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ORIGINAL ARTICLE

Comparison Between Ultrasound-guided the Genicular Nerve Block and Infiltration Between the Popliteal Artery and the Capsule of the Posterior Knee (IPACK) Block for Postoperative Pain Relief in Total Knee Replacement Surgery

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Abstract

Background: **Total knee replacement (TKR) is the optimal option for individuals with advanced knee joint disease, it has the advantages of both pain relief and improved joint function, but still faces some difficulties. The most challenging factor after TKR is pain control, so the invention of an ultrasound-guided nerve block is the optimal option.**

Aim and objectives: **In the study, the effectiveness of genicular nerve block and IPACK block was compared with regard to postoperative pain levels, the necessity of rescue analgesics, range of motion (ROM), and walking distance in cases of TKR.**

Patients and methods: **This prospective, randomized, double-blinded study was carried out in the hospitals of Al-Azhar University and involved 60 patients, divided equally into two groups based on sample size: The groupings consisted of the following: the genicular nerve block and the IPACK block group.**

Result: **A comparison of ultrasound-guided genicular nerve block and IPACK block (infiltration between the popliteal artery and the posterior knee capsule) for the treatment of postoperative pain following total knee replacement surgery.**

Conclusion: **The genicular block is a promising treatment that enhances pain control in the immediate and early postoperative period, in conclusion. Before and after TKR surgery, IPACK, and genicular blocks are utilized to improve patient comfort, perhaps reducing the need for systemic analgesics and opioids.**

Keywords: Infiltration popliteal artery capsule of the posterior knee (IPACK) block, Postoperative pain relief, Total knee replacement surgery, Ultrasound-guided genicular nerve block

1. Introduction

Total knee replacement (TKR) is the optimal option for individuals with advanced knee joint disease, it has the advantages of both pain relief and improved joint function, Despite the effectiveness of this approach, rehabilitation of limbs following TKR treatment still faces significant difficulties. The most challenging aspect of TKR is pain control, but because of the invention of an ultrasound-guided nerve block, postoperative pain can now be somewhat reduced.[1]

The Enhanced Recovery after Surgery (ERAS) states that in order to obtain early limb autonomy, hasten the rehabilitation process, shorten hospital stays, and increase patient satisfaction, a patient must control their pain completely after surgery but management of pain is our priority especially if can established that with early movement and reduce narcotics consumption.[2]

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The femoral nerve block and sciatic nerve block weaken the quadriceps femora's and the calves, which reduces early joint activity and autonomic exercise and increases the risk of falls after surgery. Additionally, it can cause peroneal nerve damage.[3]

The genicular nerves originate from the femoral, common peroneal, saphenous, tibial, and obturator nerves and innervate the knee compartment.[4]

There are about 10 genicular nerves but The genicular nerves targeted by ultrasound are superiomedial, superiolateral, inferiomedial, and inferiolateral genicular nerves because these nerves are associated with superiomedial, superiolateral, inferiomedial, inferiolateral genicular arteries.[5]

Injection of inferiorlateral genicular nerve in the inferiolatreral part of the knee lead to injury of common peroneal nerve so the genicular nerves targeted by ultrasound-guided are superiomedial, superiolateral, inferiomedial genicular nerves innervate the superolateral, superomedial, and inferomedial quadrants of the knee joint, these nerves located close to the periosteum of the distal shaft of the femur and proximal shaft of the tibia.[6]

Late examinations on patients after TKR have found that ultrasound-directed nerve block can be give absence of pain and patients satisfaction. Another procedure to accomplish self-controlled joint development and pain relief is called Infiltration between the Popliteal artery and the capsule of posterior of the Knee (IPACK), this is procedure has no effect on muscle strength, reduced pain, improves movement after surgery and decreases hospital stay.[7]

So in this study, we compare the genicular nerve block with the IPACK block for postoperative pain scores, early autonomous movement, the need for rescue analgesics, and working distance. Also, we fellow-up occurrence of infection, hematoma, and nerve injury may occur during the procedure.

2. Patients and methods

This prospective, randomised, double-blinded study was carried out in the hospitals of Al-Azhar University and involved 60 patients, divided equally into two groups based on sample size: The groups consisted of the following: the genicular nerve block and the IPACK block group.

2.1. Inclusion criteria

Patients who agreed to join the study, ages ranged from 40 to 75 years, had a body mass index (BMI) of less than 30 kg/m^2, had an ASA physical status of I to III, and were subjected to unilateral TKR.

2.2. Exclusion criteria

Revision total knee replacement, Patients with a flexion contracture, emergency procedure, allergies to or intolerances to bupivacaine, ASA class IV.

2.3. Preoperative preparation and examination

The day before surgery, an accurate history was taken, a clinical examination was conducted, and any necessary laboratory tests were run. Patients who were over 40 years old or complained of heart disease had their ECG and echo performed. The procedure was explained to all patients.

2.4. Preanesthetic preparation and premedication

All patients had a peripheral venous cannula (20 G) placed in their arms when they arrived at the operating room. A standard monitor was linked to the patient to show the patient's ECG, noninvasive arterial blood pressure (mmHg), and oxygen saturation (SpO_2).

All study patients received an intravenous dose of 1–2 mg of midazolam plus an antibiotic in the recovery before any procedure.

2.5. Materials and procedures

Before beginning the block technique, the careful sterilization between the mid shaft of the femur and the mid shaft of the tibia with betadine. The 12 MHz linear transducer of the ultrasound (sonosite, m_turbo, USA) used for visualization of the anatomical landmarks. Patient position is supine and knee extended in genicular nerve block while in IPACK block patient is supine and knee flexed with external rotation of hip, (18 ml 0.25% isobaric bupivacaine with 2 ml dexamethasone 8 mg) is performed, dose of local anesthetic is calculated before injection and patients should be monitored during procedure and postoperative carefully.

2.6. Group 1: ultrasound-guided technique for the IPACK block

2.6.1. Blocking at the level of the distal femoral shaft

IPACK block initiated ultrasound guided through transducer probe is placed in popliteal region showing popliteal artery and distal end of the femur where popliteal plexus is collected in between its. A 22 G spinal needle inserted under complete sterilization in medial to lateral plane in between popliteal artery and distal femur. 18 ml 0.25% isobaric bupivacaine with 2 ml dexamethasone 8 mg) is injected from lateral to medial (Fig. 1).

Figure 1. Probe positioning for IPACK block.

2.7. Group 2: ultrasound-guided technique for genicular nerve block

Genicular nerve block initiated ultrasound guided through transducer probe is placed on 3 sites for visualization of genicular arteries on the distal shaft of the femur and proximal shaft of tibia in diaphyseal_metaphyseal transition points close to periosteum showing superiomedial_superiolateral_inferiomedial genicular arteries which follow the similar route of genicular nerves is targeted by procedure, a 22 G spinal needle was inserted under complete sterilization and pointed in the direction of the ultrasound probe close to The superiorlateral, superiormedial, and inferiomedial genicular nerves were each given a total of 20 ml (18 ml 0.25% isobaric bupivacaine with 2 ml dexamethasone) in equal doses at various sites after making sure the needle point was adjacent to a genicular artery (Fig. 2).

Spinal block with hyperbaric bupivacaine (2.2 ml; 0.5%) solution in the L3/4 interspaces was used to give anesthesia for the total knee replacement. The same anesthesiologist who did the regional block also carried out the spinal blocks in the operating room.

Acetaminophen was administered to all patients on a normal analgesic regimen at a dose of 15 mg/kg every 6 h. We were given 3 mg of morphine IV if the VAS was more than 3.

2.8. Measurement parameters

2.8.1. Postoperative measurements

The first 24 h following surgery, the postoperative pain score, the need for rescue analgesics, and the

Figure 2. Probe positioning for superomedial genicular block.

total amount of narcotics used. Pain at 2, 4, 8, 12, 16, 20, and 24 h were measured postoperatively. At 30, 60, 90, 120 min, 6, 12, 18, and 24 h after surgery, pulse rate, blood pressure, respiratory rate, and peripheral oxygen saturation are measured postoperatively. Scores on patient satisfaction were evaluated at 24, and 48 h after surgery. On a four-point scale, patient satisfaction was scored as follows: poor (1), fair (2), good (3), and excellent (4). Anesthesia Complications: It was noted that infections, the occurrence of hematoma. Early limb movement: Patients who felt comfortable walking three hours after surgery are urged to do so. Patients were later discharged from PACU to ward; the time of ambulation was measured from the time of shift to PACU to the time patients could be ambulated.

2.9. Statistical analysis

The measurable investigation was performed utilizing GraphPad 8.0.2. Using a new report's mean and standard deviation with a force of 0.8 and an importance level of 0.05. 22 patients were at first haphazardly distributed to each gathering, taking into consideration a 30% udrop-out rate. The mean and standard deviation act as portrayals for quantitative factors. The Kolmogorov–Smirnov test was utilized to take a gander at how the factors were dispersed. A one-way ANOVA was utilized to look at the factors between the gatherings. For posthoc appraisals of the factual computations of various factors, the Bonferroni remedy was utilized. Investigations of unmitigated factors were directed utilizing the χ^2test. Factual importance was considered to exist at a 0.05 p-esteem.

3. Results

This table shows that there is no significant difference between the two studied groups regarding age, sex, and BMI (Table 1).

This table shows that there is no significant difference between the two studied groups regarding operation side (Table 2).

Table 2. Operation side of the two studied groups.

	IPACK ($N = 30$)	GNB ($N = 30$)	χ^2	P
Operation side				
Right	19 (63.3%)	21 (70%)	0.301	0.584
Left	11 (36.7%)	9 (30%)		

P (probability), significance level; χ^2, Chi square test.

This table shows that there is no significant difference between the two studied groups regarding ASA, and operative time (Table 3).

This table shows that VAS was significantly higher in IPACK group compared to GNB group at all times of measurements (Table 4).

This table shows that there is a significant difference between the groups regarding opioid consumption and time to rescue analgesic (Table 5).

The table shows that there is no significant difference between the two studied groups regarding pre or postoperative ROM. Moreover, there is a significant reduction in ROM in the two studied groups (Table 6 and Fig. 3).

The Figure shows that there no significant difference between the two studied groups regarding pre and postoperative TUG test. Moreover, there is a significant increase in TUG in the two groups (Fig. 4).

This Figure shows that there is no significant difference between the groups regarding studied postoperative complications.

This table shows that Surgeons' satisfaction is significantly higher among IPACK group compared to GNB group. Meanwhile, there is no significant difference between the groups regarding Patients' satisfaction (Table 7).

4. Discussion

In the hospitals of Al-Azhar University, a prospective randomised controlled study was carried out. 60 patients were enrolled in the study and were splited into two groups: The IPACK block group and the genicular nerve block were the two groups. The study lasted somewhere between six and twelve months. Age, sex, BMI, and co-morbidities do not significantly differ between the two study groups. Our results supported those of the Akesen and

Table 1. Demographic data of the two studied groups.

	IPACK ($N = 30$)	GNB ($N = 30$)	t	P
Age (years) Mean ± SD	51.46 ± 12.31	52.68 ± 11.44	0.398	0.692
Sex				
Female	20 (66.7%)	21 (56.7%)	0.077	0.781
Male	10 (33.3%)	9 (43.3%)		
BMI (kg/m^2) Mean ± SD	27.62 ± 3.41	28.17 ± 3.28	0.637	0.527

P (probability). significance level; t, Independent T test.

Table 3. Operative characteristics of the two studied groups.

	IPACK ($N = 30$)	GNB ($N = 30$)	χ^2/t	*P*
ASA				
I	11 (36.7%)	9 (30%)	0.601	0.741
II	13 (43.3%)	16 (53.3%)		
III	6 (20%)	5 (16.7%)		
Operative time (min) Mean ± SD	112.38 ± 12.54	106.75 ± 15.28	1.56	0.124

P (probability), significance level; *t*, Independent *T* test; χ^2, Chi square test.

Table 4. Visual Analogue Scale (VAS) of pain between the two studied groups.

	IPACK ($N = 30$)	GNB ($N = 30$)	*t*	*P*
Baseline Mean ± SD	5.44 ± 1.91	4.43 ± 1.89	**2.06**	**0.042**
2 h Mean ± SD	5.39 ± 1.47	4.26 ± 0.578	**3.9**	**<0.001**
4 h Mean ± SD	5.27 ± 0.732	4.08 ± 0.602	**6.9**	**<0.001**
6 h Mean ± SD	5.98 ± 0.783	4.02 ± 0.655	**10**	**<0.001**
12 h Mean ± SD	6.35 ± 0.736	4.05 ± 0.597	**13**	**<0.001**
18 h Mean ± SD	6.18 ± 0.822	4.12 ± 0.631	**11**	**<0.001**
24 h Mean ± SD	5.92 ± 0.671	4.48 ± 0.542	**9**	**<0.001**

P (probability), significance level; *t*, Independent *T* test.

Table 5. Clinical characteristics among the two studied groups.

	IPACK ($N = 30$)	GNB ($N = 30$)	*t*	*P*
Opioid consumption (mg) Mean ± SD	5.29 ± 6.82	4.4 ± 3.62	**7.73**	**<0.001**
Time to rescue analgesic (min) Mean ± SD	235.33 ± 18.63	268.47 ± 20.58	**6.54**	**<0.001**
Hospital stay (days) Mean ± SD	5.61 ± 1.12	4.59 ± 0.948	0.887	0.379
First mobilization (hours) Mean ± SD	12.06 ± 1.02	11.87 ± 1.26	0.642	0.523

P (probability), significance level; *t*, Independent *T* test.

Table 6. Range of motion (ROM) distribution among the two studied groups.

ROM (degree)	IPACK ($N = 30$)	GNB ($N = 30$)	t	*P*
Pre Mean ± SD	106.47 ± 12.62	112.31 ± 13.43	1.74	0.088
Post Mean ± SD	89.65 ± 8.13	86.27 ± 7.72	1.65	0.104
Paired t				
^{P}t	**6**	**9**		
P	**0.000**	**0.000**		

P (probability), significance level; *t*, Independent *T* test.

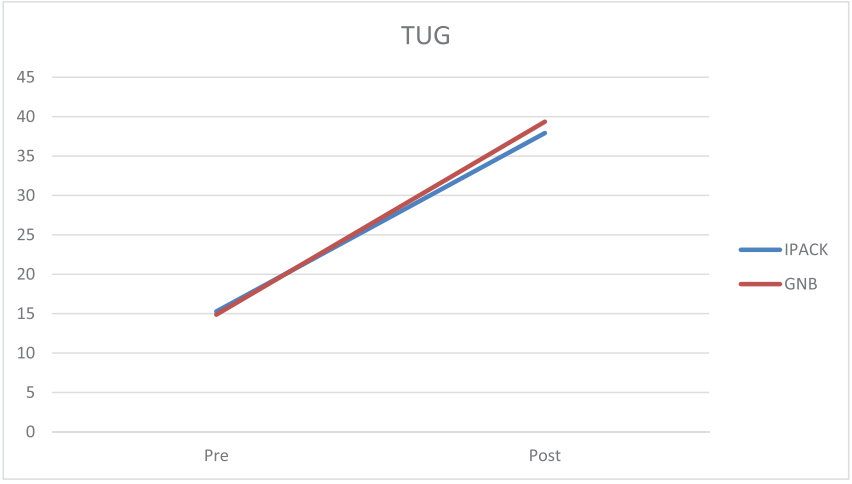

Figure 3. Timed Up and Go (TUG) test distribution among the two studied groups.

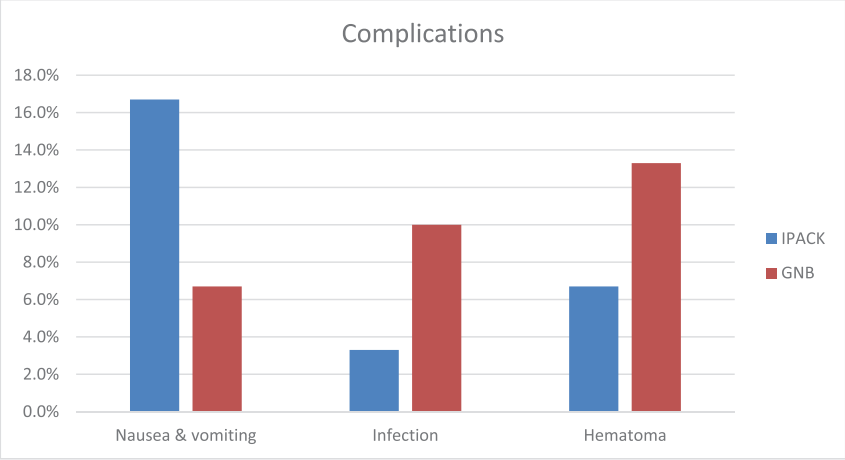

Figure 4. Postoperative complications distribution among the studied groups.

Table 7. Satisfaction distribution among the studied groups.

	IPACK ($N = 30$)	GNB ($N = 30$)	t	P
Patients' satisfaction Mean ± SD	6.54 ± 1.41	5.82 ± 1.54	1.89	0.064
Surgeons' satisfaction Mean ± SD	2.46 ± 0.534	1.65 ± 0.489	**6.1**	**<0.001**

P (probability), significance level; t, Independent T test.

colleagues experiment, this included 60 individuals evenly distributed among three categories: IPACK block, genicular nerve block, and control group made comprised the three groups. In a different study by Narejo and colleagues, 80 patients were randomly assigned to the iPACK or LIA (Local Infiltration Anesthesia) group to evaluate post-operative pain following TKR. According to Cunat and colleagues, analysis also included 29 patients in the genicular nerves block group and 30 individuals in the LIA group. TKR patients' postoperative pain levels, need for rescue analgesics, range of motion (ROM), and walking distance have only been examined in one prior study, as far as we are aware Akesen and colleagues.[8]

The current analysis showed that there's no statistically important distinction between the 2 examined groups in terms of operation aspect, ASA, and operational time. However, within the analysis by Akesen and colleagues,[8] that lined eight, there have been significantly a lot of ASA III patients within the IPACK block group. However, there's no obvious distinction between the 2 analysis groups' operational times. This study showed VAS was higher than IPACK group compared to genicular nerve block all the time. Our findings were supported by a study by Akesen and colleagues, that showed that the VAS score was significantly higher within the control group however the VAS score on mobile state preoperative was equal between the groups ($P = 0.19$) ($P < 0.01$). At 3 h (resting alone; $P < 0.01$), 6 h (resting and mobile; $P < 0.01$), 12 h (resting and mobile; $P < 0.01$), and 24 h (resting and mobile; $P < 0.05$) postoperatively, patients within the IPACK and genicular block group had VAS values that were considerably below those within the control group compared to IPACK and therefore the control group on the 3 h and 6 h postoperatively, the VAS score within the genicular block was considerably lower ($P = 0.012$). The pain score was primarily lower within the iPACK block compared with the LIA within the analysis by Narejo and colleagues, at 3 h following a process (3.34 vs. 4.70; $P = 0.0045$). At 24 and when 48 h, there may are as of not any distinction between the 2 group ($P = 0.8253$ and $P = 0.4098$, individually). In the study of Reddy and colleagues the mean VAS score for adductor block group was 2.91, 3.19, and 3.46 while adductor plus IPACK group the mean VAS score was 1.4, 2.03, 2.54 at 6, 12, and 24 postoperatively with statistically significant difference (P value < 0.0001). The IPACK block and genicular nerve block essentially showed that there is a significant difference between 2 groups regarding opioid consumption and time of rescue analgesics while in the study of Akesen and colleagues, the control group which using PCA were significant higher than IPACK and genicular nerve block for consumption of analgesics postoperatively 4_8 h ($P < 0.001$), 8–12 h, 12–16 h, and 16–20 h.

At the postoperative 48th hour in the concentrate by Erdem Y[12] the iPACK + ACB consumed less narcotics than the ACB and periarticular invasion (PAI) +ACB gatherings ($P < 0.001$). The ongoing examination exhibited that there is no way to see a change in pre or postoperative ROM between the two researched gatherings. Furthermore, ROM has been essentially diminished in the two review gatherings. Concerning preoperative and postoperative Pull test, there was no way to see a distinction between the two explored gatherings. Moreover, Pull has fundamentally expanded in the two gatherings. Be that as it may, in the concentrate by Akesen and colleagues,[8] the level of flexion was equivalent in all gatherings on the postoperative 24 h ($P = 0.92$) yet extensively higher in the genicular block bunch on the postoperative 12 h contrasted with the IPACK and the benchmark group (P 0.001).

In the study by Narejo and colleagues,[10] the TUG test took the LIA group substantially longer ($P = 0.0004$, $P = 0.0013$, and $P = 0.0017$, respectively) at 4, 24, and 48 h than the iPACK group. There were no discernible changes between the two groups in knee ROM at 4 h, 24 h, or 48 h ($P = 0.7935$, $P = 0.6979$, and $P = 0.3069$).

Both joint ROM and sleep quality were not significantly different, according to research by Cunat and colleagues[11] that supported our findings. Our findings indicated that the analyzed postoperative complications did not significantly differ across the groups. The IPACK group has much higher surgeon satisfaction than the GNB group. In the meanwhile, there is no discernible difference in the groups' patient satisfaction levels. A study by Akesen and colleagues,[8] which found that none of the participants showed any symptoms of analgesia-related problems, validated our findings. To equalize the sample size for each group, two patients from the genicular block and two patients from the IPACK group who underwent spinal anesthesia failed were removed from the study.

4.1. Conclusion

The genicular block is a promising treatment that enhances pain control in the immediate and early postoperative period, in conclusion. After TKR surgery, IPACK and genicular blocks are utilised to improve patient comfort, perhaps reducing the need for systemic analgesics and opioids.

Authorship

All authors have a substantial contribution to the article.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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Conflicts of interest

The authors declared that there were NO conflicts of Interest.

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