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**Original article**

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# *Prevention of postoperative pain after total hip arthroplasty in patients with proximal femur fractures*

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***Abstract***

**Introduction** Proximal femur fractures can be associated with nailing and total hip arthroplasty (THA). Treatment of elderly inpatients necessitates adequate postoperative pain relief. Obese patients require specific inpatient and outpatient treatments. **The objective** was to evaluate the effectiveness of pain relief in obese patients at the stages of rehabilitation after primary THA performed for a proximal femur fracture. **Material and methods** VAS score was compared in two groups of 60 clinical cases to evaluate the effectiveness of postoperative multimodal pain relief using the author's method. **Results** Comparable results of an effective and stable pain relief were obtained in the two groups by the time the patient was discharged from the hospital 5-6 days after THA. Multimodal analgesia with a glucocorticosteroid injected in the projection of the sacroiliac joint provided an effect being greater by 29 % than with use of opioids after two postoperative days and by 11 % after five postoperative days. **Discussion** Old age, comorbidities are associated with optimal surgical strategy. THA in patients with extra-articular proximal femur fractures can improve the rehabilitation potential early after surgery and general clinical and functional results providing high quality of life in the late rehabilitation period. **Conclusion** THA demonstrated a stable positive effect of pain relief in the study group of patients with proximal femur fractures, regardless of the weight and the height. Positive dynamics in pain relief was seen in patients with elevated BMI of any gradation, including those with BMI ⩾ 40.

**Keywords**: proximal femur fracture, postoperative pain, obesity, total hip arthroplasty

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## INTRODUCTION

Proximal femur fractures account for half of all femoral injuries and 3-4 % of all skeletal injuries [1, 2, 3]. The fractures are typical for elderly and associated with osteoporosis even with low-energy injuries [4]. Specifically designed population-based studies showed a high incidence of proximal femoral fractures (PFF) in patients aged 50 years and older in the Eurasian area: 176 cases per 100 thousand population in males and 279 cases per 100 thousand population in females [5]. PFF result in impaired support function, decreased quality of life and lead to life-threatening complications in severe cases [6]. The beginning of the century was marked by a rapid increase in elderly individuals and those suffering from excess weight that is characteristic of highly developed countries [7]. 1.5 billion people worldwide are obese and there is an association between body mass index and musculoskeletal disorders [8, 9].

Surgical treatment of PFF is considered the treatment of choice. Internal fixators commonly used for osteosynthesis include cannulated screws, dynamic femoral screw and locking intramedullary osteosynthesis with Gamma nail. Different fixation options are available for relatively stable PFF [10, 11], and unstable PFF can be repaired with IM nailing due to better biomechanical parameters and wide dispersion of stress [12]. Elderly patients suffer from severe osteoporosis and failed internal fixation [13] results in re-operation. The difficulties are associated with physical, psychological and financial burden on the patient and orthopaedic surgeons primarily use using total joint replacement to repair PFF in older people. According to Rosstat, the population of Russia number more than 140 million people, and the fastest growing segment of the population is people who are 60 or older [14, 15]. There are 1.66 times more older women than men, and 3.23 times more senile women [15]. Comparison of the figures with those of other regions indicated the average frequency of PFF fractures among Russian women, and a high rate among men [16]. This can be explained by longer life expectancy of the female population.

Total or unipolar hip arthroplasty (THA) is a well-established surgical procedure that allows for early weight-bearing, rehabilitation compared to other fixation options, which reduces the risk of postoperative complications [17, 18, 19]. The method is practical for ambulation, improves pain and reduces the length of hospital stay [20, 21]. THA can be used as a restorative surgical treatment option if internal fixation has failed. The proportion of obese patients

among those who have undergone THA constitutes 36-70 %, and the figure has been steadily growing in recent years [22, 23]. The objective was to evaluate the effectiveness of pain relief in obese patients who have undergone primary THA for a proximal femur fracture, at the stages of rehabilitation.

## MATERIAL AND METHODS

The study included a prospective analysis of outcomes of 60 patients with proximal femur fractures repaired with cemented THA between 2016 and 2022 at the trauma center of the Republican Clinical Hospital of the Ministry of Health of the Republic of Tatarstan. The study was performed in accordance with ethical principles for medical research involving human subjects stated in the Declaration of Helsinki developed by the World Medical Association as amended in 2000, Order of the Ministry of Health of the RF dtd 19th June 2003 No. 266 on Clinical Practice Guidelines in the Russian Federation. Permission was obtained from the local ethical committee of The study received a favourable opinion from the relevant research ethics committee of the Ministry of Health of the Republic of Tatarstan at the Kazan State Medical University of the Ministry of Health of Russia.

Of the 60 patients, there were 23 male (38.3 %) and 37 female (61.7 %) patients. The average age of the patients was 82.69 ± 5.1 years. There were two groups identified: the treatment group included 30 patients (50 %) with an increased BMI (BMI of 25 kg/m$^2$ and over), a comparison subgroup of 30 patients with PFF (50 %) with normal weight (BMI of 18.5 to 24.99 kg/m$^2$). Four subgroups were identified in the treatment group including patients with different BMI measurements (Table 1).

The average age of patients was 83.2 ± 5.1 years in the treatment group and 81.8 ± 5.1 years in the comparison group. The inclusion criteria included the age of the patient (> 70 years) and surgical treatment method (THA) for PFF. The individual BMI was measured to determine the physical condition of patients. The BMI classification of weight status was produced according to the World Health Organization with the formula for BMI being weight in kilograms divided by height in meters squared:

• Normal weight – BMI greater than or equal to 18.5 to 24.9 kg/m$^2$.

• Overweight – BMI greater than or equal to 25 to 29.9 kg/m$^2$.

• Obesity class I – BMI 30 to 34.9 kg/m$^2$.

• Obesity class II – BMI 35 to 39.9 kg/m$^2$.

• Obesity class III (severe obesity) – BMI greater than or equal to 40 kg/m$^2$.

All patients underwent primary THA for a proximal femur fracture in the period from 1 to 5 days after the injury. Cemented implants with a Muller femoral component and a metal-polyethylene friction pair were used. The procedures were produced after a preliminary examination and preparation of patients in the intensive care unit with anesthetic risk not higher than ASA III. Almost all (n = 58) interventions were performed using neuraxial anesthesia.

The author's "Method for the prevention of postoperative pain syndrome" (RF Patent No. 2702759) [24] was used to optimize prevention of postoperative pain. Analgesia technique. The patient was positioned on his normal side and the area of the sacrum and sacroiliac joints was treated with antiseptic solutions after closing the postoperative wound and applying an aseptic dressing. Injections were performed at the sacroiliac joint on both sides (by palpation). A mixture of a long-acting glucocorticosteroid solution (Triamcinolone) 20 mg and 2 ml of 2 % Lidocaine (or other anesthetic in an appropriate dosage) was used for injection on each side. Then the patient was transferred to the department and was on bed rest until the next morning to be followed by verticalization and rehabilitation. The therapy administered for the patient included anticoagulant prophylaxis, and pain relief, if needed, was performed with an adjuvant combination of a nonsteroidal anti-inflammatory drug NSAID (Aceclofenac 100 mg twice a day) and a muscle relaxant (Mydocalm 150 mg three times a day) to continue reducing the intensity of the pain. The therapy was aimed at relieving the so-called. mixed pain, which is a combination of nociceptive and neuromuscular components.

Table 1

Distribution of patients by gender and BMI

| Subgroups | | Males | | Females | | Total | |
|---|---|---|---|---|---|---|---|
| Obesity class | BMI (kg/m$^2$) | abs. | % | abs. | % | abs. | % |
| Normal weight | 18.5-24.9 | 11 | 18.3 | 19 | 31.7 | 30 | 50 |
| Obesity class I | 25-29.9 | 3 | 5 | 5 | 8.4 | 8 | 13.3 |
| Obesity class II | 30-34.9 | 4 | 6.6 | 4 | 6.6 | 8 | 13.3 |
| Obesity class III | 35-39.9 | 3 | 5 | 6 | 10 | 9 | 15 |
| Obesity class IV | 40 and over | 2 | 3.3 | 3 | 5 | 5 | 8.4 |
| Total | | 23 | 38.3 | 37 | 61.7 | 60 | 100 |

The author's technique [24] of postoperative pain relief was used after THA. The effectiveness of therapy was assessed in the form of a comparative survey using a continuous method among 30 (15 + 15 in each study group) patients who received postoperative analgesia using the author's method of multimodal pain relief (MPR) and 30 (15 + 15 in each study group) patients who had standard postoperative analgesia (SA) with opioids. Therefore, 15 patients from both study groups were included in the MPR subgroup and 15 patients from both groups were included in the SA subgroup. A standard horizontal VAS scale was employed to assess pain (in cm) on the day of surgery, daily after surgery and at ischarge. Patients were followed up at the outpatient stage during the rehabilitation. Control examinations were performed at 3, 6 and 12 months., The follow-up period was sufficient for recovery both in terms of functionality and quality of life [6]. The parameters were analyzed using tables, graphs and descriptive statistics. The results were saved in a database using Microsoft Excel 2019 for Windows®. For bivariate analyses, continuous variables were described using mean standard deviations. Binary variables were compared with percentages in cross-tabulations. Differences in BMI between the four groups were analyzed using the Kruskal-Wallis test for continuous variables (age, operating time, etc.) and the Chi-square test for dichotomous variables. The significance level was defined as $p < 0.05$. Statistical calculations were performed using SPSS (version 26, IBM SPSS Statistics for Windows, Armonk, New York, USA).

## RESULTS

The difference in VAS scores between the subgroups of patients who received postoperative analgesia using the above methods was determined after two days. The pain index measured with the author's technique (MPR) was significantly lower, by 1.5 cm, i.e. by 29.9 %. The difference was 23.3 % after three days and decreased to 11.1 % at discharge (6 days on average) (Table 2).

Table 2

Comparison of pain on the VAS scale in inpatients using postoperative analgetic options

| Timing | VAS score | | p |
|---|---|---|---|
| | MPR subgroup (n = 30) | SA subgroup (n = 30) | |
| | (M ± m), cm | (M ± m), cm | |
| Day 1, surgery | 9.04 ± 0.085 | 9.25 ± 0.14 | |
| Day 2 post-op | 3.74 ± 0.14 | 5.33 ± 0.09 | 0.001* |
| Day 3 post-op | 3.32 ± 0.04 | 4.33 ± 0.09 | 0.02 |
| Day 4 post-op | 2.88 ± 0.04 | 3.74 ± 0.08 | 0.05 |
| At discharge | 2.10 ± 0.06 | 2.36 ± 0.19 | 0.03 |

Comparison with the previous stage of observation: *differences being statistically significant.

The data obtained demonstrate the presence of a statistically significant difference in the dynamics of pain after two postoperative days in both subgroups, followed a gradual leveling during the outpatient stage of treatment (Fig. 1).

The patients were monitored at the outpatient stage going through stages 1-3 of the rehabilitation process. An almost symmetrical decrease in VAS scores was an expected phenomenon with the difference being minimal at the end of the recovery period (12 months after surgery), (Table 3).

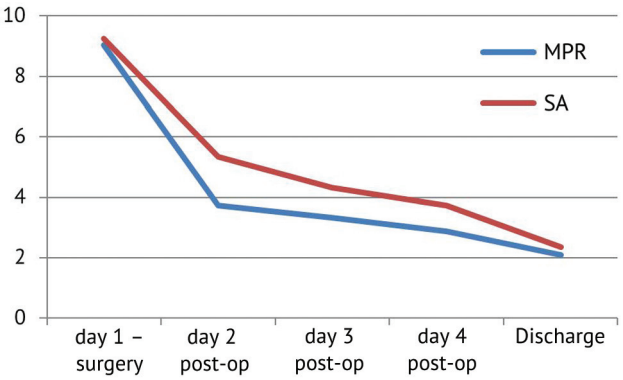


**Fig. 1** Dynamics of pain measured with the VAS scale (in cm) using postoperative analgetic options by observation days

Table 3

Dynamics in pain measured with VAS scale in the THA group at the outpatient stage of treatment, depending on the methods used to prevent postoperative pain and the height and body weight characteristics

| Timing | VAS score | | P level |
|---|---|---|---|
| | MPR subgroup (n = 30) | SA subgroup (n = 30) | |
| At discharge | 2.10 ± 0.06 | 2.36 ± 0.19 | 0.4019 |
| At 3 months | 1.86 ± 0.64 | 1.88 ± 1.07 | 0.7212 |
| At 6 months | 1.23 ± 0.53 | 1.40 ± 0.90 | 0.3340 |
| At 12 months | 0.48 ± 0.57 | 0.67 ± 0.71 | 0.1316 |

We were able to obtain the result of postoperative pain relief in each specific case of using MPR, and the effectiveness of the author's technique was evaluated in patients with normal and increased BMI.

The distribution of patients into the appropriate groups is presented above. The VAS score decreased in the "BMI Group" ("Normal BMI") by 72.1 % between the preoperative level to 3 postoperative months; by 79.3 %

between 3-month follow-up to 6-month follow-up period; by 90 % between 6-month follow-up to 12-month follow-up period. During the analyzed period of rehabilitation treatment in the category "Pain according to VAS", all indicators Positive statistically significant changes in pain were observed throughout the rehabilitation time points, at 12 months, in particular demonstrating the overall positive effect of arthroplasty (Table 4). It is important to note that the results had no correlation with the dynamics in changes in body weight, i.e. the analgesic effect was also present in patients with persisting obesity after injury.

Table 4

Analysis of the dynamics in VAS scores at different time points

| Timing | VAS score | |
|---|---|---|
| | Normal BMI | Increased BMI |
| Pre-op, M ± S | 6.74 ± 0.85 | 6.63 ± 0.69 |
| At 3 months, M ± S (%) | 1.88 ± 1.07 (-72.07) | 1.86 ± 0.64 (-72.01) |
| At 6 months, M ± S (%) | 1.40 ± 0.90 (-79.31) | 1.23 ± 0.53 (-81.52) |
| At 12 months, M ± S (%) | 0.67 ± 0.71 (-90.00) | 0.48 ± 0.57 (-92.80) |
| P level | < 0.0001 | < 0.0001 |

Table 5

VAS score measured in the group receiving multimodal pain management, depending on the BMI of patients

| Timing | VAS score measured in patients with increased BMI | | | | p level (df = 3) |
|---|---|---|---|---|---|
| | I (25-30) | II (30-35) | III (35-40) | IV (40 and over) | |
| VAS score | | | | | |
| At discharge | 2.17 ± 0.75 | 2.4 ± 0.62 | 2.48 ± 0.71 | 2.64 ± 0.67 | 0.5112 |
| At 3 months | 2.00 ± 0.72 | 1.81 ± 0.63 | 1.68 ± 0.56 | 2.00 ± 0.63 | 0.2754 |
| At 6 months | 1.31 ± 0.59 | 1.19 ± 0.55 | 1.08 ± 0.40 | 1.45 ± 0.52 | 0.1466 |
| At 12 months | 0.53 ± 0.67 | 0.40 ± 0.54 | 0.48 ± 0.51 | 0.64 ± 0.50 | 0.5197 |

*p level (df = 3), degrees of freedom

## DISCUSSION

Surgical treatment of proximal femoral fractures include internal fixation and THA. The use of a perticular method should suggest evaluation of characteristics of older patients, osteoporosis, comorbidities and obesity. THA provides good limb support and sufficient functionality reducing postoperative complications, improving the quality of life and creating conditions for early rehabilitation [25, 26]. A number of studies have shown [27] that obese patients are unable to perform a set of functional exercises due to postoperative pain, and other authors have found that the use of multimodal analgetic options can provide positive results in obese patients [28, 29, 30, 31]. These options include prolonged epidural blockade with limited use of oral anticoagulants for mandatory prevention of thromboembolic complications in the case. Intraoperative infiltration anesthesia of a wound with a various complex of drugs fails to provide the proper duration of postoperative pain relief [19, 32, 33]. Postoperative pain is one of the main factors restricting activity of patients after THA. Studies have shown that severe postoperative pain can directly lead to unfavorable short- and mid-term outcomes, and 1/3 of patients can develop chronic pain [34]. Routine clinical pain assessment and pain management regimens are non-recurring and may fail to reflect the pain status of patients performing functional activities. Severe pain reduces functional load during activities and does not facilitate restoration of joint function [35]. Single injections of a mixture of long-acting glucocorticosteroid solutions and anesthetic are performed in the projection of both sacroiliac joints immediately after the operation. Glucocorticosteroids are adaptive hormones that increase the body's resistance to stress. Surgery is a huge stress for the body with significantly increased production of endogenous cortisol (10 times or more) affecting the function of the endocrine system. The use of long-acting corticosteroids allows for termination of the body's stress response and potentiates the analgesic effect of anesthetics. The drug reduces the risk of developing reactive inflammation and swelling of the posterior portion of the pelvic ring and the hip joints [36].

The area of analgesic effect is limited to the area of the hip joint and the lateral surface of the femur, down to th knee joint. A mixture of corticosteroid and anesthetic solutions

ensures maximum concentration of drugs in plasma within 1.5 hours, and the biological half-life period is from 36 to 54 hours, which is sufficient for postoperative pain relief [37]. Glucocorticosteroids introduced at the site of the sacroiliac joints eliminates the risk of hematomas that can develop during epidural anesthesia using a catheter, which allows the use of thromboprophylactic agents early after surgery (4-6 hours) according to the instructions for the use of oral anticoagulants (Pradaxa, Xarelto, etc.). Injections at the site of both sacroiliac joints of the pelvis are necessary, to prevent pain irradiating from the lumbar spine to lower extremities [25].

With the perioperative management patterns being consistent in the two groups of our series, the results were mainly dependent on the use of analgesics. The goal of our development was to prevent postoperative complications after THA and reduce the dosage of opioids and a toxic effect on the body of elderly patients. The idea of the method for preventing postoperative pain was to conduct multimodal pain relief. Multimodal analgesia suggested simultaneous use of several drugs and/or techniques that had different mechanisms of action and allowed for achieving adequate pain relief with minimum side effects being inherent in the administration of large doses of one analgesic as monotherapy [32].

The results of the study demonstrated the effectiveness of the method at the inpatient stage of treatment. The advantage was especially evident on the second day after surgery with a decrease in the difference in the time the patients were discharged from the hospital. We can assume that the analgesic effect obtained was due to the use of multimodal anesthesia and further restorative treatment in both groups was performed without the use of our method. All patients were in equal conditions. This fact allowed us to specify the analgesic effect of surgical treatment in patients with different BMI at the stages of outpatient treatment. The VAS score was nearly identical at discharge and at 3 months in the two study groups at the outpatient stage which indicated effective operation, rehabilitation early post-op and equal potential of patients for improved quality of life. The patients across the groups developed pain relief with improved VAS score at the follow-up periods of 6 and 12 months. There was no statistical significance in VAS score for all parameters between the four categories of patients depending on BMI. Our findings showed no direct correlation between BMI and the pain severity. In addition to that, variations in the body weight were not reflected in the outcome, and the dynamics in pain relief measured with VAS scale demonstrated homogeneity in all patients.

## CONCLUSION

A significant difference determined between the pain measured on the day of surgery and after two days post surgery indicated the efficiency of the method developed and implemented for postoperative pain relief in THA patients who underwent surgical treatment for a proximal femur fracture. THA dramatically reduces pain in patients with PFF. Positive dynamics in pain relief was noted in patients with increased BMI, including those with morbid obesity (BMI $\geq$ 40).

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***Ethical expertise*** *The authors confirm that the rights of people who took part in the study were respected, including obtaining informed consent in cases where it was necessary.*

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