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Using the Pipkin classification in determining the treatment tactics of femoral head fractures

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Femoral head fractures are a rare injury with limited information in the literature. Recent studies have been based on small case series, indicating that the incidence of fractures in hip dislocation varies from 7 to 18 %. Fractures of the femoral head are classified according to Pipkin. Treatment is often accompanied by significant complications, and the choice of the optimal treatment method remains a matter of debate. The choice of treatment tactics affects the duration of treatment and functional outcome. The article presents the results of treatment of patients whose treatment tactics were based on the Pipkin classification. Objective. To substantiate the use of the Pipkin classification of femoral head fractures in the selection of treatment and diagnostic tactics. Methods. The study was performed by evaluating the results of treatment in 44 patients. The Pipkin classification was used to determine the treatment tactics. The results were evaluated according to the HHS scale. The results were statistically analysed by comparing the median scores for different groups using the Mann-Whitney U test. Results. The worst prognosis was for patients with Pipkin III and Pipkin IV fractures. HHS scores for patients with complicated outcomes are worse than for patients with uncomplicated outcomes. Treatment outcomes for Pipkin type III fractures are statistically significantly lower than for other types. Conclusions. Pipkin fractures are a rare and severe injury that can cause significant limb dysfunction with proper treatment. Treatment of Pipkin type I and type II includes immediate reduction of the dislocation and conservative treatment in case of satisfactory fragmentation or open reduction with metal osteosynthesis for displaced fractures; for type III and IV, open reduction and osteosynthesis are possible for young patients, and primary arthroplasty is recommended for patients over 60 years of age or with concomitant metabolic diseases.

Переломи головки стегнової кістки є рідкісною травмою, із обмеженою кількістю інформації в літературі. Дослідження останніх років базуються на невеликих серіях випадків, де зазначається, що частота переломів у разі вивиху стегна варіює від 7 до 18 %. Переломи головки стегна класифікують за Ріпкін. Лікування часто супроводжується значними ускладненнями, і вибір оптимальної методики залишається предметом суперечок. Від тактики лікування залежить як термін, так і функціональний результат. У статті презентовані результати лікування пацієнтів, під час визначення тактики лікування яких використовувалась класифікація Ріпкін. Мета. Обґрунтувати застосування класифікації переломів головки стегнової кістки за Ріпкін під час вибору лікувально-діагностичної тактики. Методи. Дослідження виконали шляхом оцінювання результатів лікування 44 пацієнтів. Під час визначення тактики лікування використовувалась класифікація за Ріпкін. Оцінювання результатів здійснювали за шкалою ННС. Проведено статистичний аналіз результатів — порівняння медіан оцінок для різних груп із використанням U-критерію Манна-Уїтні. Результати. Найгірший прогноз для пацієнтів із переломами Ріпкін III та Ріпкін IV. Оцінка за ННС для осіб з ускладненим перебігом гірша, ніж для пацієнтів з неускладненим. Результати лікування для переломів типу III за Ріпкін статистично значущо менші, ніж для інших типів. Висновки. Переломи Ріпкін — рідкісна та важка травма, яка за умов неправильно обраної тактики лікування може призвести до значного порушення функцій кінцівки. Лікування типів I та II за Ріпкін включає невідкладне вправлення вивиху й консервативне лікування у випадку задовільного розташування фрагментів або відкритої репозиції з металоостеосинтезом для переломів зі зміщенням; для типів III та IV у молодих пацієнтів можлива відкрита репозиція й остеосинтез, для осіб старше 60 років чи зі супутніми метаболічними захворюваннями рекомендується розглядати первинне ендопротезування, як варіант вибору. Ключові слова. Перелом головки стегнової кістки, вивих стегна, кульшовий суглоб, остеосинтез, ендопротезування.

Key words. Fracture of the femoral head, dislocation of the hip, hip joint, osteosynthesis, endoprosthetics

Introduction

Fractures of the femoral head were first described by Birkett in 1869 [1]. This injury is rare and literature sources have a limited amount of information about it, which is mostly based on small case series. One of the most recent meta-analyses included information from 15 publications, in which a total of 274 patients were described for the period 1996–2020 [2]. According to Braun et al. the frequency of head fractures due to hip dislocation varies from 7 to 18 % [3], while Enocson et al. report a frequency of 5–15 % [4]. Usually, dislocation of the hip in combination with a fracture of the femoral head is the result of high-energy trauma (traffic accidents (TA) — 84.3 %, motorcycle injuries — 5.15 %, falls — 4.3 %) in young people (approximate average age of patients is 38.9 years old) [3, 4].

The most common classification of this injury is according to Pipkin, which distinguishes it into four different types, depending on the location of the fracture of the femoral head and the presence of a concomitant fracture of the femoral neck or acetabulum [5].

The type of fracture that occurs depends on the mechanism of injury. Previously, it was believed that different fracture configurations were caused by the retaining effect of the ligament of the femoral head, but more modern studies show that damage to the ligament in case of dislocation can only cause the detachment of a small bone-cartilaginous fragment [3]. According to modern views, the fracture is caused by the shearing effect of the acetabulum wall on the head of the femur [6]. Usually, the morphology and type of Pipkin fracture depends on the position of the hip at the time of injury. In the case of hip flexion less than 60° and adduction, type I according to Pipkin is typical (the medial part of the femoral head is “cut” by the massive posterior wall of the acetabulum). Abduction of the hip during its flexion less than 60°, for the most part, leads to type II according to Pipkin. In the case of hip flexion of more than 60°, the head of the femur opposes the thinner part of the back wall of the acetabulum, which can lead to its fracture in combination with cartilage damage, impression fracture of the head or its fracture (type IV according to Pipkin) [7]. Pipkin III fractures are characterized by a double mechanism of injury — the first stage is dislocation of the femoral head with its fracture with a shearing mechanism (similar to Pipkin I and Pipkin II), further abduction causes a fracture of the femoral neck due to its contact with the posterior edge of the acetabulum [8].

Studies published in the literature usually focus on different subtypes of Pipkin fracture, and report negative outcomes with a high complication rate and reoperation rate that can be as high as 57 % [7, 9].

The choice of the best method of treatment for this injury is a matter of controversy and includes the possibility of both non-surgical treatment and surgical excision of the fragment, osteosynthesis of the fracture, or primary arthroplasty.

The main question to be answered is which treatment strategy improves function and reduces the number of complications. We hypothesize that presenting the results of a series of patients with femoral head fractures who were treated according to the proposed therapeutic algorithm will shed light on the course of treatment of such injuries. In this study, we present information about the initial treatment, the obtained results, and the detected complications during the follow-up of patients with femoral head fractures in a series of consecutive clinical cases who were treated in the same medical center according to the same therapeutic recommendations.

Purpose: to substantiate the use of Pipkin’s classification of femoral head fractures during the selection of therapeutic and diagnostic tactics.

Material and methods

The study involved 44 patients diagnosed with femoral head fractures. The average age of the participants was 36.4 years and varied from 22 to 69 years. The condition for inclusion in the study was the presence of an isolated fracture of the femoral head or in combination with a fracture of the neck or acetabulum. An important condition was that patients have no history of injuries or diseases, in particular, primary or secondary coxarthrosis.

Operations and follow-up examinations were carried out in the traumatology department of Zaporizhia Regional Clinical Hospital of Zaporizhia Regional Council and traumatology department of MOTOR-SICH CLINIC LLC in the period from 2008 to 2023. All patients were informed about their participation in the clinical trial and familiarized with its design, and gave their consent to participate.

The diagnosis was established on the basis of clinical examination findings — symptoms of a femoral neck fracture, hip dislocation. Unconscious patients with a history of high-energy trauma (traffic accident, fall from a height) received special attention. The next step was radiography — a classic anterior-posterior projection. The area of the neck of the femur deserves special attention for the purpose of early diagnosis of type III fractures according to Pipkin. An obliqua-

tory option when diagnosing a patient with a fracture of the femoral head and/or hip dislocation is to perform radiography in additional projections, which were replaced by computer tomography.

The choice of treatment tactics was carried out taking into account the type of fracture according to the Pipkin classification and clinical data. Systematized according to the following types:

- I — dislocation of the hip with a fracture of the head of the femur below the point of attachment of the round ligament (pit of the head);
- II — dislocation of the hip with a fracture of the head of the femur above the point of attachment of the round ligament;
- III — type I or II in combination with a femoral neck fracture;
- IV — type I or II together with a fracture of the acetabulum.

In patients with Pipkin I and Pipkin II fractures, a closed dislocation reduction was attempted under general anesthesia. The impossibility of closed reduction was considered as an indication for urgent surgical treatment — open dislocation reduction and metallo-osteosynthesis with screws.

Metallosteosynthesis of the femoral head was performed with cannulated screws with a diameter of 4.0 mm, the length of the screw was determined intraoperatively using fluoroscopy.

In the postoperative period, all patients received standard treatment — wound dressings, two-day antibiotic prophylaxis with second-generation cephalosporins, prevention of thrombosis with low-molecular-weight heparins, adequate analgesia (NSAIDs + paracetamol), PPI gastroprotection, mechanical thromboprophylaxis, physical therapy. Rehabilitation took place excluding axial load in all groups for 6 weeks.

Clinical outcome was assessed using the Harris Hip Score (HHS) scale with a maximum possible score of 100, i. e. a higher score indicates a better outcome. The assessment on the HHS scale was classified as follows: poor (< 70 points), satisfactory (70–80), good (80–90) and excellent (score 90–100 points) [10]. The results were analyzed no earlier than 6 months after surgery. The presence of avascular necrosis, heterotopic ossification, osteoarthrosis, and fracture union were radiologically evaluated. Any postoperative complications were also highlighted: infection, arterial damage, sciatic nerve neuropathy, dislocation, and conversion to total hip arthroplasty.

Statistical processing of the obtained numerical values was carried out using the license package STATISTICA 13 En (License JPR709H998119TE-A). The median and confidence interval for the median were used to analyze the HHS scores (ordinal type of scale), using the methods of nonparametric variational statistics — the Mann-Whitney U-test. The difference between sample values was considered significant if p value ≤ 0.05.

A clinical example

A 22-year-old patient L. with posterior superior fracture dislocation of the femoral head, damage to the femoral head according to the Pipkin I type (Fig. 2, a). An open reposition was performed through a posterior approach with osteosynthesis of the fracture with screws (Fig. 2, b).

Results

Of the 44 patients included in the study, 9 (20.45 %) were found to have complications. Aseptic necrosis of the femoral head was most common — 6 cases (13.63 %), two patients developed heterotopic ossification in the intervention area (4.54 %), one

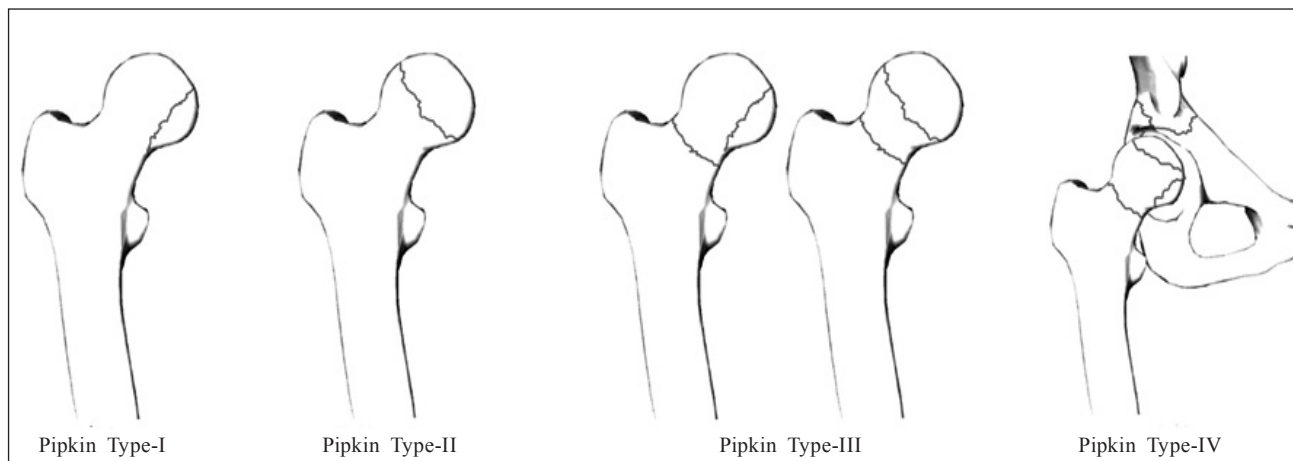


Fig. 1. Classification of femoral head fractures according to Pipkin [9]

had a loss of stability of the fixator (screws) (after metal-osteosynthesis of a Pipkin-type fracture II) (2.27 %). During observation, no non-unions, infectious complications, cases of hip joint instability, etc. were detected.

The median and 95 % confidence interval for the HHS scale was 82.1 points (95 % CI = 64–98). According to the HHS scale, poor, fair, good and excellent results were observed in 2 (4.5 %), 7 (15.9 %), 14 (31.8 %) and 21 (47.7 %) patients, respectively. Of the two individuals with poor results, one had Pipkin type III and the other one had type IV. The breakdown of HHS status by Pipkin type is shown in the Table. The obtained results indicate the worst prognosis for patients with Pipkin III and Pipkin IV fractures, which corresponds to the data of the literature [11].

The median HHS score was 71.3 points (95 % CI = 64–83) in patients with a complicated outcome and 87.4 (95 % CI = 77–98) in patients with an uncomplicated outcome. This difference was statistically significant ($p = 0.007$).

The median HHS score was 92.0 (95 % CI = 88–94) for Pipkin type I; 87.0 (95 % CI = 82–91) — for Pipkin II type, 68.5 (95 % CI = 64–73) — for Pipkin III type, and 82.0 (95 % CI = 77–88) — for Pipkin IV type. During a sequential comparison of the median scores for HHS for each type with the overall median, it was determined that the score for type III fractures was statistically significantly lower ($p = 0.035$).

No statistically significant difference was found for other types.

Discussion

Femoral head fractures require immediate treatment within 6 hours from the moment of injury — dislocation reduction or, if indicated, surgical treatment (metalosteosynthesis, total arthroplasty, removal of fragments).

Closed reduction of dislocations is possible in case of Pipkin I and Pipkin II fractures, followed by conservative treatment of the patient in the case of satisfactory reduction and close contact of the fragments,

Table

Distribution of indicators of HHS status according to the Pipkin classification

Type	Excellent	Good	Satisfactory	Poor	Total
Pipkin I	12 (75.0 %)	4 (25.0 %)	—	—	16 (100.0 %)
Pipkin II	3 (42.8 %)	3 (42.8 %)	1 (14.3 %)	—	7 (100.0 %)
Pipkin III	—	—	1 (50.0 %)	1 (50.0 %)	2 (100.0 %)
Pipkin IV	6 (31.6 %)	7 (36.8 %)	5 (26.3 %)	1 (5.3 %)	19 (100.0 %)
Total	21 (47.7 %)	14 (31.8 %)	7 (15.9 %)	2 (4.5 %)	44 (100.0 %)

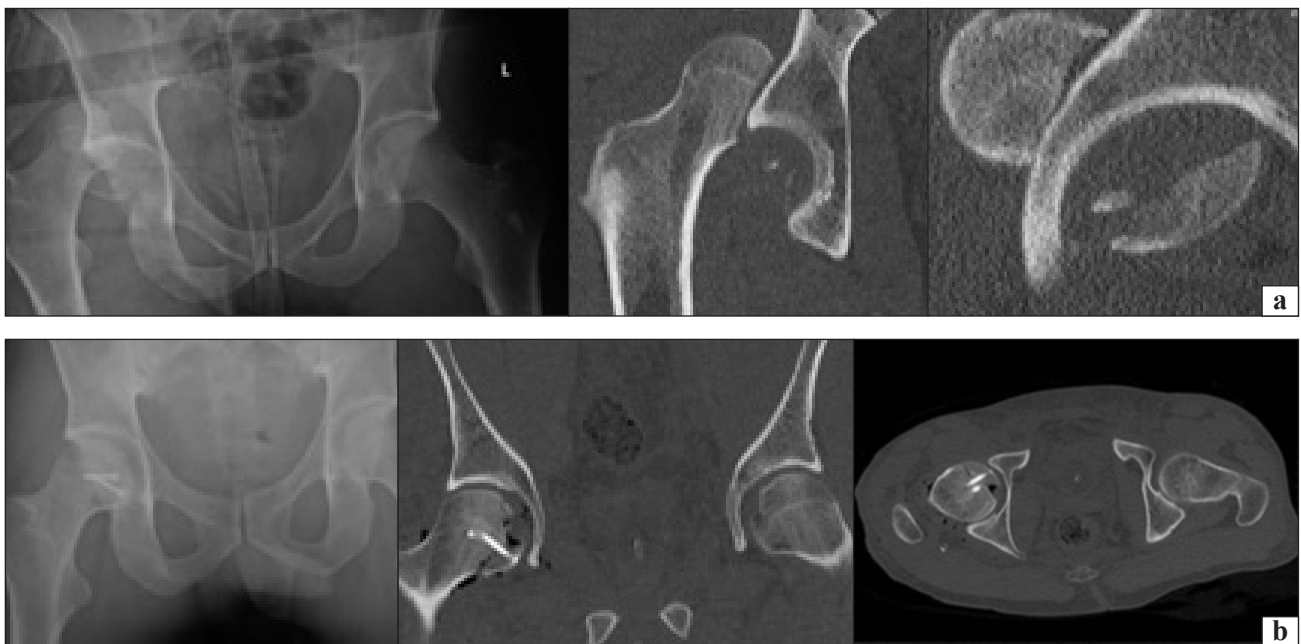


Fig. 2. Photographs from X-rays of patient L. after injury (a) and after surgery (b)

which is confirmed by CT data and the absence of joint instability.

Removal of the bony fragment for Pipkin I fractures should not be considered as an option. Preference should be given to osteosynthesis except for situations in which osteosynthesis is impossible (small size of the fragment, its significant impression, etc.). Based on the biomechanical research data of D. Dong et al. — the method of bone fragment removal for Pipkin I fractures, where the authors concluded that removal is justified only for small bone fragments, the size of which made metalosteosynthesis impossible [12].

Pipkin III fractures are the least common and have the worst prognosis. It is advisable for patients to undergo an MRI — a study aimed at evaluating the process of blood supply to the femoral head and the state of articular cartilage. It is also necessary to take into account the age of the patient and the presence of concomitant abnormalities, in particular, diabetes mellitus, metabolic disorders, rheumatological diseases. If there is a risk of non-union of the fracture (age over 60 years, concomitant diseases, complex morphology of the fracture), it is worth considering the tactics of primary total endoprosthetic repair of the hip joint. If osteosynthesis is performed, it is necessary to monitor the condition of the joint and the rehabilitation of the patient every 3 months, if necessary, timely conversion to an endoprosthesis.

Osteosynthesis of the acetabulum and femoral head fracture is the treatment of choice for Pipkin IV fractures in young patients.

Considering the high percentage of unsatisfactory functional results and the high frequency of osteosynthesis conversion during arthroplasty in the early stages in the elderly with Pipkin type III and IV fractures, and for patients older than 60 years, primary total hip arthroplasty may be considered as the option of choice.

Conclusions

Pipkin's fractures are a rare injury, in case of wrong tactics or untimely treatment, it can lead to severe impairment of limb function. Patients with fractures of the femoral head, regardless of the type, need urgent treatment: in the presence of dislocation — reduction; if fragments are displaced, open

reposition and metal-osteosynthesis (if fixation is impossible, fragment removal). Patients older than 60 years or with concomitant metabolic diseases can be recommended primary arthroplasty.

Conflict of interest. The authors declare no conflict of interest.

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