this extensive receptor network within the fascial system.[2] For these reasons, fascia may play an important role in chronic pain. Administration of local anesthetic into fascial planes may affect free nerve endings, and hydrodissection of these planes may release adhesions, thereby relieving chronic pain. Adhesions play an important role in the development of chronic pain.[3] Activation of mechanoreceptors and proprioceptors within the fascia and fascial planes, as well as the connective septa of adhesions, may alter fascial sliding. Opening the fascial plane with local anesthetic facilitates the spread of the solution by disrupting adhesions and connective septa.[4,5] In chronic pain, multiple fascial changes and adhesions are present within fascial planes; therefore, fascia may represent a key target in chronic pain management. Based on this information in the literature, we performed several fascial plane blocks in patients with chronic pain in our pain medicine department. In this report, we share our successful experiences with fascial plane blocks in patients with chronic pain.

Written informed consent was obtained from the patients for the procedures and for publication. Patient 1 was a 32-year-old male (173 cm, 91 kg) with left-sided abdominal and sternal pain who was referred to our pain medicine department. His pain extended from the sternum, nipple, epigastrium, and arcus costarum to the mid-axillary line and the umbilicus. He had experienced pain for three years. We decided to perform a pecto-intercostal fascial plane block (PIFPB) and a modified thoracoabdominal nerve block through a perichondrial approach (M-TAPA). Under sterile conditions, we used a high-frequency (11–12 MHz) linear transducer (B. Braun, Philips, Xperius, USA) and a 22G, 100 mm needle (Stimuplex® Ultra 360®, B. Braun, USA). Following infiltration of the skin with 2 ml of 2% lidocaine, PIFPB was performed in the fascial plane between the pectoralis major and internal intercostal muscles at the level of the fourth intercostal space. Subsequently, M-TAPA was performed between the internal oblique and transversus abdominis

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Table 1. The demographic data, pain scores, interventions, and the volume used for the blocks of the patients

Patient	Gender	Age	Height/weight	Block	Content of local anesthetic	Volume	NRS
1	Male	32	173 cm, 91 kg	PIFPB + M-TAPA	10 ml of 0.5% bupivacaine, 4 mg dexamethasone, and 9 ml of isotonic solution	Totally 40 ml	9→1
2	Female	45	160 cm, 78 kg	PIFPB + M-TAPA	10 ml of 0.5% bupivacaine, 4 mg dexamethasone, and 9 ml of isotonic solution	Totally 40 ml	9→2
3	Male	42	171 cm, 95 kg	TTMPB	10 ml of 0.5% bupivacaine, 4 mg dexamethasone, and 9 ml of isotonic solution	Totally 40 ml	10→2

Cm: Centimeter; kg: Kilogram; PIFPB: Pectointercostal fascial plane block; M-TAPA: Modified thoracoabdominal nerves block through perichondrial approach; TTMPB: Transverse thoracic muscle plane block; mg: Milligram; ml: Milliliter; NRS: Numerical Rating Scale.

muscles at the level of the costal margin. A total of 20 ml of local anesthetic solution was used for each block, consisting of 10 ml of 0.5% bupivacaine, 4 mg dexamethasone, and 9 ml isotonic solution (total volume 40 ml). The patient's Numerical Rating Scale (NRS) score was 9 before the procedure and decreased to 1 at 45 minutes after the intervention. Oral dexketoprofen 25 mg twice daily was prescribed. The patient was followed for three months, during which no additional analgesic medication or invasive intervention was required.

Patient 2 was a 45-year-old female patient (160 cm, 78 kg) with left-sided thoracoabdominal pain. Her pain was localized to the left side of the sternum, within the T4–T7 parasternal intercostal space. In addition, she reported pain around the left epigastric region and along the arcus costarum line. She had experienced pain for two years. We decided to perform PIFPB and M-TAPA. The blocks were performed in the same manner as described for Patient 1, using the same volumes (20 ml+20 ml). Her NRS score was 9 before the procedure and decreased to 2 at 45 minutes after the intervention. She was prescribed oral dexketoprofen 25 mg every 8 hours and thiocolchicoside 8 mg. The patient was followed for three months, during which no additional analgesic medication or invasive intervention was required.

Patient 3 was a 42-year-old male patient (171 cm, 95 kg) presenting with angina-like chest pain. A stent had been placed in the left anterior descending artery 1.5 years earlier. He had undergone coronary angiography three times within the past year because of persistent chest pain; however, no abnormalities were detected in the coronary vessels. He was referred to our pain medicine department due to refractory and persistent chest pain. We decided to perform a transverse thoracic muscle plane block (TTMPB). The transverse thoracic muscle, internal thoracic artery, and veins were identified, and bilateral TTMPB was performed between the transverse thoracic and intercostal muscles. A total of 20 ml of local anesthetic solution was administered on each side (total volume 40ml). His NRS score was 10 before the procedure and decreased to 2 at 45 minutes after the intervention. He was prescribed oral paracetamol 1 g twice daily. The patient was followed for six months, during which no additional analgesic medication or invasive intervention was required. The demographic data, pain scores, interventions, and volumes used for the blocks are presented in Table 1.

There is growing evidence supporting the use of fascial plane blocks with local anesthetics and corticosteroids as part of a multimodal approach to chronic pain management. The anatomy and content of fascial planes play an important role in the mechanisms underlying chronic pain syndromes. Fascial plane blocks have a key role in releasing interfascial adhesions and are therefore recommended in chronic pain management. In our patients, we performed relatively novel blocks, including PIFPB, M-TAPA, and TTMPB. To the best of our knowledge, there are currently no reports describing the use of these fascial plane blocks in the management of chronic pain. Long-term follow-up revealed no

need for additional analgesic medication. Based on our experience, fascial plane blocks may be used effectively in the management of chronic pain.

Informed Consent: Written informed consent was obtained from the patients for the procedures and for publication.

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Peer-rewiew: Externally peer-reviewed.

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