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Hip function in postoperative physical treatment after trochanteric fractures intramedullary and extramedullary fixation

Функција кука у постоперативној рехабилитацији код трохантерних прелома лечених интрамедуларном и екстрамедуларном фиксацијом

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SUMMARY

Introduction/Objective Postoperative inpatient physical treatment after trochanteric fracture fixation plays an important role in the hip function restoring and promoting overall recovery. The aim of this work was to compare initial and final hip range of motions and general muscle strength, as well as gender influence on these scores, during the rehabilitation after intramedullary and extramedullary trochanteric fracture fixation.

Method The outcome of physical treatment (hip flexion, extension and abduction, and general muscle strength) was analyzed in 49 patients after a trochanteric fracture fixation by an intramedullary nail (IM group) or Selfdynamizable Internal Fixator (SIF group).

Results There was significant improvement in ranges of all evaluated motions and GMS after postoperative inpatient physical therapy ($p < 0.05$). There was no significant influence of the gender and age on the observed functional results ($p > 0.05$). Hip flexion was slightly more improved in SIF group, while GMS was slightly more improved in IM group, but close to the level of statistical significance in both the comparisons ($p < 0.2$).

Conclusion Inpatient rehabilitation provides significant recovery of injured hip range of motions and GMS after trochanteric fractures internal fixation. Intramedullary and extramedullary fixation are considered similar in the rehabilitation outcome following these patients. The degree of osteoporosis, being generally higher in female, does not significantly affect the final functional results.

Keywords: hip function; trochanteric fracture; selfdynamizable internal fixator; intramedullary nailing

САЖЕТАК

Увод /Циљ Постоперативна физикална терапија након фиксације трохантерних прелома игра важну улогу у обнављању функције кука и укупном опоравку повређених. Циљ овог рада био је упоређивање почетних и крајњих вредности опсега покрета и укупне мишићне снаге у пределу кука, као и утицај старости и пола болесника на ове параметре, током рехабилитационог лечења након интрамедуларне и екстрамедуларне фиксације трохантерних прелома.

Методе Код 49 болесника са трохантерним преломом, лечених фиксацијом интрамедуларним клином (*IM* група) или самодинамизирајућим унутрашњим фиксатором (*SIF* група), анализирани су параметри ефекта физикалног лечења (флексија, екстензија и абдукција кука, као и укупна мишићна снага кука).

Резултати Потврђен је значајан напредак у погледу повећања свих праћених обима покрета у куку и укупне мишићне снаге кука, услед примењеног стационарног физикалног постоперативног лечења ($p < 0.05$). Није било значајног утицаја пола и старости болесника на наведене функционалне параметре ($p < 0.05$). Повећање обима флексија кука је било нешто веће у *SIF* групи, док је повећање укупне мишићне снаге кука била нешто веће у *IM* групи, али само близу прага статистичке значајности ($p < 0.2$).

Закључак Стационарно физикално лечење омогућује значајно враћање обима покрета и мишићне снаге у повређеном зглобу кука, након унутрашње фиксације трохантерних прелома. Интрамедуларна и екстрамедуларна фиксација показују сличност у утицају на крајње функционалне резултате кука. Степен остеопорозе, који је генерално већи код жена, не утиче значајно на наведене крајње резултате.

Кључне речи: функција кука; трохантерни прелом; самодинамизирајући унутрашњи фиксатор; интрамедуларна фиксација

INTRODUCTION

Hip fractures are considered serious injuries that can result from falls, various accidents, etc. Trochanteric fractures, as a type of hip fracture, are specific to the elderly population. The

frequency of hip fractures increases with age, but trochanteric fractures occur more often in patients over 75 years of age, while neck fractures occur in slightly younger patients [1, 2]. As the age of trochanteric fractures population is often accompanied by various diseases and poor general condition, the treatment is conservative in just a part of patients. However, more than 90% of patients with a trochanteric fracture who are admitted to the hospital where the authors are working are treated surgically by one of the two internal fixation methods: intramedullary nailing or extramedullary fixation using a Selfdynamizable Internal Fixator (Fig. 1) [3–7].

The Selfdynamizable Internal Fixator (SIF), developed by Academician Prof. Milorad Mitković, has been in routine clinical use since 1998 [8, 9]. Its advantages include a straightforward surgical technique, standard instrumentation, and reduced X-ray exposure. This implant allows for simultaneous dynamization and compression in two axes, with delayed axial dynamization possible without reoperation. Globally, cephalomedullary nails and extramedullary devices like the Sliding Hip Screw (SHS) are widely accepted as standard treatments for trochanteric fractures [10, 11, 12]. While intramedullary fixation offers shorter incisions and greater stability for certain fracture types, it typically requires more complex instrumentation and longer fluoroscopy time compared to SIF [7, 10].

At our institution, trochanteric fractures account for more than 20% of all trauma surgeries, making them the most frequent trauma case. Combined with femoral neck and subtrochanteric fractures, hip fractures constitute nearly 50% of all surgically treated trauma patients [5, 7].

After surgery, patients undergo inpatient physical rehabilitation aimed at early mobilization and restoration of hip function. This process significantly improves clinical outcomes and quality of life [8]. Conservative treatment, in contrast, is linked with higher complication rates and worse outcomes, including thromboembolism due to prolonged immobility [1, 2, 11].

In this paper, the outcome of physical treatment was analyzed after trochanteric fracture internal fixation by intramedullary nailing or SIF method. This work aimed to compare initial and final range of motion and general muscle strength in the hip joint, as well as the gender influence on these scores.

METHODS

A total of 49 cases, who had surgery at orthopedics and traumatology department of our hospital and then sent to inpatient rehabilitation department of the same hospital very soon, were analyzed in this research. There were 17 male and 32 female patients, with the average age of 72.4 years. All the patients had a trochanteric fracture, treated surgically by one of the two fixation methods – intramedullary nailing (IM group, 20 cases) and Selfdynamizable Internal Fixator method (SIF group, 29 cases). Gender distribution of the fixation methods is presented in Table 1. According to the AO classification system, 12 patients (24.5%) had A1 (pertrochanteric two-part), 28 patients (57.1%) had A2 (pertrochanteric multi-fragmentary), and nine patients (18.4%) had A3 (intertrochanteric) fracture.

All patients were applied a standard rehabilitation plan that began at seven weeks after surgery, including kinesiotherapy, occupational therapy, magnetotherapy and electrotherapy. Electro and magnetic therapy had been used to induce recovery of injured and frozen tissues, circulation stimulating, swelling decrease, and to have an analgesic effect. Kinesiotherapy and occupational therapy had also played a major role in the rehabilitation, such as range of motion improvement. Rehabilitation lasted three weeks.

The initial assessment (early postoperative status) and the final assessment were performed at the beginning and at the end of the physical therapy (just upon admission and just before

discharge from the rehabilitation department). Range of motions, including hip flexion with knee extended and knee flexed, hip extension, hip abduction and general muscle strength of the operated leg, were measured using a goniometer. General muscle strength (GMS) was scaled by MMT (Manual Muscle Test) – applying resistance manually and grading the muscle strength based on the patient's ability to resist as grade 1 (10%), grade 2 (25%), grade 3 (50%), grade 4 (75%), and grade 5 as 100%.

A comparison of the parameters was performed between genders too. The data were statistically analyzed by IBM SPSS Statistics for Windows, Version 22.0. (IBM Corp. Armonk, NY, USA), performing Wilcoxon test, Mann–Whitney U test, and χ^2 test.

Ethics: The study was performed in line with the Declaration of Helsinki and approved by the Ethics Board of the University Clinical Center Niš (Decision No. 37288/17).

RESULTS

There was significant difference in ranges of evaluated motions and GMS next before and next after postoperative physical therapy ($p < 0.05$; Table 2).

The obtained data on the range of motion improvement upon discharge from rehabilitation therapy between IM and SIF groups, but also between genders, indicate that there was no statistically significant difference in any of the modalities ($p > 0.05$; Table 3, Table 4). There was no significant influence of the gender and age on the observed functional results ($p > 0.05$; Table 1, Table 4).

DISCUSSION

Trochanteric fractures are in elderly population mostly sustain as a low-energy trauma, such as a fall at home during daily activities, while in younger population it mostly occurs by high forces affecting directly the hip area [3]. The incidence of trochanteric fractures is constantly increasing due to the increase of general average age in the population, being in accordance with our study, where the average age was about 72 years.

Since there is no significant difference in the final functional results between genders, there can be considered that the degree of osteoporosis, being generally higher in women, does not affect significantly on the functional outcome.

As trochanteric fractures mostly occur in the oldest population, a large part of patients never reach their previous level of activity. The success of physical therapy is influenced by the patient's general condition and previous physical activity. To achieve as more progress in recovery after a trochanteric fracture as possible, further extension of the physical therapy at home is required.

Hip function improving due to the applied physical therapy after a trochanteric fracture internal fixation surgery was confirmed by significant increase in range of all hip joint motions tested and in hip area general muscle strength (GMS) ($p<0.05$).

Hip flexion increasing was slightly higher in SIF group, but without statistical significance. Here could be considered that the choice between these two fixation methods didn't have a general impact on enhancement of hip joint range of motion after physical therapy completed. This also confirms that lateral presence of an extramedullary implant on the proximal part of femur, as it is in SIF, does not interfere significantly with the hip function.

When comparing IM and SIF types of the fixation, there should be mentioned that different surgical approaches are being used. Beside shorter distal incisions, intramedullary fixation of trochanteric fractures is followed by a slightly longer proximal incision for approaching through the hip abductor muscles. Extramedullary fixation of trochanteric fractures includes only one slightly longer incision, distal to greater trochanter, for approaching through the knee extensor muscles. Our study showed that the choice between one of these approaches did not affect significantly on postoperative function of the hip. Even though there was no statistically significant difference in the comparisons between the fixation methods, here should be mentioned that the difference in flexion increase was noticeably closer to the level of statistical significancy ($p<0.2$), compared to abduction ($p>0.7$) and extension ($p>0.4$) increase.

Since the difference on hip range of motion tested and hip general muscle strength was not significantly different between genders, here can be concluded that the gender did not have an impact on postoperative physical treatment functional outcome. Lahtinen et al. [13], and Lieberman et al. [14] also reported that there was no significant difference in final functional results after postoperative physical rehabilitation in trochanteric fractures treatment between genders. In our study, the difference in increase of hip flexion with knee extended (it was higher in female) was noticeably closer to the level of statistical significancy rather in other motion tests. This could possibly be due to the eventual difference in lesser trochanter comminution frequencies among gender groups (these frequencies were not checked in the study), because Van der Sijp et al. [15], reported that a comminution of lesser trochanter can be a considered deaccelerating factor in injured hip flexion restoring.

In almost all patients (47 of 49 cases), GMS in hip area was either unchanged or improved compared with the level of the strength before physical treatment. Only two patients, treated by IM fixation, had worse level of GMS after the rehabilitation. Range of motions and GMS

are the parameters tightly related to both the hip function and gait, as well as quality of life. Lewis et al. [10], Liu et al. [16], and Schemitsch et al. [17], reported that there was no significant difference in functional state of the hip in a trochanteric fracture surgical treatment, when comparing intramedullary and extramedullary (DHS) fixation. Memon et al. [18] also presented evidence that there was no significant difference in mobility status of the injured hip between the intramedullary (PFN) and extramedullary (DHS) methods. Prakash et al. [19] reported that the average Harris Hip Score (HHS) was in average, 5 score points higher in the intramedullary (PFN) group compared to the extramedullary (DHS) group 24 weeks after surgery. Saarenpaa et al. [20], compared groups of patients who had trochanteric fracture surgery, by the use of SAHFE (Standardized Audit of Hip Fractures in Europe) scoring system for hip functionality, and found that the scores regarding the gait 4 months after surgery were better in extramedullary (DHS) group than in intramedullary (Gamma nail) group. In another study by Mitkovic et al. [8], it was reported that no significant difference in HHS and health-related quality of life (SF-12 questionnaire) was noted at least two years after trochanteric fracture surgery between the group with a Gamma nail and the group with a Self-dynamizable Internal Fixator (SIF).

Our statistical findings about no significant difference in hip functional recovery between intramedullary (IM) and extramedullary (EM) fixation are in correlation with several recent studies. Clinical trial by Schemitsch et al. found no significant difference in hip function outcomes such as mobility, pain, and daily activities between patients treated with intramedullary and extramedullary methods over a 12-month follow-up [21]. This aligns closely to the results of our study, denying any notable differences in hip flexion, extension, abduction, and overall muscle strength between the IM and EM groups. Similarly, Prakash et al. reported a slightly higher Harris Hip Score (HHS) in the IM group (about five points higher than in EM group) after 24 weeks of rehabilitation [19]. However, they concluded that the

difference was not clinically significant. This matches our results about a slightly higher muscle strength IM fixation, though not statistically significant.

Although Bilanović et al. [12], Gleich et al. [22], Grønhaug et al. [23], La Barbera [24], and Zeelenberg et al. [25] did not all directly evaluate postoperative hip function, they emphasized that both EM and IM are reliable options for fracture stabilization. Their conclusion, that the choice of implant should be based on the fracture type rather than an inherent superiority of one method, supports our finding that the quality of recovery appears similar regardless of the implant used. These studies also support the statement that while implant type may have some influence in complex or unstable fractures, it is not a determining factor for outcomes in stable fractures. Micro-movements between fixed fragments of a hip fracture could be expected to be lager in an unstable fracture, reducing the hip motions. In addition to the fracture stability, Zheng et al. found that five more factors (age, history of hypertension, blood transfusion, PARKER baseline score, adverse events occurred within 12 months postoperatively, discharge disposition, and time from surgery to weight-bearing) significantly influence one-year functional outcome following hip fracture surgery in geriatric patients [26]. Thus, they also didn't note that the choice between intramedullary or extramedullary fixation had important role in functional outcome.

The weakness of this study is the relatively small number of patients (less than 30 in both groups). Groups with more cases would be needed to more precisely explain the appearance of two patients in the intramedullary group with lower GMS after the physical treatment, and if the surgical approach through abductor muscles of the hip, following proximal femur intramedullary fixation technique, was the factor for this GMS decrease. Studies with more patients would also clear out whether the hip flexion improvement can still be significantly higher in SIF compared to IM fixation, as well as whether post physical hip flexion with the

knee extended can still be significantly more improved at women, in trochanteric fractures internal fixation.

CONCLUSION

Trochanteric fractures are common in patients over 70, usually caused by low-energy falls. Osteoporosis increases the risk but does not worsen recovery outcomes when care is properly managed. Surgical fixation is essential, followed by early and intensive rehabilitation. Two main techniques are used: extramedullary fixation, which may allow better hip flexion, and intramedullary fixation, which often leads to slightly better overall mobility. Studies show no major difference in final outcomes between men and women. This suggests that gender and bone density have limited impact on functional recovery. Successful rehabilitation requires a multidisciplinary approach. Early mobilization, tailored physiotherapy, and adequate nutritional and emotional support are crucial for restoring independence and quality of life.

Conflict of interest: None declared.

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Table 1. Distribution of fixation methods by gender

Fixation methods	Male	Female	p
IM	9	11	0.208*
SIF	8	21	
Average age (years)	73.5 ± 6.7	71.8 ± 8.5	0.514**

IM – intramedullary nail; SIF – Selfdynamizable internal fixator;

*χ^2 test

**Mann–Whitney U test

Table 2. Clinical parameters before and after physical therapy, for all patients

Parameters	Beginning of the physical therapy (seven weeks after surgery) *(mean ± SD)*	End of the physical therapy (10 weeks after surgery) *(mean ± SD)*	*p**
Hip flexion with knee extended (degrees)	34.8 ± 22.9	59.4 ± 25.1	< 0.001
Hip flexion with knee flexed (degrees)	52.3 ± 21.8	21.3 ± 14	< 0.001
Hip extension (degrees)	0	1 ± 2.7	0.015
Hip abduction (degrees)	16.1 ± 8.9	26.6 ± 12.2	< 0.001
General muscle strength	2.1 ± 0.6	2.7 ± 0.6	< 0.001

**Wilcoxon test*

Table 3. Improvement of clinical parameters due to applied physical therapy between SIF and IM group

Physical therapy improvement (E-B)*	SIF *(mean ± SD)*	IM *(mean ± SD)*	p**
Hip flexion with knee extended (degrees)	26 ± 12.3	22.5 ± 17.7	0.196
Hip flexion with knee flexed (degrees)	24.3 ± 12.7	17 ± 15.1	0.127
Hip extension (degrees)	1.4 ± 3.2	0.5 ± 1.5	0.422
Hip abduction (degrees)	10.2 ± 8.5	11 ± 9.8	0.769
General muscle strength	0.6 ± 0.5	0.7 ± 0.9	0.154

*B – beginning (seven weeks after surgery); E – end (ten weeks after surgery) of the physical therapy; IM – intramedullary nail; SIF – Selfdynamizable internal fixator;

**Mann–Whitney U test

Table 4. Improvement of clinical parameters due to applied physical therapy between genders

Physical therapy improvement (E-B)*	Male *(mean ± SD)*	Female *(mean ± SD)*	*p***
Hip flexion with knee extended (degrees)	20.3 ± 13.5	26.9 ± 14.9	0.125
Hip flexion with knee flexed (degrees)	23.2 ± 12.5	20.3 ± 14.9	0.855
Hip extension (degrees)	1.2 ± 2.8	0.9 ± 2.7	0.653
Hip abduction (degrees)	9.7 ± 7.2	10.9 ± 9.9	0.880
General muscle strength	0.6 ± 0.7	0.6 ± 0.7	0.970

*B – beginning (seven weeks after surgery); E – end (ten weeks after surgery) of the physical therapy;

**Mann–Whitney U test

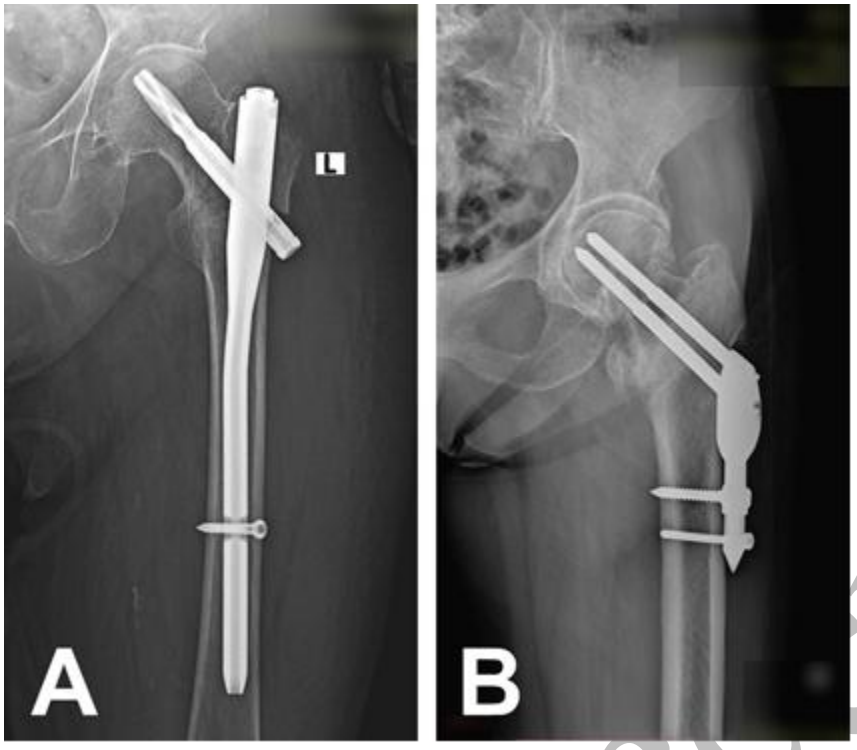

Figure 1. Intramedullary and extramedullary internal fixation methods used in the cases from the study; A – proximal femoral nail antirotation; B – Selfdynamizable internal fixator

