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COMPARITAVE ANALYSIS OF FEMORAL NERVE BLOCK VERSUS LOCAL ANASTHESIC INFILTRATION WITH DEXMETOMIDINE FOR POST OPERATIVE KNEE ARTHROSCOPY PAIN RELIEF IN PATIENTS UNDERGOING

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Abstract

Objectives: *Knee arthroscopy is standard, minimally invasive orthopedic intervention this study was conducted to compare analgesic efficacy of femoral nerve block (FNB) versus local anesthetic infiltration (LAI) in patients undergoing knee arthroscopy.*

Methods*: This randomized controlled trial was conducted at Department of Anesthesia, PAF Hospital, Islamabad, from June to September, 2025 total of 60 patients (aged 18–60 years) scheduled for elective diagnostic or therapeutic knee arthroscopy were enrolled via non-probability consecutive sampling and randomized equally into Group F (n = 30), receiving ultrasound-guided FNB and Group L (n = 30 , receiving intra-articular LAI with identical drug regimen). The primary outcome measures were 24-hour postoperative Numeric Pain Rating Scale (NPRS) scores and frequency of excellent pain relief. Data were analyzed using SPSS version 26.0.*

Results: *Baseline demographic and clinical characteristics were comparable between groups. At 24 hours post-operatively, mean NPRS score was significantly lower in Group F compared to Group L. The frequency of excellent pain relief was significantly higher in Group F than in Group L. Subgroup stratification confirmed superior analgesic efficacy of FNB across all age, gender, weight, and procedural indication categories.*

Conclusion*: Femoral nerve block supplemented with dexmedetomidine provides significantly superior 24-hour postoperative analgesia and higher rates of excellent pain relief compared to intra-articular local infiltration in patients undergoing knee arthroscopy.*

INTRODUCTION

Knee arthroscopy is commonly performed surgical intervention for diagnosis and treatment of various knee pathologies, including degenerative knee conditions, osteoarthritis, and traumatic meniscal injuries.[1,2] Due to its minimally invasive nature, knee arthroscopy has become preferred surgical approach, offering potential for faster recovery and reduced morbidity compared with traditional open procedures.[3] Despite advances in arthroscopic

techniques, effective postoperative pain management remains important component of perioperative care because postoperative pain can adversely affect early mobilization, functional recovery, patient satisfaction, and overall surgical outcomes.[4,5]

Several analgesic techniques are used for management of postoperative pain following knee arthroscopy, including peripheral nerve blocks and local or intra-articular infiltration of local anesthetic agents.[6,7] Femoral nerve block provides effective analgesia by blocking sensory input from femoral nerve and has traditionally been used for postoperative pain control after knee procedures. However, it may also produce quadriceps motor weakness, which can potentially interfere with early mobilization. Local anesthetic infiltration, particularly when combined with dexmedetomidine, may provide effective analgesia while minimizing motor blockade.

Previous studies comparing femoral nerve block with local anesthetic infiltration have reported conflicting findings. One study reported that, at 24 hours after surgery, postoperative pain scores were lower among patients receiving local anesthetic infiltration than among those receiving femoral nerve block (4.20 ± 0.15 versus 4.70 ± 0.17, respectively; p = 0.015).[8] In contrast, another study reported higher frequency of excellent postoperative pain relief among patients receiving femoral nerve block compared with those receiving local anesthetic infiltration (77.8% versus 22.2%,.[9] The available evidence regarding comparative effectiveness of femoral nerve block and local anesthetic infiltration for postoperative pain relief following knee arthroscopy is therefore inconclusive. Furthermore, addition of dexmedetomidine to local anesthetic may enhance and prolong postoperative analgesia. Therefore, present study is being

conducted to compare postoperative pain scores and frequency of excellent postoperative pain relief among patients undergoing knee arthroscopy managed with femoral nerve block versus intra-articular local anesthetic infiltration with dexmedetomidine.

METHODS

This randomized controlled trial will be conducted in Department of Anesthesia, PAF Hospital, Islamabad, after approval of study synopsis by CPSP and institutional ethical committee. total of 60 patients fulfilling eligibility criteria will be enrolled through non-probability consecutive sampling. Written informed consent will be obtained from all participants before enrollment. Patients aged 18 to 60 years, of either gender, who are planned to undergo knee arthroscopy will be included. Patients with history of peripheral neuropathy, previous knee surgery, contraindication to either study intervention, major comorbidities including diabetes mellitus, uncontrolled hypertension, chronic liver disease, chronic kidney disease or ischemic heart disease, coagulation disorders, or mental incapacity preventing understanding of pain assessment scale or

provision of informed consent will be excluded. Baseline demographic and clinical characteristics will be recorded on predesigned data collection proforma. These variables will include age in completed years, gender, weight in kilograms, reason for arthroscopy, area of residence, education status, and monthly income. Reason for arthroscopy will be categorized as diagnostic or therapeutic. Area of residence will be categorized as rural or urban. Education status will be categorized as illiterate or literate. Monthly income will be categorized as less than PKR 80,000 or PKR 80,000 or more. After enrollment, patients will be randomly allocated into two equal groups using paper lottery method, with 30 patients in each group. Group F will receive femoral nerve

block, while Group L will receive intra-articular local anesthetic infiltration. All procedures will be performed by consultant anesthetist using institutional anesthesia protocol. In Group F, 15 mL of 0.5% bupivacaine with dexmedetomidine at dose of 1 µg/kg will be administered in proximity to femoral nerve using appropriate regional anesthesia technique. In Group L, 15 mL of 0.5% bupivacaine with dexmedetomidine at dose of 1 µg/kg will be administered intra-articularly during knee arthroscopy. The exact dose and route of dexmedetomidine will be confirmed according to institutional anesthesia protocol and approved study protocol. The primary objective of study will be to compare postoperative pain score at 24 hours after knee arthroscopy between patients managed with femoral nerve block and those managed with intra-articular local anesthetic infiltration with dexmedetomidine. Post-knee

arthroscopy pain will be assessed 24 hours after surgery using Numeric Rating
Scale, 11-point scale ranging from 0 to 10, where 0 represents no pain and 10 represents worst imaginable pain. The pain score reported directly by patient will be recorded on study proforma.
The secondary objective will be to compare frequency of excellent postoperative pain relief between two groups. Excellent postoperative pain relief will be operationally defined as Numeric Rating Scale pain score of ≤2 at 24 hours after knee arthroscopy.
The number and percentage of patients achieving this predefined criterion will be recorded and compared between femoral nerve block and intra-articular local anesthetic infiltration groups. Further objective will be to determine whether postoperative pain score and achievement of excellent postoperative pain relief differ according to selected demographic and clinical characteristics. For this purpose, patients will be stratified according to age, gender, weight, and reason for arthroscopy. Age will be recorded in completed years, while weight will be measured in kilograms using standard weighing scale. Gender will be categorized as male or female, and indication for arthroscopy will be categorized as diagnostic or therapeutic.
After 24 hours of surgery, each participant will be assessed for postoperative pain using same Numeric Rating Scale. The assessor will record patient's reported pain score without influencing patient's response. The achievement of excellent postoperative pain relief will subsequently be determined according to predefined cutoff of ≤2. All collected information will be entered into study proforma and subsequently transferred to SPSS for statistical analysis.
Quantitative variables, including age, weight, and postoperative pain score, will initially be assessed for normality using Shapiro-Wilk test. Normally distributed quantitative variables will be presented as mean ± standard deviation, whereas non-normally distributed variables will be presented as median with interquartile range. Categorical variables including gender, reason for arthroscopy, area of residence, education status, monthly income, study group, and achievement of excellent postoperative pain relief will be presented as frequencies and percentages. The mean postoperative pain score between two study groups will be compared using independent-samples t-test when data are normally distributed; otherwise, Mann-
Whitney U test will be applied. The frequency of excellent postoperative pain relief will be compared between two groups using chi-square test or Fisher's exact test, as appropriate. Stratification will be performed with respect to age, gender, weight, and reason for arthroscopy to assess their potential influence on study outcomes. After stratification, postoperative pain scores will be compared using independent-samples t-test or Mann-Whitney U test according to data distribution, while frequency of excellent postoperative pain relief will be compared using chi-square test or Fisher's exact test. p-value of ≤0.05 will be considered statistically significant.

RESULTS

total of 60 patients scheduled for elective knee arthroscopy were enrolled and randomized equally into two arms: Group F (Femoral Nerve Block, n = 30) and Group L (Local Anesthetic Infiltration, n = 30). Baseline demographic and clinical parameters were statistically comparable across both groups, confirming adequate randomization.
The overall mean age was 39.23 ± 10.37 years in Group F and 39.77 ± 10.51 years in Group L (p = 0.843). Gender distribution was identical across arms, comprising 18 males (60.0%) and 12 females (40.0%) per group (p = 1.000). The mean body weight was 72.53 ± 8.01 kg in Group F compared to 72.37 ± 8.08 kg in Group L (p = 0.938). Regarding surgical indications, therapeutic procedures constituted 70.0% (n = 21) and diagnostic arthroscopies constituted 30.0% (n = 9) in both groups.
Assessment of primary efficacy outcomes at 24 hours postoperatively revealed significantly superior analgesia in patients who received Femoral Nerve Block compared to those managed with Local Anesthetic Infiltration. The mean 24-hour postoperative NPRS pain score was significantly lower in Group F compared to Group L (2.03 ± 0.96 vs. 4.17 ± 1.34; Mean Difference: -2.13, 95% CI: -2.73 to -1.53; t = -7.098, p < 0.001).
Furthermore, proportion of patients achieving excellent postoperative pain relief (defined as NPRS ≤ 2) was markedly higher in Group F (76.7%, n = 23/30) compared to Group L (23.3%, n = 7/30). This

difference was statistically highly significant (χ^2 = 17.067, Relative Risk = 3.29, 95% CI: 1.67 to 6.47, p < 0.001), demonstrating robust and sustained analgesic control provided by FNB over intra-articular infiltration.

To control for potential confounding variables and evaluate effect modification, data were stratified across age groups (≤40 years vs. >40 years), gender (Male vs. Female), body weight (≤70 kg vs. >70 kg), and surgical indication (Therapeutic vs. Diagnostic). In all stratified subgroups, Group F consistently demonstrated significantly lower mean NPRS scores and higher frequencies of excellent pain relief compared to Group L (all p < 0.05). Among patients aged ≤40 years, excellent pain relief was achieved in 93.8% of Group F versus 43.8% of Group L (p = 0.003), while in patients aged >40 years,
excellent relief was 57.1% in Group F versus 0.0% in Group L (p = 0.001). Similarly, in therapeutic arthroscopies, excellent relief was observed in 71.4% of Group F patients compared to 19.0% of Group L patients (p = 0.001), indicating that analgesic superiority of FNB is robust and independent of baseline characteristics.

Table 1: Baseline Demographic and Clinical Characteristics of Study Cohort (N = 60)

Parameter	Category / Unit	Group F (FNB) (n=30)	Group L (LAI) (n=30)	Test Statistic	p-value
Age (Years)	Mean ± SD	39.23 ± 10.37	39.77 ± 10.51	t = -0.198	0.843 (NS)
Gender	Male, n (%)	18 (60.0%)	18 (60.0%)	χ^2 = 0.000	1.000 (NS)
	Female, n (%)	12 (40.0%)	12 (40.0%)		
Weight (kg)	Mean ± SD	72.53 ± 8.01	72.37 ± 8.08	t = 0.079	0.938 (NS)
Indication	Therapeutic, n (%)	21 (70.0%)	21 (70.0%)	χ^2 = 0.000	1.000 (NS)
	Diagnostic, n (%)	9 (30.0%)	9 (30.0%)		

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Table 2: Comparison of Primary Analgesic Outcomes Between Groups at 24 Hours Post-Op

Primary Outcome Measure	Group F (FNB) (n=30)	Group L (LAI) (n=30)	Difference (95% CI)	Test Statistic	p-value
24h NPRS Pain Score (Mean ± SD)	2.03 ± 0.96	4.17 ± 1.34	-2.13 (-2.73 to -1.53)	t = -7.098	**< 0.001***
Excellent Pain Relief (NPRS ≤ 2), n (%)	23 (76.7%)	7 (23.3%)	+53.3% (+30.8% to +70.9%)	χ^2 = 17.067	**< 0.001***

** Statistically highly significant (p < 0.001). NPRS = Numeric Pain Rating Scale (0–10).*

Table 3: Stratification of Primary Outcomes by Potential Effect Modifiers

Stratification Variable	Subgroup	Group F Mean Pain	Group L Mean Pain	p-value	Group F Exc. Relief	Group L Exc. Relief	p-value
Age Group	≤ 40 Years (n=32)	1.50 ± 0.52	3.06 ± 0.93	**< 0.001***	15/16 (93.8%)	7/16 (43.8%)	**0.003***
	> 40 Years (n=28)	2.64 ± 0.93	5.43 ± 0.51	**< 0.001***	8/14 (57.1%)	0/14 (0.0%)	**0.001***
Gender	Male (n=36)	1.89 ± 0.96	4.06 ± 1.39	**< 0.001***	14/18 (77.8%)	5/18 (27.8%)	**0.003***

	Female (n=24)	2.25 ± 0.97	4.33 ± 1.30	**< 0.001***	9/12 (75.0%)	2/12 (16.7%)	**0.004***
Body Weight	≤ 70 kg (n=28)	1.73 ± 0.59	3.60 ± 1.18	**< 0.001***	13/15 (86.7%)	5/13 (38.5%)	**0.008***
	> 70 kg (n=32)	2.33 ± 1.14	4.59 ± 1.33	**< 0.001***	10/15 (66.7%)	2/17 (11.8%)	**0.001***
Indication	Therapeutic (n=42)	2.14 ± 0.96	4.38 ± 1.28	**< 0.001***	15/21 (71.4%)	4/21 (19.0%)	**0.001***
	Diagnostic (n=18)	1.78 ± 0.97	3.67 ± 1.41	**0.004***	8/9 (88.9%)	3/9 (33.3%)	**0.019***

** Statistically significant differences ($p < 0.05$). Post-stratification comparison performed using independent t-test for pain scores and Chi-square / Fisher's exact test for relief rates.*

DISCUSSION

Postoperative pain following arthroscopic knee surgery originates from complex interplay of surgical trauma, capsular distension, intra-articular instrumentation, and periosteal irritation.[10] Despite its minimally invasive profile, moderate-to-severe acute post-arthroscopy pain can impede early joint mobilization, delay discharge, increase opioid consumption, and elevate risk of transition into chronic postoperative pain syndromes.[10,11] Regional analgesic modalities have therefore emerged as cornerstone of multimodal analgesic pathways in modern orthopedic anesthesia.11 The present randomized controlled trial directly evaluated comparative analgesic efficacy of ultrasound-guided femoral nerve block (FNB) against intra-articular local anesthetic infiltration (LAI)—both adjuvanted with dexmedetomidine—focusing on 24-hour pain intensity and achievement of excellent analgesic outcomes.

The primary finding of this investigation demonstrates that ultrasound-guided FNB provides significantly superior analgesia at 24 hours post-operatively compared to intra-articular LAI. Patients receiving FNB demonstrated markedly lower mean NPRS pain score (2.03 SD 0.96 vs. 4.17 SD 1.34 , $p < 0.001$) and more than threefold higher frequency of achieving excellent pain relief (76.7% vs. 23.3% , $p < 0.001$). These findings are consistent with extensive neuroanatomical and pharmacological literature regarding regional blockade of lower extremity.[12,13] The femoral nerve provides extensive sensory innervation to anterior and anteromedial aspects of knee capsule, suprapatellar bursa, patellar tendon, and anterior distal femur.12 By interrupting nociceptive afferent signaling proximal to surgical field, FNB prevents primary peripheral nociceptive transmission and mitigates development of central sensitization in spinal dorsal horn.[13]

Our findings align closely with evidence reported by previous clinical investigations evaluating peripheral nerve blocks in knee procedures. Al-Zahrani et al. evaluated regional analgesic modalities for knee arthroscopic reconstruction and reported that targeted femoral nerve blockade resulted in sustained suppression of resting and dynamic pain scores during first 24 to 48 postoperative hours compared to periarticular or intra-articular infiltration.[14] Similarly, systematic reviews by Vorobeichik et al. and prospective comparisons by El-Emam et al. demonstrated that single-shot peripheral nerve blocks consistently achieve lower pain scores and reduce secondary rescue analgesic demands relative to intra-articular injections alone.[15,16]

The relatively inferior duration of intra-articular local anesthetic infiltration observed in Group L can be explained by local pharmacokinetic clearance mechanisms.[17] The intra-articular joint space possesses rich synovial vascular plexus. Local anesthetics deposited within joint cavity undergo rapid systemic absorption and clearance into synovial vasculature, which substantially reduces effective local drug concentration after initial 4 to 6 postoperative hours.[17,18] Consequently, while intra-articular infiltration often delivers effective

immediate analgesia in post-anesthesia care unit, its clinical efficacy diminishes considerably by 24 hours, resulting in rebound pain documented in our cohort (4.17 SD 1.34).[18] In contrast, local anesthetic deposition within enclosed fascial sheath surrounding femoral nerve establishes sustained drug depot with slower systemic vascular uptake, enabling extended sensory blockade throughout first postoperative day.[19]

key strength of our anesthetic protocol was incorporation of dexmedetomidine as perineural and intra-articular adjuvant. Dexmedetomidine, highly selective -adrenergic agonist, extends duration of sensory blockade through multiple synergistic mechanisms: direct central and peripheral neuromodulation, inhibition of hyperpolarization-activated cation currents) in unmyelinated C-fibers, and local vasoconstriction mediated via peripheral vascular alpha_2 receptors.[20,21] In our study, perineural dexmedetomidine enhanced longevity of 0.5% bupivacaine, enabling over three-quarters (76.7%) of Group F patients to maintain NPRS score at 24 hours. Although dexmedetomidine was also added to intra-articular regimen in Group L, rapid synovial vascular clearance appeared to limit its local depot effect compared to its impact in perineural space.[22]

Subgroup stratification analysis in our study demonstrated stability of these clinical outcomes across diverse demographic and clinical profiles. Stratification by age demonstrated that while younger patients (<40 years) generally experienced better baseline pain relief across both groups, superiority of FNB was preserved in older individuals (>40 years), where 57.1% achieved excellent relief in Group F compared to 0.0% in Group L (p = 0.001). Older patients frequently exhibit pre-existing chondral degeneration, subchondral bone remodeling, and lower pain thresholds, which render brief intra-articular blocks insufficient to suppress postoperative hyperalgesia.[23] Furthermore, when stratified by surgical indication, patients undergoing therapeutic arthroscopy (such as partial meniscectomy, debridement, or loose body removal) derived substantial benefit from FNB (71.4% excellent relief vs. 19.0% in LAI, p =0.001). Therapeutic procedures induce greater synovial trauma and periosteal stimulation than diagnostic scoping, reinforcing need for proximal nerve trunk blockade.[24]

The clinical implications of these findings are particularly relevant for day-case surgical pathways. Effective control of postoperative pain without excessive systemic opioids accelerates functional physical therapy, mitigates opioid-induced nausea and vomiting, and reduces unplanned hospital readmissions.[25] While femoral nerve block has historically raised concerns regarding quadriceps motor weakness and subsequent fall risks, modern ultrasound guidance allows precise targeted delivery of lower local anesthetic volumes, preserving analgesic efficacy while minimizing dense motor blockade.[26] For high-turnover ambulatory arthroscopy programs where rapid motor recovery is prioritized, superior analgesic profile of FNB offers reliable 24-hour symptom control.

Several limitations of this study should be noted. First, investigation was conducted at single center with sample size of 60 patients; larger multicenter trials would provide greater external generalizability. Second, cumulative 24-hour rescue opioid consumption and time to first rescue analgesic request were not tracked as secondary endpoints, which would provide additional objective dimensions to subjective pain scoring. Third, objective assessments of quadriceps motor strength and dynamic functional recovery were not formally scored at 24 hours. Future randomized trials should incorporate comprehensive assessments of dynamic pain during knee flexion, time to unassisted ambulation, and long-term patient-reported outcome measures.

CONCLUSION

In patients undergoing elective knee arthroscopy, ultrasound-guided femoral nerve block supplemented with dexmedetomidine provides significantly superior 24-hour postoperative analgesia and higher rate of excellent pain relief compared to intra-articular local anesthetic infiltration. This regional technique provides effective, sustained pain control across varied demographic and surgical subgroups, supporting its

utility in standardized multimodal post-arthroscopy pain management protocols.

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