Research Article

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Benefit of Ultrasound Guided Peripheral Nerve Blocks for Patients Undergoing Femoropopliteal Bypass Surgery Concerning Postoperative Pain and Perfusion

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ABSTRACT

Background: *Anaesthesia for peripheral revascularization surgery is really challenging and the choice of the anaesthetic technique can contribute to the postoperative outcome.*

Aims: *To evaluate the effect of adding peripheral nerve blocks (Femoral and Sciatic) to general anaesthesia, as an analgesic technique, on the control of postoperative pain, reduction of surgical stress response, providing haemodynamic stability and reducing the vasospasm in the venous graft following femoropopliteal bypass surgeries*

Methods: *Patients were randomly categorized into two equal groups (20 each) by closed envelope method. In the general anaesthesia group, patients were induced with fentanyl, propofol and cisatracurium. An LMA was inserted and anaesthesia was maintained with isoflurane (1-2%) and fentanyl infusion with a controlled ventilation. In this group, analgesia was achieved postoperatively with nalbuphine and Ketorolac. While in the regional anaesthesia group, 20 patients received ultrasound guided femoral nerve block and sciatic nerve block 20 minutes prior to induction of general anaesthesia. General anesthesia was induced and maintained with the same technique as in group 1 without the fentanyl infusion. The parameters evaluated were the postoperative heart rate, mean arterial blood pressure, visual analogue scale at rest and movement, plasma nitric oxide and interleukin levels, total opoid consumption, patient's satisfaction with the pain control and blood flow through the graft. Also complications such as nausea and vomiting were evaluated.*

Results: *It was found that combining ultrasound guided peripheral sciatic and femoral nerves blocks to the general anaesthesia provided a better postoperative pain control as demonstrated by a reduction in the heart rate, mean arterial blood pressure, visual analogue scale, total opioid consumption and pain mediators levels. It also helped the distal blood flow to the operated limb by reducing the vasospasm of the graft. Patient satisfaction did not show a statistical significance between the two groups.*

Conclusion: *It is better to combine ultrasound guided sciatic and femoral nerve blocks to general anaesthesia for peripheral revascularization surgeries.*

Keywords

Ultrasound guided Femoral and Sciatic block, Peripheral revascularization surgery, Distal blood flow, IL-6, Niric oxide.

Introduction

Peripheral vascular revascularization (PVR) surgery is classified as high risk by the recent American College of Cardiology and American Heart Association (ACC/AHA) guidelines on preoperative assessment, with a combined incidence of cardiac death and non-fatal myocardial infarction (MI) of >5% [1].

Complications after surgical bypass include wound infection, necrosis, tissue loss, graft occlusion, and bleeding. Independent predictors of adverse outcomes include female sex, advanced age, diabetes mellitus, and below-knee bypass. Other complications include graft failure, wound dehiscence, sepsis, patients who undergo infrainguinal bypass for limb salvage often experience delayed wound healing, episodes of recurrent ischemia, and need for repeat operations [2,3].

Acute stress in the perioperative period has four major sources: anxiety; pain; surgical stress response; and potential neurotoxicity of anaesthetic agents. Hence the choice of the anaesthetic technique helps to modulate the surgical stress response and the postoperative outcome.

The literature has not been very clear on the issue of which type of anaesthesia a patient receives for infrainguinal bypass is the safest in terms of postoperative complications, including early graft failure. Therefore, the type of anaesthesia used is usually at the discretion of the anaesthesiologist and the surgeon, and it is usually based on their experience and comfort in the administration of one type of anaesthesia over another [4].

The rationale behind this study, was trying to identify an anaesthetic plan that can achieve a good control of the postoperative pain and a good control of the surgical stress response, while in the same time gaining the benefits of regional anaesthesia in terms of sympatholytic effect and peripheral vasodilation, without a dramatic haemodynamic change, hence improving the postoperative limb perfusion as proved afterwards [5].

Patients and Methods

This study was carried out on 40 adult (20-80 years old) vascular patients of both sexes and scheduled to undergo femoropopliteal bypass with a venous graft surgery in Vascular surgery unit at Alexandria main University Hospital.

After approval of the Ethics Committee, and a written consent from each patient, all patients were randomly allocated to one of two groups, (20 patients each), via the sealed envelope technique:

- **Group A:** General anesthesia and postoperative nalbuphine.
- **Group B:** Bitrunckal femoral and sciatic nerve block before the conduction of general anaesthesia.

The sample size was determined according to the recommendations of the Department of the Biostatistics. Evaluation of the patients was carried out on the day before surgery through proper history taking, clinical examination, routine laboratory investigations, ECG for patients above 40 years, X- ray chest for patients above 60 years, or if otherwise indicated. All patients were informed of the procedure and were trained to use the visual analogue scale (VAS) [6-8].

Group A: General anaesthesia and postoperative nalbuphine:

In the 20 patients randomized to the general anaesthesia group, anesthesia was induced using fentanyl (1µg/kg), propofol (2-2.5 mg/kg), and cisatracurium (0.15 mg/kg). A laryngeal mask airway (LMA) was inserted. Anaesthesia was maintained using isoflurane (1-2 % in 100% oxygen) and continuous infusion of fentanyl (0.5 µg/kg/h) [10]. Controlled ventilation was maintained at a rate of (10 breath/min), and a tidal volume to maintain the end-tidal carbon dioxide at (35 mmHg). At the end of the operation, residual muscle relaxation was reversed with atropine (0.15 mg/kg) and neostigmine (0.04 mg/kg). In this group, analgesia was controlled postoperatively with nalbuphine in a dose of 10 mg/70 kg administered intravenously every 6 hours and ketorolac in a dose of 30 mg intravenousely every 6 hours. A rescue dose of nalbuphine (10 mg) was given in case of a VAS (Visual Analogue Scale) ≥ 4.

Group B: Bitrunckal femoral and sciatic nerve blocks preceding the general anaesthesia:

In the 20 patients randomized to the bitrunckal block, realtime ultrasound guided femoral and sciatic nerve blocks were performed 20 minutes before the induction of general anaesthesia. Ultrasonographic identification of the femoral and sciatic nerves was done respectively and 15 mls of Bupivacaine 0.25% were injected to completely surround each nerve separately. Then, general anaesthesia was induced and maintained with the same technique as in group A without fentanyl infusion.

In this group, analgesia was controlled postoperatively with ketorolac in a dose of 30 mg intravenously every 6 hours. A rescue dose of nalbuphine (10 mg) was given in case of a VAS ≥ 4.

Measurements

Vital signs: Heart rate (beats/min) and Mean arterial blood pressure (mm/Hg) were recorded immediately postoperatively, every hour for the first 4 postoperative hours then every 4 hours for the rest of the 24 postoperative hours constituting the study period.

Laboratory: Peripheral blood sample was collected from all patients in vacutainer tubes with EDTA on ice. The blood samples were centrifuged to isolate plasma was stored at -20°C till the time of the assay for the measurement of [9] Plasma nitrite/nitrate and (NOx) Interleukin-6 (IL-6). Samples were collected preoperatively, 6 hours postoperatively and then at 24 postoperatively.

Pain assessment: Visual analogue scale during rest (VASR) and movement (VASM) at 6 hours postoperatively and then at 24 postoperatively. Also, the total dose of postoperative rescue analgesia with nalbuphine (mg) was measured by the end of the 24 hours of the study period. When the patient was asleep, no attempt was made to wake him or her, and the patient was considered as having pain relief.

Postoperative limb perfusion: Distal blood flow in the operated limb was measured using a duplex study (measuring the flow velocity volume through the venous graft in cc/second) at 6 hours and 24 hours postoperatively.

Statistical analysis

Data was fed to the computer and analyzed using IBM SPSS software package version 20.0 [10]. Qualitative data was described using number and percent. Quantitative data was described using range (minimum and maximum), mean, standard deviation and median. Comparison between different groups regarding categorical variables was tested using Chi-square test. When more than 20% of the cells have expected count less than 5, correction for chi-square was conducted using Fisher’s Exact test or Monte Carlo correction. The distributions of quantitative variables were tested for normality using Kolmogorov-Smirnov test, Shapiro-Wilk test and D'Agstino test. If it reveals normal data distribution, parametric tests were applied. If the data were abnormally distributed, non-parametric tests were used. For normally distributed data, comparison between two independent population were done using independent t-test, comparison between different periods using ANOVA with repeated measures and Post Hoc (LSD) test was assessed. For abnormally distributed data, comparison between two independent population were done using Mann Whitney test. To compare between the different periods Wilcoxon signed ranks test was applied. Significance of the obtained results was judged at the 5% level.

Results

Regarding haemodynamics namely heart rate and mean arterial blood pressure, there was no significant difference between the two groups in the immediate postoperative period while the measures were statistically significantly less in group B relative to group A in the subsequent postoperative study periods (Figures 1,2).

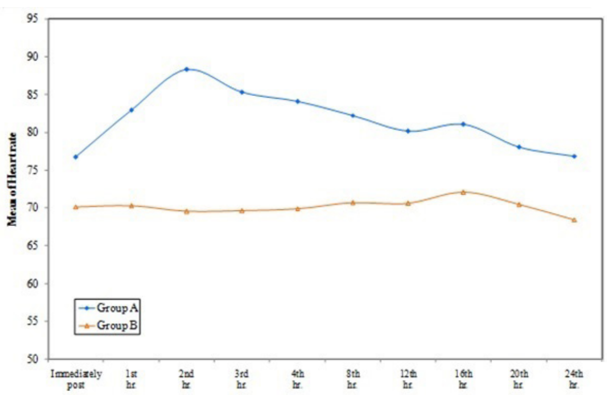

Figure 1: Comparision between the studied groups according to post-operative heart rate.

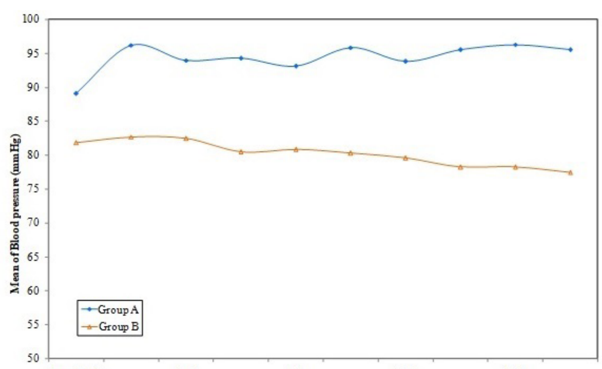

Figure 2: Comparision between the studied groups according to mean arterial blood pressure.

Plasma Nitric Oxide and interleukin 6 were statistically significantly less in group B compared to group A 6 hours and 24 hours postoperatively (Table 1).

		NO			IL6		
		Pre	6thhr.	24thhr.	Pre	6thhr.	24thhr.
Group A	Min.	3.00	8.00	5.50	1.60	38.00	25.80
	Max.	17.00	31.00	22.00	1062.40	1441.80	1277.80
	Mean	8.91	18.14	13.70	157.81	332.32	235.31
	SD.	±3.77	±6.05	±4.82	±231.52	±374.12	±294.43
	Median	9.20	17.45	13.80	94.40	204.70	130.60
Group B	Min.	2.10	3.10	2.10	0.80	4.60	4.20
	Max.	13.50	15.20	9.80	78.60	209.00	145.60
	Mean	6.61	6.83	4.81	20.02	51.91	29.47
	SD.	±2.92	±2.77	±2.30	±24.40	±60.07	±36.64
	Median	6.80	6.00	4.00	9.50	23.60	14.90
t		6.599	7.606	7.448	3.949*	4.301	4.653
p		0.06	<0.001*	<0.001*	<0.007	<0.001*	<0.001*

Table 1: Comparison between the studied groups according to Nitric Oxide (NO) (nmol/l) and Interleukin 6 (pg/ml).

t: Student t-test; Z: Z for Mann Whitney test;
*: Statistically significant at $p \le 0.05$.

Regarding pain assessment, comparing both groups, the mean values of the Visual analogue scale during rest (VASR) were significantly lower in group B compared to group A immediately postoperatively and at 2 hours postoperatively (Figure 3) while the mean values of the Visual analogue scale during movement (VASM) were significantly lower in group B compared to group A immediately postoperatively and at most of the postoperative study periods (Figure 4).

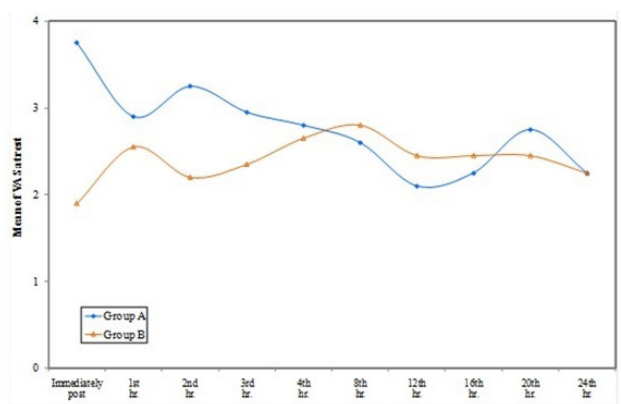

Figure 3: Comparision between the studied groups according to VAS at rest.

As well, postoperative rescue analgesia in the form of intravenous nalbuphine was statistically significantly lower in group B when compared to group A (Table 2).

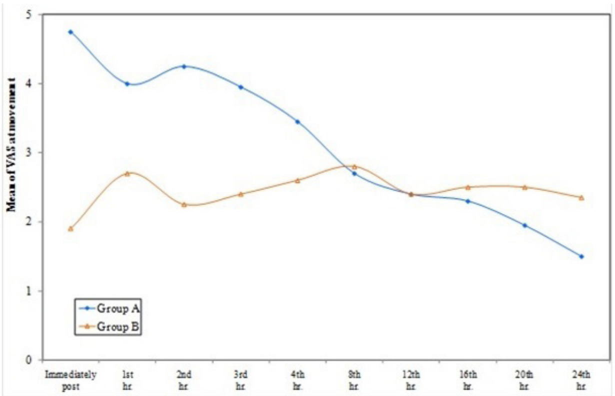

Figure 4: Comparision between the studied groups according to VAS at movement.

	Total Postoperative Nalbuphine (mg)	
	Group A	**Group B**
Min.	0.00	0.00
Max.	40.00	20.00
Mean	21.00	6.50
SD.	9.68	8.75
Median	20.00	0.00
Z(p)	3.941*(<0.001*)	

Table 2: Comparison between the studied groups according to total Postoperative Nalbuphine (used as a rescue) consumption in mg.

Z: Z for Mann Whitney test; *: Statistically significant at $p \leq 0.05$.

As regards to the distal blood flow when comparing the two groups, the distal blood flow velocity was found to be significantly less in group B than group A at 6 hours postoperatively (P<0.001). In the same way, it was found to be significantly less in group B than group A 24 hours postoperatively (P=0.007) (Table 3).

		Distal flow velocity (cc/second)	
		6thhr.	**24thhr.**
Group A	Min.	80.00	50.00
	Max.	220.00	180.00
	Mean	122.50	82.50
	SD.	±33.23	±29.18
	Median	110.00	75.00
Group B	Min.	70.00	50.00
	Max.	100.00	90.00
	Mean	83.40	63.85
	SD.	±8.46	±9.85
	Median	83.50	63.50
Z		4.831	2.713
p		<0.001*	0.007*

Table 3: Comparison between the studied groups according to distal arterial blood flow velocity (cc/second).

Z: Z for Mann Whitney test; *: Statistically significant at $p \leq 0.05$.

Comparing both groups, although there were more patients scoring excellent and good satisfaction in group B than group A, statistically speaking no significant difference could be found between the two groups (Figure 5).

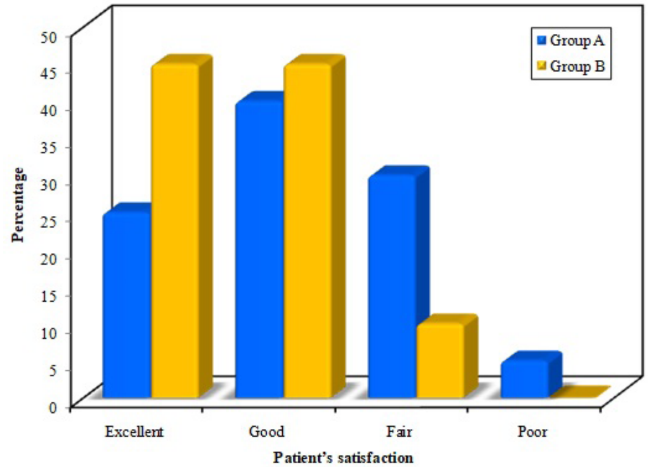

Figure 5: Comparison between the two studied groups regarding patient satisfaction.

When comparing the two groups, more patients were found to have PONV in group A than in group B but without a true statistically significant evidence. Intravenous metoclopramide (10 mg) and Ondansetron (4 mg) were given as the first and second lines of treatment of vomiting respectively (Figure 6).

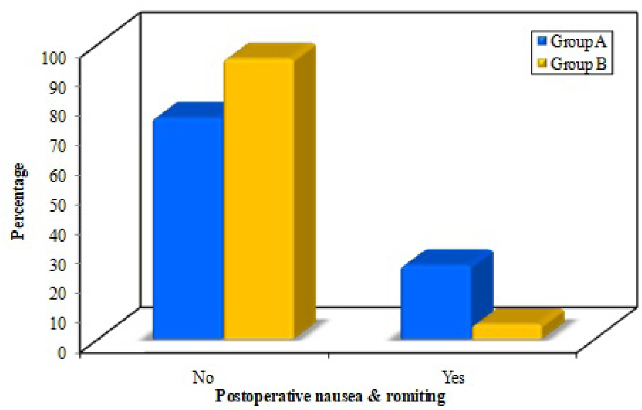

Figure 6: Comparison between the two studied groups according to postoperative nausea and vomiting (PONV).

Discussion

The current study aimed at evaluating the role of peripheral nerve blocks as adjuncts to general anesthesia in peripheral revascularization surgeries. Observation of the haemodynamics throughout the study showed better haemodynamic control in the peripheral nerve blocks group when compared to the control group. These results were consistent with that of a previous study done by Baddoo [11], who found that the use of peripheral nerve blocks for lower limb amputation surgeries provided a better postoperative pain control and more stable hemodynamics in the postoperative period. Indices looked at were the effectiveness of the nerve block, cardiovascular stability (Heart rate and mean arterial blood pressure) during surgery and the duration of postoperative analgesia provided by the block. Postoperative pain relief provided by the blocks ranged from 5 hours to 30 hours. Contrary to the current assumption that "pain triggers a sympathetic stress response". Ledowski et al. [12], conducted a study that stormed the current believes. They obtained 239 pain readings from 84 subjects undergoing orthopedic or plastic surgery. They disproved the existence of a correlation between NRS (numeric rating scale) and any of the studied haemodynamic parameters: heart rate (HR), respiration rate (RR), mean arterial pressure (MAP) or cardiac autonomic parameter: heart rate variability (HRV) or even catecholamine plasma levels.

Findings of the present study showed better postoperative pain control in the blocks group compared to the opioids analgesia group as evidenced by the lower pain scores in addition to lower postoperative opioid requirements. These findings are in agreement with the results of the study done by Ayling et al. [13], who found that peripheral nerve blocks provided a better postoperative pain control and reduced opioid requirements after major limb amputation surgeries.

In accordance with this study, Volka et al. [14], proved in their study that patients receiving femoral nerve blocks required less postoperative analgesia and showed more overall satisfaction than patients receiving spinal anaesthesia for long saphenous stripping operations.

The level of plasma Nitrite/Nitrate in both groups was measured preoperatively, at 6 hours and at 24 hours postoperatively. When comparing the two groups, there was a significant reduction in the mean value of the plasma nitrite/nitrate levels at 6 hours postoperatively in group B (mean =6.83) compared to group 1 (mean=18.14). There was also a significant reduction in the mean value of the Plasma nitrite/nitrate levels at 24 hours postoperatively in group B (mean =4.81) compared to group 1 (mean=13.70).

This difference may be attributed to the fact that Nitric Oxide which plays an important role in the surgical stress response and which is triggered by postoperative pain (considered in this study as an indicator for pain) is less released in the perioperative period, in the peripheral nerve block group. Again, this might be an indicator for a better postoperative pain control.

In the present study, comparing both groups, there was a significant reduction in the mean value of the plasma interleukin 6 levels at 6 hours postoperatively in group B (mean =51.91) compared to group A (mean=332.32), (P>0.001). There was also a significant reduction in the mean value of the interleukin 6 levels at 24 hours postoperatively in group B (mean =29.47) compared to group A.

Again, this difference may be attributed to the fact that interleukin 6 plays an important role in the surgical stress response triggered by postoperative pain [15] (considered in this study as an indicator for pain) and hence less released in the perioperative period, in the peripheral nerve block group. Again, this might be an indicator for a better postoperative pain control.

There has been a number of studies [16-18] in the literature concerning the vasodilatory effect of the regional anaesthesia in vascular surgery patients, assuming that the sympatholytic effect of regional anaesthesia (whether it is neuroaxial or peripheral nerve block) would cause a distal vasodilatation and a better blood flow in the graft. In the present study, when comparing the two groups, the distal blood flow velocity was found to be significantly less in group B than group A at 6 hours and 24 hours postoperatively. The less the blood flow velocity in a vessel the more is its caliber which most probably signifies more vasodilatation and less postoperative vasospasm. Modig et al. [16], succeeded to prove in their study that the distal calf blood flow was better in patients who received epidural block rather than patients who received general anaesthesia with positive pressure ventilation for total hip replacement surgery. Contrary to these results, Pierce et al. [19], concluded in their study enrolled on vascular patients that the type of anaesthesia whether regional or general did not influence the overall graft patency and the rate of success of vascular reconstruction and hence the limb salvage.

The present study shows that femoral and sciatic nerve blocks during general anaessthesia for peripheral revascularization surgery may achieve better haemodynamic stability, less surgical stress response and better postoperative pain control relative to the classic analgesia achieved with opioids and non-steroidal anti-inflammatory drugs alone. As well, distal blood flow through the graft may be an important advantage of peripheral nerve blocks in such procedures.

The results obtained by the present study may be limited by the short course of follow up of the graft patency.

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