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Rapid recovery after total hip arthroplasty: direct anterior approach combined with PENG block and lateral cutaneous femoral nerve block

I.K. Eremin[1], A.A. Daniliyants[2]✉, N.A. Ermakova[1], U.A. Baysarov[1], Z.M. Molarishvili[1], N.A. Semenov[1], N.V. Zagorodniy[2,3]

[1] Fomin Michurinsky Clinic, Moscow, Russian Federation
[2] Patrice Lumumba Peoples' Friendship University of Russia, Moscow, Russian Federation
[3] National Medical Research Center of Traumatology and Orthopedics named after. N.N. Priorov, Moscow, Russian Federation

Corresponding author: Armen A. Daniliyants, armendts@mail.ru

Abstract

Introduction The "gold" standard for the treatment of late stages of coxarthrosis is total hip arthroplasty. Direct anterior approach (DAA) refers to minimally invasive surgical interventions in orthopaedics. Extended anesthetic measures in combination with low-traumatic surgical techniques may reduce postoperative pain and accelerate patient's recovery.

The **purpose** of the study was to compare the rate of recovery of patients after hip arthroplasty using DAA in combination with PENG block, lateral cutaneous femoral nerve (LCFN) block and without extended anesthetic measures.

Materials and methods A prospective randomized comparative clinical study was performed, which involved 62 patients divided into two groups: the study one (n = 29) and the control one (n = 33). In both groups, arthroplasty was performed using DAA. Patients of the study group underwent PENG block and LCFN block. The patients in the control group did not receive extended anesthesia. The evaluation criteria were pain assessment using the visual analogue scale (VAS), administration of painkillers, patient's mobility and the length of hospital stay.

Results The VAS score for pain in the study group were lower than in the control group after 6 hours — 3.7 (3.4; 4.1) and 4.3 (4.2; 4.8); 24 hours after surgery — 3.5 (3.3; 3.6) and 4.1 (3.9; 4.5) (p < 0.001). After 48 hours, the indices were comparable: 3.5 (3.1; 4.1) and 3.7 (3.6; 3.9) (p = 0.19). The rate of requests for pain relief in the first 24 hours was lower in the study group than in the control group: 2 (1; 2) and 3 (2; 3) cases (p = 0.003). The results of the manual muscle test after 6 hours and 24 hours were comparable (p > 0.05). The time interval between the end of the operation and the first walking on crutches was shorter in the study group — 3.1 hours (2.9; 3.4) and 3.98 hours (3.8; 4.2) (p < 0.001). The length of hospital stay was shorter in the study group: 1.5 (1.2; 2) and 2.5 (2; 3) days (p < 0.001).

Discussion Lower postoperative pain allows faster activation of patients, thus improving the results of the early rehabilitation period.

Conclusion The use of PENG block and LCFN block in arthroplasty with the use of DAA has clinical effectiveness in the first 24 hours, and helps to accelerate the postoperative recovery of patients.

Keywords: hip arthroplasty, direct anterior approach, lateral cutaneous femoral nerve block, PENG-block, extended anesthetic management

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INTRODUCTION

According to the literature, the incidence of coxarthrosis in the world population has been steadily increasing [1]. Aging, overweight and genetic predisposition are the most important factors in the development of degenerative processes in large joints of the lower extremities [2, 3]. Nelson A found that by the age of 85, one in four patients has a pronounced clinical picture of osteoarthritis in the hip joint (HJ), significantly worsening the patient's quality of life [4].

The "gold" standard for treating late stages of coxarthrosis is hip arthroplasty. According to Sloan et al., by year 2030, the annual number of such operations in the United States will reach 635 thousand [5]. At the same time, leading orthopaedists strive to improve the techniques of surgical interventions. Direct anterior approach may significantly reduce postoperative pain, speed up the start of rehabilitation, and reduce the length of the patient's stay in the hospital [6–8].

Postoperative pain syndrome is a common problem that slows down the rehabilitation process and patients often require the administration of opioid analgesics, which can contribute to the development of delirium, cause respiratory depression, constipation and urinary retention [9–11]. Against this background, regional methods of pain relief may reduce the recovery time and decrease the intensity of nociceptive impulses from the surgical intervention area [12]. The simplest and at the same time effective method of conduction anesthesia in hip arthroplasty is the blockade of the pericapsular group of nerves of the hip (PENG-block) [13–17]. This method of analgesia is commonly used in arthroscopy, primary and revision hip arthroplasty [18, 19]. Based on the fact that the blockade of the indicated nerves does not solve the problem of pain in the area of the postoperative wound, a number of researchers proposed to block the lateral cutaneous femoral nerve (LCFN), which is responsible for the sensitive innervation of the skin of its anterolateral region [20]. Later, it was proposed to combine the PENG-block and LCFN blockade in order to achieve a deeper analgesic effect [21].

Thus, the assessment of the practical effectiveness of these methods in hip arthroplasty prompted us to conduct this study.

The **purpose** of the study was to compare the recovery rate of patients after hip arthroplasty using direct anterior approach in combination with PENG block, lateral cutaneous femoral nerve block, and without extended anesthesia.

MATERIAL AND METHODS

Study design A prospective randomized comparative clinical study was performed. A total of 62 patients (28 men and 34 women) participated in the study, divided into 2 groups: the study (n = 29) and the control (n = 33) groups.

Inclusion criteria Primary patient selection was carried out according to the following inclusion criteria:

— male and female gender, age range from 18 to 85 years old;
— established diagnosis of idiopathic stage II–III coxarthrosis according to the classification of NS Kosinskaya; post-traumatic coxarthrosis without fracture of the anterior/posterior column;

dysplastic coxarthrosis in stage 1–2 according to the classification of J. Crowe; aseptic necrosis of the femoral head stage 3–5 according to the classification of Steinberg.

Final selection of patients for inclusion in the study was done following *exclusion criteria*:

— previous surgical treatment of the hip joint;

— defects of the femur such as destruction or absence of the medullary canal of the femur, making it impossible to correctly install the femoral component;

— chronic inflammation of any location requiring surgical debridement;

— anemia of any severity.

Study conditions The study was conducted at the department of traumatology and orthopaedics of the Fomin Clinic for one year (from January 2023 to January 2024). All subjects were randomized using a random number generator and assigned to either the main or control group. Randomization was performed by an independent investigator. Subsequently, all procedures were performed by one group of surgeons and one anaesthesiology team.

Surgical methods Patients of the study group underwent arthroplasty through a direct anterior approach (DAA) in combination with PENG block and LCFN block. Extended anaesthesia was performed in the following order: spinal anesthesia, PENG block, LCFN block. Patients of the control group underwent arthroplasty through the direct anterior approach without extended anesthesia. The technique of arthroplasty through DAA is described in detail by the authors of the study [22].

All patients received premedication in the following volume: cefazolin — 2 g diluted in 20 ml of 0.9 % NaCL intravenously; omez — 40 mg intravenously; tranexamic acid — 15 mg/kg intravenously; latran — 4 mg intravenously; dexamethasone — 8 mg intravenously; midazolam — 100 mcg/kg intravenously.

Methods of result evaluation The main criterion was pain severity in the postoperative period. Pain was assessed using the visual analog scale (VAS) on the day of hospitalization, as well as 6, 24, and 48 hours postsurgery.

The following indicators were also used as criteria for assessing the clinical effectiveness of the operation:

1) intake of pain-killers (ketorol, single dose — 0.3 mg/kg);

2) patient's mobility state:

- time to first walking with crutches, defined as the period between the end of surgery and the first time the patient was able to walk with crutches under the supervision of a physician;
- in patients who underwent regional blocks, the presence of quadriceps motor block was assessed using a manual muscle test, evaluated as:

  0 — absent contraction and movement of the muscle;

  1 — weak muscular contraction;

  2 — movements are performed only in the horizontal state;

3 — the patient is able to lift the limb independently, but without artificial resistance from the doctor;

4 — full range of motion, the patient is able to lift the limb with little resistance;

5 — normal mean statistic muscle power;

3) hospital stay since admission till discharge.

Criteria for patient's discharge from the hospital:

— readiness to return to everyday life: ability to dress independently, get out of bed, sit and get up from a chair/toilet, independent care of oneself, walk 70 m with crutches, pain level according to VAS lower than 3 points;

— correct position of the implant components in the postoperative checking radiograph;

— absence of ECG rhythm disturbances and pathological changes;

— CBC values within reference range;

Complications A complication was defined as any unexpected event occurring during the entire surgical procedure or in the postoperative period, manifested by a local or systemic response that may prolong the patient's hospital stay or impair hip joint function.

Statistical methods Statistical analysis was performed using Jamovi 2.4.11. Quantitative indicators were assessed for compliance with the normal distribution using the Shapiro – Wilk test. Since all the studied characteristics in both groups had a distribution different from normal, quantitative data were described using the median (Me) and interquartile range. Categorical data were described using absolute values and percentages. Comparison of two groups by a quantitative indicator whose distribution differed from normal was performed using the Mann – Whitney U test. Comparison of two groups by a qualitative indicator whose distribution differed from normal was performed using the Spearman chi-square test. Differences were considered reliable at statistical significance $p \leqslant 0.05$.

RESULTS

The study did not reveal statistical differences between the two groups in regard to gender, age, BMI, and distribution of the sides of the intervention (Table 1). Thus, the absence of statistical differences in the studied groups allows for their further analysis.

VAS pain scores in the patients who received extended anaesthesia were lower than in the control group at 6 and 24 hours after surgery ($p < 0.001$). However, after 48 hours, the pain scores were comparable ($p = 0.213$) (Table 2).

Table 1

Baseline characteristics of patients who participated in the study

Parameter	Study group ($n = 29$)	Control group ($n = 33$)	p
Age, years	64 (58; 68)	66 (64; 72)	0.074*
BMI	32.4 (29.8; 34.1)	30.8 (28.9; 33.5)	0.413*
Affected side (right/left), abs	16/13	15/18	0.961**
Gender (M/F), abs	13/16	15/18	0.961**

Note: method used: * — Mann – Whitney U test; ** — Spearman's chi-square test

Table 2

VAS score for pain in the groups after 6, 24 and 48 hours

Group	VAS score, Me (Q1; Q3)		
	after 6 h	After 24 h	after 48 h
Study group	3.7 (3.4; 4.1)	3.5 (3.3; 3.6)	3.5 (3.1; 4.1)
Control	4.3 (4.2; 4.8)	4.1 (3.9; 4.5)	3.7 (3.6; 3.9)

Note: method used: median (Me) and interquartile range (Q1; Q3).

The total number of patients' requests for pain relief during the first 24 hours after arthroplasty was lower in the study group — 2 (1; 2) cases, compared to the control group — 3 (2; 3) cases ($p = 0.003$).

No postoperative motor blockade of the quadriceps femoris was recorded in either group. The results of the manual muscle test after surgery were comparable: after 6 hours — 3 (2.5; 3) and 3 (2; 3), after 24 hours — 5 (4.5; 5) and 5 (4; 5) in the study and control groups, respectively ($p > 0.05$).

The time interval between the end of the operation and the first walking on crutches was shorter in the study group compared to the control group: 3.1 hours (2.9; 3.4) and 3.98 hours (3.8; 4.2), respectively ($p < 0.001$).

The length of hospital stay was shorter in the study group compared to the control group: 1.5 (1.2; 2) days and 2.5 (2; 3) days, respectively ($p < 0.001$).

In both groups, no complications associated with extended regional anaesthesia or THA performance through the DAA were recorded. In neither group was it necessary to prescribe opioid analgesics.

DISCUSSION

We believe that the longer analgesic effect in patients of the study group was due to the peripheral block of the sensory branches of the femoral and obturator nerves innervating the hip joint capsule. At the same time, during the study, it became clear that after 48 hours, afferent impulses of this group of nerves restore, and the analgesic effect ceases. The advantage of this technique compared to other existing regional blockades of this area is the absence of a motor block of the quadriceps muscle of the thigh, which is also confirmed in this work. The results obtained are consistent with the literature data and the conclusions of randomized clinical trials conducted by Pascarella et al., Hu et al. and Zheng et al. [9, 23–28].

Low pain levels immediately after surgery allow patients to be out of bed faster, thereby reducing the time interval between the end of surgery and the first walking on crutches. We believe that rapid mobilization of patients after THA has a positive effect on both the early postoperative rehabilitation period and the patient's satisfaction with surgical treatment. The ability of patients to stand up independently, move around with crutches, and take care of themselves in the first hours after surgery reduces the need for urinary catheters and allows the use of diapers, which reduces the risk of genitourinary infection. Another advantage of an active early rehabilitation period is the absence of the need to prescribe compression stockings and elastic bandages to patients without concomitant cardiovascular pathology.

In our study, we found that the length of hospital stay of patients in the study group was one day

shorter than that of the patients in the comparison group. This is due to the fact that low pain syndrome and rapid postoperative recovery of patients allowed them to achieve the discharge criteria after THA described by Wainwright et al [29] more quickly.

Our work revealed a decrease in the rate of taking nonsteroidal anti-inflammatory drugs in the first 24 hours after surgery in the patients of the study group, which is due to the continuing analgesic effect of the regional anesthesia. Results comparable to those obtained by us were demonstrated in a randomized clinical trial conducted by Liang et al [30].

CONCLUSION

The study allows us to conclude that the use of PENG-block in combination with the LCFN block during hip arthroplasty through the DAA has a clinical advantage in the first 24 hours of the postoperative period compared to the performance of THA through the DAA without extended anaesthesia. The obtained data allow us to consider the use of extended anaesthesia in THA through the DAA as an additional way to achieve a faster postoperative recovery of patients.

Conflict of interest *The authors declare no obvious or potential conflicts of interest related to the publication of this study.*

Funding *The authors declare no external funding for the study.*

Ethical statement *All manipulations performed in the study involving people complied with the standards of the local ethics committee, as well as the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Formal consent from the local ethics committee is not required for this type of study.*

Informed voluntary consent *was obtained.*

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Information about the authors:

Ivan K. Eremin — orthopaedic surgeon, eremindoctor@yandex.ru, https://orcid.org/0000-0002-0992-0706;

Armen A. Daniliyants — resident, armendts@mail.ru, https://orcid.org/0000-0001-6692-0975;

Natalya A. Ermakova — anesthesiologist-reanimatologist, Head of the Department, dr.anesthesiaandreevna@gmail.com, https://orcid.org/0009-0001-6084-0082;

Usman A. Baysarov — orthopaedic surgeon, maas_zn@mail.ru, https://orcid.org/0009-0003-9434-8736;

Zurab M. Molarishvili — orthopaedic surgeon, zurab2mail.ru@gmail.com, https://orcid.org/0009-0006-8436-8575;

Nikita A. Semenov — orthopaedic surgeon, senikitaal@gmail.com, https://orcid.org/0009-0006-5818-9063;

Nikolay V. Zagorodniy — Doctor of Medical Sciences, Professor, Corresponding Member of the Russian Academy of Sciences, Head of the Department, zagorodniy51@mail.ru, https://orcid.org/0000-0002-6736-9772.