



Multimodal Neural Block Analgesia Versus Morphine Analgesia After Elective Knee Surgery

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ABSTRACT

Background: Total knee arthroplasty has become a standard for treatment of end-stage knee osteoarthritis. Due to intense and complex knee innervation, there is a need to improve the anaesthetic/analgesic approach to such operations. The aim of this randomised clinical trial was to compare the analgesic efficacy of the classical regimen and two of those based on the nerve blocks.

Methods: A total of 60 patients was included and subjected to elective total knee arthroplasty under the general balanced anaesthesia. They were randomised to receive postoperatively (1) only morphine 5-10 mg q6h and paracetamol 1 g q6h (MP), (2) femoral nerve block (FNB) or (3) fascia iliaca compartment nerve block (FICNB). Nerve blocks were produced by a single administration of 30-40 ml of bupivacaine 0.5%. Pain intensity, duration of neural block and additional consumption of analgesics were recorded postoperatively.

Results: There were no demographic differences among the three groups of patients. Pain intensity was significantly lower in the two nerve block groups than in the MP group. The same two groups also demanded significantly less analgesics postoperatively than the MP group. Cardiovascular control was significantly better in the nerve block groups. There were no significant differences between the FNB and FICNB groups of patients regarding any of the studied parameters.

Conclusion: In comparison with the classical MP analgesia, use of FNB or FICNB after the elective total knee arthroplasty results in lower pain scores, lower systolic blood pressure and less consumption of analgesics in the immediate postoperative course.

Key words: knee arthroplasty, anaesthesia, nerve block, morphine, paracetamol.

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INTRODUCTION

Osteoarthritis (OA) is the leading form of arthritis in humans and is responsible for suffering of the 15-18% of the population.¹ According to the Danish registry of chronic diseases, the prevalence of the knee localisation of OA is 3.9%.² According to the Korean study performed in patients aged >50 who underwent knee radiography, prevalence of knee OA was 13% and it was positively associated with risk factors, such as older age, female gender, obesity, hypertension, low educational level, and infrequent strength exercises.³

It remains the main cause of the dysfunctionality of the knee joint⁴ and contributes significantly to the disability retirement⁵. Its prevalence is on the rise and reflects the longer life span, sedentary lifestyle and epidemic of obesity worldwide.^{4, 6-9}

OA of major joints, such as hip or knee, is associated with increasing and sometimes intolerable pain and movement disabilities¹⁰ that, with the progression of the disease, limit not only the professional performance, but also the everyday

activities.¹¹ Several non-pharmacological (body weight loss, muscle strength-increasing exercises, physiotherapy) and pharmacological regimens (non-steroidal anti-inflammatory drugs po or im, intraarticular injections of viscosupplementation with hyaluronic acid, corticosteroids or biologicals) are used to treat this very painful and disabling condition.¹²

Total knee arthroplasty (TKA) remains an ultimate refugium for the patients with end-stage osteoarthritis and its prevalence is also on the rise, along with the prevalence of OA. In the UK study, the indication for TKA was made in 2.04% of people older than 55 with knee problems.¹³ In Canada, for example, there was a 5-year increase in the use of TKA over the last five years of 16%.¹⁴ It is projected that between the 2005 and 2030 the number of performed TKAs in the US will increase 673% to 3.5 million procedures annually and if the revision operations are taken into consideration, the overall increase is expected to be over eight-fold¹⁵. Additional explanation for this phenomenon is in the fact that TKAs, despite the increased rate of postoperative complications, represent a rational solution for the end-stage knee OA even in the population aged over 80.¹⁶

In Spain, a 10-year prospective cohort study in patients diagnosed with OA of the knee or hip joint revealed a significantly higher average lifetime risk for knee than for hip replacement - 30% (95% confidence interval - CI - 25-36%) versus 14% (95% CI 10-19%). Among the studied risk factors precipitating TKA, early age at the time of diagnosis of knee OA and the increased body mass index (BMI) were identified.¹⁷ In a German study the OA prevalence among the population aged 60 or older was 21.8%, rising to 31% in those older than 80.¹⁸

Due to a significant list of comorbidities in patients undergoing TKA¹⁹ on one hand and the complex innervation of the knee joint on the other,²⁰ postoperative analgesia following the elective knee surgery evolves towards a multimodal approach, combining nerve blocks with the conventional systemic administration of analgesics.^{21,22} Among the several nerve blocks used so far,^{20,23,24} the "3-in-1" femoral nerve block (FNB)²⁵ and the fascia iliaca compartment nerve block (FICNB)²⁶ have been most frequently used.

The aim of this clinical trial was to compare these two techniques with the classical systemic

analgesic scheme and to compare their postoperative analgesic efficacy between themselves in patients undergoing TKA.

METHODS

A total of 60 patients of both genders older than 55, scheduled for total knee replacement were included in this randomised clinical study. They were randomised to reach equal gender distributions by means of a block-randomisation method into three groups - MP, NFB and FICNB. The study protocol had been approved by the local Ethics Committee for Trials Involving Human Subjects and followed the principles of the Declaration of Helsinki.

All patient were subjected to TKA under the general balanced anaesthesia and received postoperatively a standard analgesic treatment consisting of morphine 5 or 10 mg q6h iv (a dose of 5 mg administered to patients weighing up to 60 kg, while the 10 mg dose was reserved for those above that weight limit) and paracetamol 1 g q6h iv. In order to obtain equal gender ratio in every group, patients were block-randomised to one of three groups: (1) standard morphine/paracetamol (MP) group, (2) "3-in-1" femoral nerve block (FNB) group and (3) fascia iliaca compartment nerve block (FICNB) group.

FNB was performed in the inguinal region as a "3-in-1" block, as described elsewhere.^{25,27} It included injection of 30-40 ml of a local anaesthetic bupivacaine 0.5% around the femoral nerve in the inguinal region. For FICNB a technique published earlier^{26,28} was followed. A single injection 30-40 ml of bupivacaine 0.5% was administered to anaesthetise the three branches of the lumbar plexus: n. cutaneus lateralis, n. femoralis and n. obturatorius.

The following parameters were registered: basic demographics, pain intensity on the 0-10 numeric pain scale (NPS), need for extra doses of analgesics postoperatively, time to the occurrence of such a need, duration of nerve block and cardiovascular parameters.

Statistical analysis was performed by using SPSS version 17.0. Kolmogorov-Smirnov test was used to test the normality of the data dis-

tribution. For parametric data Student t-test, ANOVA and Tukey post-hoc test were chosen as optimal statistical methods. For non-parametric

data Mann-Whitney U test and Kruskal-Wallis test were employed. Probability at <0.05 was considered significant.

RESULTS

The demographic characteristics of all three groups of patients are contained in Table 1.

Characteristic		MP	FNB	FICNB
Number of patients		20	20	20
ASA status (N)	II	7	6	8
	III	13	14	12
Gender	Female	13	13	13
	Male	7	7	7
Age (years)	Mean \pm SD	72.45 \pm 9.70	72.70 \pm 10.68	70.25 \pm 9.50
	Range	57-90	56-88	57-85
Body weight (kg)	Mean \pm SD	73.90 \pm 11.58	72.80 \pm 13.00	75.25 \pm 10.57
	Range	56-96	55-101	57-93
Body height (m)	Mean \pm SD	1.70 \pm 0.07	1.69 \pm 0.10	1.70 \pm 0.09
	Range	1.56-1.84	1.47-1.88	1.51-1.82
BMI (kg/m ²)	Mean \pm SD	25.58 \pm 3.14	25.36 \pm 3.96	26.17 \pm 3.37
	Range	20.57-32.91	18.62-35.76	19.27-34.58
Duration of operation (min)	Mean \pm SD	107.45 \pm 15.00	111.25 \pm 15.22	106.25 \pm 17.40
	Range	87-131	83-135	80-135

Table 1: Demographic characteristics of patients subjected to total knee arthroplasty.

MP - morphine paracetamol, FNB - femoral nerve block, FICNB - fascia iliaca compartment nerve block

All three groups of patients were similar regarding the ASA status, age, body weight and height, BMI and the duration of operation.

Mean numeric pain scores for all three groups of patients taken hourly after the end of the operation are contained in Figure 1.

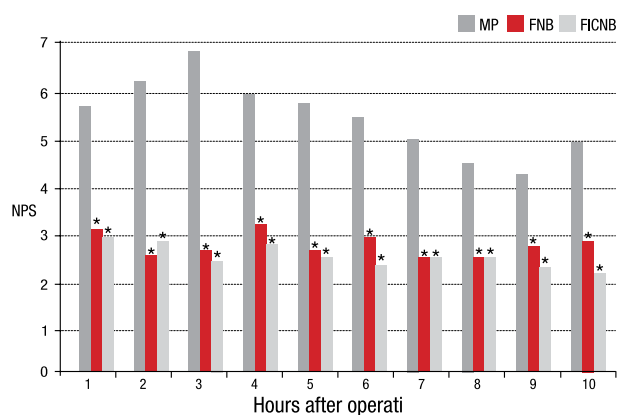


Figure 1: Effect of analgesic regimens on postoperative pain scores in patients after knee arthroplasty.

NPS - numeric pain scale, MP - morphine/paracetamol, FNB - femoral nerve block, FICNB - fascia iliaca compartment nerve block; * $p < 0.05$ vs the MP group.

It is obvious that the patients in the MP had much higher pain scores than in the other two groups. This difference was the greatest three hours after the end of operation. Thereafter it started to diminish, becoming non-significant only after 9th hour. There was no difference in pain scores between the FNB and FICNB.

The time when additional analgesic was needed postoperatively, and the duration of neural blocks are given in Table 2.

In the MP group, the need for additional doses of analgesics occurred much earlier than in the other two groups, while the difference in this time was not significant when the FNB and FICNB groups were compared.

The postoperative use of morphine and paracetamol during the first 24 h postoperatively in all three groups of patients is shown in Table 3.

Table 2: Need for additional analgesics and duration of neural block in patients undergoing total knee arthroplasty.

		MP	FNB	FICNB
Time until first additional dose of analgesic (h)	Mean ± SD	4.10 ± 1.25	7.90 ± 1.12*	8.20 ± 1.58*
	Range	2-6	6-10	6-11
Duration of nerve block (h)	Mean ± SD	n/a	4.60 ± 1.19	5.10 ± 0.97
	Range	n/a	3-7	4-7

MP - morphine paracetamol, FNB - femoral nerve block, FICNB - fascia iliaca compartment nerve block *p<0.05 vs the MP group, n/a - not applicable.

Table 3: Additional analgesic consumption in patients undergoing total knee arthroplasty during first 24 h after the end of operation.

		MP	FNB	FICNB
Morphine (mg/patient/first 24 h)	Mean ± SD	5.50 ± 4.84	1.25 ± 2.22*	1.00 ± 2.05*
	Range	0-10	0-5	0-5
Paracetamol (g/patient/first 24 h)	Mean ± SD	4.70 ± 0.8	2.10 ± 0.85*	2.05 ± 0.94*
	Range	4-6	1-4	1-4

MP - morphine paracetamol, FNB - femoral nerve block, FICNB - fascia iliaca compartment nerve block *p<0.05 vs the MP group.

Both in case of morphine and paracetamol, the postoperative consumption was significantly higher in the MP group in comparison with the FNB and FICNB groups. At the same time, the difference between these two groups themselves was not significant.

Changes in systolic blood pressure over the 5-hour period after the end of operation in all three groups of patients is shown in Figure 2.

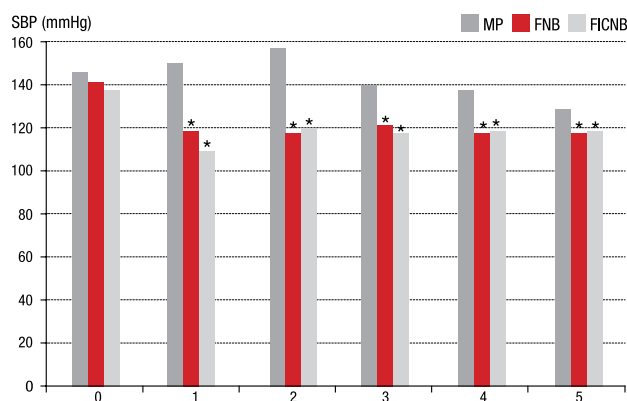


Figure 2: Changes in systolic blood pressure in three groups of patients after total knee arthroplasty.

SBP - systolic blood pressure, MP - morphine/paracetamol, FNB - femoral nerve block, FICNB - fascia iliaca compartment nerve block; *p<0.05 vs the MP group.

It is obvious that at the end of operation values of systolic blood pressure were similar in all three groups. However, in the following hours, they stayed high only in the MP group, while in

the FNB and FICNB groups they significantly decreased.

Mean number of episodes of adverse effects is shown in Table 4.

Table 4: Frequency of postoperative adverse effect in patients subjected to total knee arthroplasty (number of episodes /patient).

		MP	FNB	FICNB
Nausea	Mean ± SD	2.30 ± 0.98	0.55 ± 0.69	0.55 ± 0.69
	Range	1-4	0-2	0-2
Vomiting	Mean ± SD	1.25 ± 0.97	0.10 ± 0.31*	0.15 ± 0.37*
	Range	0-3	0-1	0-1
Pruritus	Mean ± SD	0.35 ± 0.49	0.15 ± 0.37*	0.10 ± 0.31*
	Range	0-1	0-1	0-1
Sedation	Mean ± SD	0.85 ± 0.37	0.15 ± 0.37*	0.15 ± 0.37*
	Range	0-1	0-1	0-1

MP - morphine paracetamol, FNB - femoral nerve block, FICNB - fascia iliaca compartment nerve block *p<0.05 vs the MP group.

It is obvious that postoperative nausea, vomiting, pruritus and sedation occur significantly less frequently in FNB and FICNB groups, in comparison with the MP group.

DISCUSSION

Results of the present study indicate that the two peripheral nerve block procedures, FNB and FICNB, assure significantly less frequent need for rescue analgesic medication, better analgesia, cardiovascular control and adverse effect profile when compared to the morphine/paracetamol regimen. In none of the monitored parameters any difference in efficacy or tolerability between 3-in-1 FNB and FICNB could be found.

Reduction in the pain intensity, judged according to the lower scores on the NPS in comparison with the opioid group, found in the FNB group was in accordance with the results of several other clinical trials.²⁹⁻³⁶ Publications on the postoperative efficacy of FICNB are less abundant, but a meta-analysis unequivocally confirms the results of the present study.³⁷ One of the rare available clinical studies publishing the head-to-head comparison between 3-in-1 FNB and FICNB found no difference in the efficacy and safety of these two multi-modal analgesic techniques,³⁴ corroborating thus the current results.

Use of classical opioid-based postoperative techniques is accompanied by classical opioid adverse effects, such as postoperative nausea and vomiting (PONV), pruritus and sedation. In the present study, the decreased need for the rescue morphine administration resulted in diminished frequency and intensity of the morphine adverse effects, which paralleled the findings of the quoted clinical trials.²⁹⁻³¹ Present results were also similar to the ones obtained in the same clinical settings, but in patients subjected to total hip replacement.³⁸

When it comes to pain control during and after TKA, five anaesthetic/analgesic techniques are being used: (1) general anaesthesia (2) spinal anaesthesia, (3) spinal and peripheral anaesthesia, (4) general and spinal anaesthesia and (5) general and peripheral anaesthesia. Although each technique has some advantages and drawbacks, it seems that the combination of intraoperative general balanced anaesthesia and postoperative peripheral anaesthesia (nerve blocks) offers best analgesia and adverse effect profile.²³ Neural blocks other than FNB and FICNB are also being used, with similar effects, such as psoas compartment block (PCB)³⁹ and adductor canal block (ACB).⁴⁰ These new variations of the multimodal concept of analgesia offer no additional value, in comparison with the FNB and FICNB.

Both morphine and bupivacaine, a long-acting amide local anaesthetic, affect cardiovascular system. Morphine is an opioid obtained from the plant known as opium poppy (*Papaver somniferum*), while the other currently used opioid analgesics are synthetic. There are many side effects of opioids⁴¹ and one of the most common effects on the cardiovascular system is prolongation of the QT interval which can lead to torsade de pointes (TDP), kind of the ventricular tachyarrhythmia that can provoke sudden death.^{42,43} The other side effects on the cardiovascular system are bradycardia, histamine release, and rhythm disturbance. Mechanism of action of prolongation of QT interval is associated with prolonged cardiac repolarisation that is initiated by rapid outflow of potassium (K⁺), through the cardiac rapid-rectifying K⁺ channel.⁴²

Racemic bupivacaine (Marcaine) is potentially cardiotoxic, having depressant electrophilic effects on the heart, especially in patients with

compromised cardiac function. It depresses the intracardiac conduction velocity and cardiac contractility. By blocking Na⁺ and K⁺ channels it causes the prolongation of the PR and QT intervals in the electrocardiogram. Levobupivacaine is less cardiotoxic than the racemic bupivacaine.⁴⁴ Cardiotoxicity is usually not a problem in low single doses of bupivacaine, as the ones used in this clinical trial.

CONCLUSION

Multimodal anaesthesia, combining intraoperative general balanced anaesthesia and postoperative local anaesthetic-induced peripheral nerve blocks, such as FNB and FICNB, enables better analgesia and fewer adverse effects than the morphine/paracetamol postoperative regimen.

CONFLICT OF INTEREST

None.

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