Review Article
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# Hoffa Fracture: Review

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**Abstract**
Hoffa fracture is an extremely rare injury of one or two condyles of the femur in the frontal plane, more often associated with injury to other structures of the knee joint area. The main cause of the Hoffa fracture is considered to be a high-energy injury (road accident — in 80.5% of cases). The isolated Hoffa fracture accounts for 0.65% of all femoral fractures. To date, there is no consensus on surgical approach or optimal technique of internal fixation for the frontal fracture of the femoral condyles. There is also a large percentage of mistakes in the X-ray diagnosis of this pathology. The existing classifications have not found wide application in clinical practice, being difficult and inapplicable for solving the issue of treatment tactics and preoperative planning. The aim of the study is to present modern views on the diagnosis, principles and techniques of surgical treatment of patients with the Hoffa fractures based on the analysis of the literature. Based on the analyzed literature, conclusions are drawn about the need for careful collection of injury anamnesis, increased surgeon caution in the presence of this injury clinical picture and the simultaneous absence of pathology on standard knee joint X-rays, the need to perform an additional examination in the form of lateral (non-standard) projections of the knee joint X-rays, CT or MRI. During preoperative planning, preference should be given to minimally invasive technologies, including arthroscopically-associated methods of treatment.

**Keywords:** Hoffa fracture, frontal femoral condyle fracture, hidden fracture.

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# Перелом Гоффа: обзор иностранной литературы

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**Реферат**
Перелом Гоффа (ПГ) — это крайне редкая травма одного или двух мыщелков бедренной кости во фронтальной плоскости, чаще ассоциированная с повреждением других структур области коленного сустава. Основной причиной ПГ считается высокоэнергетическая травма. На долю изолированного перелома Гоффа приходится 0,65% всех переломов бедренной кости. На сегодняшний день не существует единого мнения о хирургическом доступе или оптимальной технике внутренней фиксации при фронтальном переломе мыщелков бедренной кости. Также существует большой процент ошибок при рентгенологической диагностике данной патологии. Существующие классификации не нашли широкого применения в клинической практике, являясь громоздкими и неприменимыми для решения вопроса о тактике лечения и предоперационного планирования. Цель обзора — на основании анализа литературы представить современные взгляды на диагностику, принципы и технику хирургического лечения пациентов с переломами Гоффа. На основе анализа литературы сделаны выводы о необходимости тщательного сбора анамнеза травмы, повышенной настороженности хирурга при наличии клинической картины данного повреждения и одновременного отсутствия патологии на стандартных рентгенограммах коленного сустава, необходимости выполнять дополнительное обследование в виде боковых (нестандартных) проекций рентгенографии коленного сустава, СКТ или МРТ. Во время предоперационного планирования следует отдавать предпочтение малоинвазивным технологиям, в том числе артроскопически-ассоциированным методам лечения.

**Ключевые слова:** перелом Гоффа, фронтальный перелом мыщелка бедренной кости, скрытый перелом.

**Источник финансирования:** исследование проведено без спонсорской поддержки.

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## Background

Hoffa fracture (HF) is a rare injury to one or both femoral condyles in the frontal plane. The fracture was first described by Albert Hoffa in 1904, but the general recognition of this pathology by the orthopedic community came in the 1970s after the appearance of J. Letenneur's classification of frontal femoral fractures [1] and its publication in the 2nd edition of the Manual of Internal Fixation [2].

HF is often associated with multiple high-energy injuries of the knee joint area [3]. Therefore, according to S. Pathak et al., it is sometimes not diagnosed during routine research [4]. Based on the insignificant frequency (on average, isolated HF occurs in 0.007% of all bone injuries), studies on this injury are relatively few represented in the scientific literature. Thus, O. Martinet et al. believe that the share of all fractures of the distal femur accounts for 6%, and HF, according to Y. Zhou et al. account for only 8.7-13.0% of intra- and periarticular injuries [5, 6]. However, the results of a retrospective study performed by S.E. Nork et al. showed that, out of 220 cases of supra- and transcondylar femoral fractures, associated HF was detected in 38.1%, but isolated HF was diagnosed in only 0.65% of all femoral fractures [3].

M. Manfredini et al. showed that due to the anatomical features of the region, a fracture of the lateral condyle occurs in 78-87% of HF: physiological valgus of the distal femur leads to the primary involvement of its external part in the structure of the injury [7]. According to the research of B. Harna et al., bicondylar HF is more common in the children's age group [8].

Most researchers consider high-energy trauma to be the main cause of HF in young people (road accidents, including motorcycle injury – 80.5%, catatrauma – 9.1%), with an average age of 42.8 years, men of working age twice prevail [6]. In elderly people and patients with severe osteoporosis, this injury is more often caused by low-energy trauma. In addition, Y. Zhou and S.E. Nork et al. investigated the causes and nature of iatrogenic HF [4, 6].

According to J.-S. Bel et al., in 95% of cases of HF, a decision is made on surgical treatment [9]. Surgical treatment is also recommended for HF without displacement of fragments due to the high risk of secondary displacement, non-union, development of post-traumatic osteoarthritis, contractures and other complications, while there is currently no consensus on surgical approaches and optimal technique of internal fixation [10].

It should be noted a large percentage of mistakes in the diagnosis: according to W. Mak et al., with standard radiography of the knee joint in two projections (direct and lateral), the correct diagnosis is established in less than 70% of cases, so many researchers classify HF as a "hidden fracture" [11].

*The purpose of the review* is to present modern views on the diagnosis, principles and techniques of surgical treatment of patients with HF based on the analysis of the literature.

## Diagnostic features

HF without displacement are usually difficult to diagnose from radiographs made in standard projections, because the fracture line is overlapped by the lateral condyle. The latter, according to M. Manfredini et al., leads to wrong radiological conclusions in 30% of cases [7]. Radiography should include a straight, lateral, internal or external oblique projection (if injury to the lateral or medial condyle is suspected, respectively). Also, when detecting hemarthrosis and severe pain syndrome, it is necessary to suspect a "hidden" fracture of the knee joint area, which, according to J.S. Apple et al., turns out to be HF in 14% of cases [12]. Computed tomography (CT) remains the gold standard for the diagnosis of intra-articular fractures, and in the case of HF, CT allows you to determine the presence of fracture and its nature, the degree of displacement and the location of the fracture line relative to soft tissues. This makes it possible to adequately classify this injury and determine further treatment tactics [13]. According to S.E. Nork et al., among 102 patients who underwent CT, HF was diagnosed in 47. In the control group of 100 patients who did not undergo CT, the injury in question was detected only in 29% – 1.5 times less often [3].

In connection with the above, A.M. Wagih considers it necessary to increase the alertness of orthopedic surgeons to potential HF. In his opinion, in such patients anamnesis and the mechanism of injury must carefully collected. Most of the patients note instability of the knee joint in the 30 ° flexion position, but with full extension, instability is not determined. With timely undiagnosed HF, patients will experience pain and restricted movement in the knee joint, followed by the development of post-traumatic osteoarthritis [14].

An analysis of the literature shows the need for a thorough clinical examination of a patient with knee joint injuries, the appointment of more complex studies (CT and MRI) in any doubtful cases, especially taking into account the careful collection of anamnesis and understanding of the injury mechanism.

## Mechanism of injury

The most common cause of high-energy injuries in the modern world remain road accidents. Y. Zhou et al. described in detail the mechanism of injury that leads to HF during an accident: during collision on a knee bent at 90 degrees, a large inertial force causes a shock load in the direction from the proximal femur to the condyles of the lower leg. At the same time, the braking force creates high shear forces between the femoral condyles and the tibial plateau, which leads to the displacement of the femoral condyle in the ascending direction, as well as ruptures of the quadriceps tendon, its own patellar ligament, severe dislocations of the lower leg and other injuries. Depending on the valgus or varus direction of the axial force, fractures of the lateral or medial femoral condyle occur, and two-condyle injuries are possible [6].

Low-energy fractures of the femoral condyles were studied by A.K. Mootha et al.: in addition to elderly people and patients with severe osteoporosis, HF occur in patients who have had polio and have long-term consequences in the form of paresis of the lower extremities, as well as in cases of bone hypoplasia or some metabolic disorders [15].

The main cause of iatrogenic HF is considered by B.C. Werner and M.D. Miller to be incorrect surgical interventions during the reconstruction of the anterior cruciate ligament (ACL) [16]. The most common surgical mistake during surgery is the incorrect formation of the bone canal in the lateral femoral condyle, which causes up to 70% of the unsatisfactory results of the ACL reconstruction . J.P. Rue et al. came to the conclusion that when the femoral canal is formed too close to the posterior edge of the articular surface, tendon conduction, as well as its fixation with an interference screw, can lead to a fracture [17]. The same conclusions were reached by T.S. Wilson et al., considering intraoperative destruction of the posterior wall of the canal as a technical error of the operative technique [18]. Both groups of researchers calculated that the bone canal for grafting and fixing with a screw with a diameter of more than 20% of the total diameter of the femur reduces bone strength by more than 2 times. Therefore, the formation of a bone canal of more than 10 mm is always accompanied by a risk of fracture, especially in delicate patients. A single case of stress fracture of the proximal femur to the formed canal 8 months after surgery has also been described [18].

Based on the specific mechanism of this injury, increased alertness of the doctor is necessary when examining and collecting anamnesis in patients with suspected HF. The described clinical picture, the specific mechanism of injury of the knee joint, located at a certain angle at the time of exposure to it, both in young people and in elderly patients, are indications for the appointment of radiography in atypical planes, CT and MRI of the knee joint to exclude HF.

## Classifications

Currently, several classifications of HF are known: the first and most famous among foreign surgeons is the classification of J. Letenneur (1978), the classification of W.H. Li (2013), V. Bagaria (2019), the classification of AO with additions (2018) [1, 19, 20, 21 22].

J. Letenneur divided HF into three types. Type I (the most common): the fracture line runs parallel to the posterior cortical layer of the femur with the involvement of the entire condyle. Often, the fracture line is located at the site of attachment of the ACL and lateral collateral ligament (LCL) to the femur, while the tendon of the popliteus muscle (TPM) and the lateral head of the gastrocnemius muscle (LHGM) remain attached to the distal fragment. Type II: the fracture line is located posteriorly and parallel to the posterior cortical layer of the femur, also posteriorly from the attachment of the LCL; it is divided into 3 subtypes depending on the attachment of soft tissues to the fragment. The fragments located behind the dotted line "a" retain the attachment of the TPM and LHGM. The fragments located behind the dotted line "b" retain partial attachment of the TPM or LHGM. There is no attachment of soft tissues to the fracture fragments located behind the dotted line "c". Type III: oblique fracture of the femoral condyle involving the entire condyle with a fracture line located anteriorly from the joint capsule, ACL, LCL, TPM and LHGM (Fig. 1).

In fractures of types I and III, the prognosis is favorable, because soft tissues retain attachment to fragments, thereby providing sufficient blood supply to the fracture area. With type II injuries, there is a high risk of non-union and avascular necrosis due to poor blood supply (intra-articular fracture with the formation of a free intra-articular fragment) [1].

W.H. Li et al. improved the Letenneur classification in 2013. After additional CT imaging, two lines are drawn in the sagittal plane of the thigh: the first is the anatomical axis of the thigh, the second is parallel to the axis of the thigh, and the third line is drawn along the posterior cortical layer of the femur. Thus, the distal femur is divided into three parts [19]. However, due to the sufficient complexity, this classification has not been widely recognized in the scientific literature and is mentioned only in the work of Y. Zhou et al. [6].

According to the AO classification, HF are classified as 33-B2 and 33-B3 [21]. However, due to excessive generalization, A. Dua and R. Shamshery consider it impossible to use this classification for preoperative planning. The researchers proposed an addition to the AO classification (2010), identifying 4 subtypes of HF, and tried to adapt the classification to select the type of fixation. The proposed clarifications are based on the location of the fracture line and combined injuries of the distal femur. Type I is characterized by an isolated frontal fracture of one condyle, while the authors consider it sufficient to fix such injury with two or three spongy screws carried out in the anteroposterior direction. Type II, in which both condyles of the femur are involved, requires fixing both condyles with screws, also in the anteroposterior direction. In these cases, if the line of one of the fractures is proximal to the other, a medial or lateral buttress plate is required. Type III is a single-condylar HF with associated supracondylar fracture, type IV is a single-condylar HF with a comminuted intraarticular fracture of the distal femur in other planes. In case of injuries of types III and IV, osteosynthesis of the fracture is performed similarly to isolated HF with additional fixation of the concomitant fracture with a buttress plate [22].

V. Bagaria et al. identified 4 types of HF in 2019: type 1 — all frontal fractures with a fragment of more than 2.5 cm coming from the posterior edge of the condyle, type 2 — a fragment of less than 2.5 cm, type 3 — a comminuted fracture of one condyle, 4a — a frontal fracture of the anterior femoral condyle, 4b — a bicondylar fracture, 4c — an osteochondral fracture, 4d - HF associated with a supracondylar fracture [20] (Fig. 2). Depending on the type of fracture, the tactics of surgical treatment are determined, i.e. in type I, it is recommended to carry out spongy screws in the anterior-posterior direction (hereinafter A-P), type II — carrying out spongy screws in the posterior-anterior (hereinafter P-A), type III — carrying out spongy screws with additional fixation with a buttress plate; 4a - fixing screws in the direction A-P, 4b — tactics is determined depending on the size of the fragment and the nature of the fracture, 4c — fixing with a Herbert screw or biodegradable screws, 4d – fixing with spongy screws with additional fixation by locking plate for the distal femur (Fig. 3).

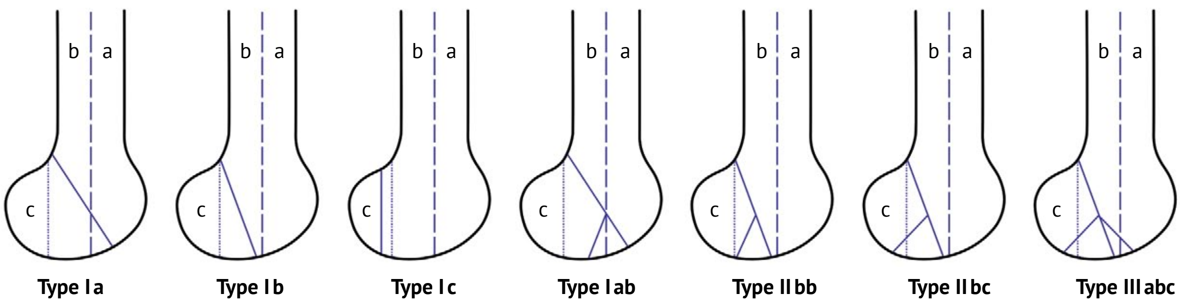


**Fig. 1.** Letenneur's classification (1978) [1]

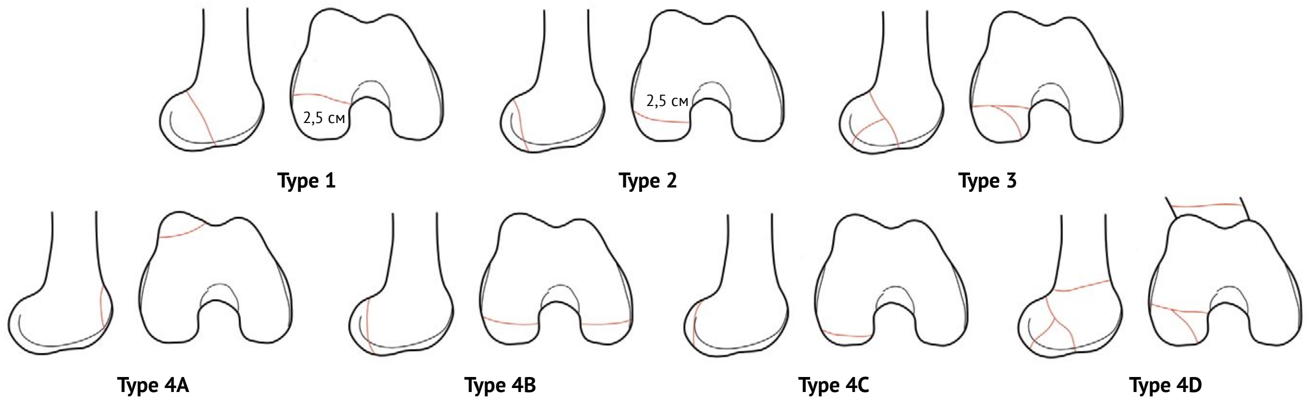


**Fig. 2.** Classification of V. Bagaria et al. (2019)

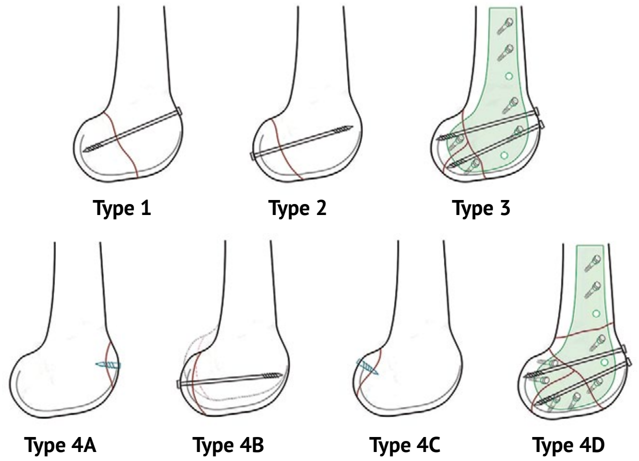


**Fig. 3.** Osteosynthesis with screws and plate for all types of the Hoffa fracture

The determination of the size of the fragment is 2.5 cm due to the average value of the compression ability of spongy screws with a thread length of 16 mm.

The classification is based on a retrospective analysis of 30 cases of HF in the period 2013-2017, as well as 77 studies that meet the requirements of “Hoffa's fracture", "coronal fracture", "osteochondral fracture distal femur", "Letenneur classification", describing 412 cases of HF. The main goal of the authors was the convenience and universality of classification for preoperative planning. Assessment of the perception of classification was carried out by six independent surgeons. As a result, the kappa Cohen consistency coefficient reached 1, which means a complete match, the so-called the consent of experts in the study of the material [20]. The classification was published relatively recently — in 2019, which is probably why it has not yet found wide application among surgeons. Nevertheless, it seems to be quite universal and convenient for the unification of fractures and the definition of surgical treatment tactics.

Currently, the Letenneur classification remains the most frequently mentioned among foreign surgeons and appears in all the articles studied, but it does not meet the criteria necessary for preoperative planning, it is cumbersome. An increase in interest in this pathology and the emergence of new, including improved classifications based on CT imaging, may gradually lead to a decrease in the popularity of the Letenneur classification, leaving it only as the historically most well-known.

## Features of treatment

A. Dua and P. Shamshery perform conservative treatment for HF without displacement of fragments: immobilization is carried out in the average physiological position of the knee joint (flexion 20–35°). Also, conservative treatment of a bicondylar HF is possible using skeletal traction carried out through the tuberosity of the tibia. However, in most cases, secondary displacement, joint contracture and early development of osteoarthritis are observed [22]. Therefore, the overwhelming number of researchers are inclined to early internal fixation of this injury.

## Surgical approaches

The choice of surgical approach depends on the location and nature of the fracture, but there are no generally accepted recommendations [6, 13]. Most authors use standard lateral and lateral parapatellar approaches when the lateral condyle is damaged.

Some authors believe that combined lateral parapatellar approach with Gerdy tubercle osteotomy provides the most adequate visualization for bicondylar HF. A skin incision is made from the middle of the lateral condyle of the femur along the iliotibial tract, not reaching 2 cm to the tuberosity of the tibia, passing between the Gerdy tubercle and the anterior edge of the fibular head; skin, soft tissues are mobilized, the Gerdy tubercle is released. Osteotomy of the anterior part of the tubercle is approximately 10 mm wide, 20 mm long and 7-10 mm with the place of attachment of the iliotibial tract, which is diverted in the proximal direction. The m. biceps, LCL, popliteus muscle, posterolateral joint capsule, posterior horn of the lateral meniscus are visualized [23, 24, 25].

With a medial fracture of the femoral condyle, medial parapatellar approach is more often used. In addition, D.G. Viskonas et al. describe medial "subvastus" access. The researchers consider the advantages of the latter to be the preservation of the quadriceps femoral muscle, good visualization of the patellofemoral ligament with its subsequent anatomical restoration, preservation of the medial superior knee artery, which reduces the risk of avascular necrosis and non-union [26].

To fix fractures of the external condyle at the end of the last century (1999), a modified anterolateral "swashbuckler" ("hooligan") access was described: a lateral approach located between the lateral patellofemoral ligamnet and M. vastus lateralis. A parapatellar arthrotomy is performed, m. quadriceps with the patella are removed medially, which allows you to visualize almost the entire articular surface of the distal femur. The advantage of approach is its location: the skin incision does not interfere with subsequent approach during knee arthroplasty [27].

In some cases, technically more complex approaches are also offered. Thus, Y. Tan et al. describe a variant of posterolateral approach starting from the space between the N. peroneal and biceps femoris muscle [28]. M. Gao et al. propose a minimally invasive posteromedial approach that begins between M. gracilis, the medial head of m. gastrocnemius and the medial collateral ligament [29].

W. Orapiriyakul et al. conducted a large study on cadaveric material based on the Letenneur classification, as a result of which the following data were obtained. With HF of the medial condyle with a distal fracture fragment of less than 18.3% of the length of the medial condyle in the anteroposterior direction and a fragment of less than 10.1%, similarly for the lateral condyle, parapatellar approaches incompletely visualize the fracture zone, which corresponds to type II according to the Letenneur classification. However, with a fragment of more than 28.7% for the medial condyle and more than 19.9% for the lateral condyle, parapatellar approaches are recommended. Direct posteromedial and posterolateral approaches are recommended in the case of fragments less than 28.7% for the medial and less than 19.8% for the lateral condyles, respectively [30].

An analysis of the literature shows that even though there is not always sufficient visualization of the fracture area, most researchers tend to fairly simple and accessible parapatellar medial and lateral approaches. Posterior approaches due to the high risk of nearby major vessels and nerves injury are technically extremely difficult and require high skill. However, in some cases, given the small size of the displaced fragments or other features, they need to be considered during preoperative planning after adequate two- and three-dimensional visualization of the fracture area.

## Arthroscopy options

Considering surgical approaches, it is impossible not to bypass the options of modern arthroscopy, while standard ports are usually sufficient [14, 31]. The advantages of arthroscopic treatment are known: this is a low injury rate, minimal impact on blood supply, early exercise and, as a result, prevention of contractures. In HF arthroscopic technique due to the limited intra-articular space for manipulation is not always applicable. However, visualization of the soft tissues interposition and their elimination is technically feasible arthroscopically, while the most difficult tasks are reduction and carrying out screws perpendicular to the fracture line. A.M. Wagih and A. Goel independently describe the course of therapeutic and diagnostic arthroscopies of the knee joint with a frontal fracture of the lateral femoral condyle [14, 31]. After diagnostic part, the knee joint bends to 120°, the distal fragment is fixed with an arthroscopic instrument. In the femoral condyle, 2 k-wires are percutaneously carried out, along which cannulated screws are inserted, after having countersink the insertion point to immerse the screw heads below the surface of the articular cartilage.

With all the current trends in reducing the traumatic nature of surgery, one of the goals of which is arthroscopic technique, it is impossible not to mention the risk of possible negative consequences. Thus, the possibility of developing one of the most formidable complications — compartment syndrome, has been known since the last century [32]. At the same time, the probability of injury to the joint capsule leading to the release of the solution into the soft tissues is extremely high. Nevertheless, a number of authors consider arthroscopically assisted fracture fixation technique to be quite safe [33, 34].

In contrast to fractures of the tibial plateau, relatively few works have been devoted to the arthroscopic technique of HF fixation. Limiting factors in the use of the technique are technical difficulties in the manipulation of fragments and their reduction, removal of soft-tissue interponents, difficulties in carrying out various hardware, especially if additional fixation with a plate is necessary. However, significant advantages in the form of good visualization of the fracture, including subchondral injuries, combined with low trauma and skin scars insignificant for any subsequent surgeries, make arthroscopy one of the most promising methods of treating HF.

## Implants selection and fixation technique

Back in the last century, S. Lewis et al. showed that fixation with two or three cortical or spongy screws (cannulated or conventional) of various diameters is sufficient to eliminate possible rotation and secondary displacement of femoral condyle fracture fragments [10]. The main screw was inserted from the intact extra-articular anterolateral surface of the lateral condyle in the posterior direction, an additional screw was carried through the lateral outer fragment to the center of the diaphysis inside to eliminate the rotational component. S.Y. Lee et al. demonstrated a satisfactory result of fixation with six Herbert compression screws with a diameter of 4.5 mm, carried out in the P-A direction of the two-condyle HF [23]. The advantage of this fixation was considered to be a smaller square of injury to the articular surface and, accordingly, a lower risk of developing post-traumatic changes in the joint.

For long-standing fractures of the femoral condyles, M.P. Somford et al. proposed options for internal fixation using Herbert compression screws with a diameter of 5.0 and 6.5 mm with a bone autograft from the iliac crest, while a neutralizing plate should additionally be implanted [35].

A. Dua et al. describe the osteosynthesis of a bicondylar HF with three spongy screws 6.5 mm in diameter, carried out in the direction A-P proximal to the articular surface, strictly perpendicular to the fracture line; the lateral condyle is additionally fixed by a buttress plate due to the concomitant supracondylar fracture [22].

A number of researchers believe that screws in combination with a lateral or posterior anti-slide buttress plate are indicated for patients who have a high body mass index (BMI) or will not (cannot) comply with the recommended regimen. Also, an additional fixator can be recommended for patients with osteoporosis, fractures passing to the metaphysis of the femur and multifragmental HF. It should be especially noted that the use of posterior buttress plate damages more soft tissues, especially the place of attachment of the head of the gastocnemius muscle. The latter can lead to disruption of the fragment's blood supply, while the lateral plate provides fairly stable support and, in combination with an autograft, demonstrates consolidation even with long-standing fractures [6, 35, 36].

The results of biomechanical tests conducted by independent scientists are interesting, the purpose of which was to find an adequate method of fixation and study the factors affecting the strength of osteosynthesis. So, G.J. Jarit et al. in their study performed osteotomy of the femoral bones on 8 cadavers, then used two methods of fixing the femoral condyles: 2 screws with a partial thread with a diameter of 6.5 mm and 2 similar screws in the direction of P-A were carried out in the A-P direction. The difference in the load applied to the displacement of the fragments fixed by the screws was significantly greater for the screws held in the P-A direction [37]. However, due to technically difficult approach and a high risk of injury to the neurovascular structures, carrying out screws in the P-A direction is used less often by surgeons.

D.J. Hak et al. performed osteotomy on 20 synthetic femurs and performed fixation with screws in four different ways. It has been proved that the use of two parallel screws with a diameter of 6.5 mm is the strongest fixation, while the second screw does not significantly change the strength of the fixation [38]. In addition, there was no significant difference in the rigidity of the fixation between one 6.5 mm diameter screw and one or two 3.5 mm screws. The authors believe that an increase in the diameter and number of screws increases the load required to shift the fracture fragments, but at the same time damage to the articular surface increases. The passage of screws with a diameter of 6.5 mm through small fracture fragments increases the risk of their further destruction. When choosing to fix a fracture with 3.5 mm screws, at least two screws should be used to create optimal rigidity. The obvious advantage of smaller diameter screws is the preservation of more space for the implantation of the metaphysical plate [39].

G.L. Westmoreland et al. studied the strength of fixing hardware by pulling out screws of various diameters (6.5 mm spongy screws with incomplete threads, 3.5 mm and 4.5 mm cortical screws). As a result, data were obtained on a slight difference in the tear-off force of screws of different diameters. Fixation with several screws of smaller diameter has the same "tear-off" ability compared to screws of larger diameter, which can minimize damage to both bone tissue and articular cartilage [40].

In most publications of recent years, there has been a persistent tendency to fix the fracture with screws and additionally with a buttress plate. However, V. Lu et al. conducted a comparative analysis of the HF fixation results with compression screws with an anti-slide plate (24 patients) and fixation only with compression screws (21 patients). The result showed that there is no significant difference between the two methods of HF fixation: satisfactory functional results were achieved in both cases, consolidation occurred, there was no displacement and other complications [41].

It should be noted that in most works, regardless of the chosen method of fracture fixation, with anatomical reduction, timely detection of pathology and elimination of possible rotational displacement due to the additional screw, the results were mostly good and satisfactory. Evaluation of the functional result of treatment was carried out mainly using the Knee Society Score (KSS) and the achieved knee range of motion (ROM) [42].

However, T. Onay et al. described unsatisfactory long-term results after 93 months in 13 patients with HF who underwent fracture fixation with two screws, among which were cortical 2.5-3.5 mm and cannulated 4.0-6.5 mm (depending on the size of the distal fragment). Anatomical reduction was achieved in all cases, however, varus deformity was formed in one patient, osteoarthritis – in 7 patients [43].

Thus, the analysis of the literature shows that the choice of the final fixation remains with the surgeon, clinically proven algorithms for choosing the number and type of fixing structures have not yet been proposed. However, the analyzed material leads to the conclusion that it is necessary to fix the HF with at least two screws that will run parallel to each other and strictly perpendicular to the fracture line, while the diameter and length of the screws will be determined depending on the size of the distal fragment. Depending on the clinical situation, preoperative planning and the chosen surgical approach in difficult or doubtful cases, as well as in case of poor quality of bone tissue, a buttress plate can be additionally applied along the lateral or posterior surfaces.

## Conclusions

Hoffa fracture is a relatively rare injury of the lower limb, occurring both in isolation and as part of multiple and combined high-energy injuries. Analysis of foreign literature has shown that, first of all, a thorough collection of anamnesis and special caution regarding these rather rare fractures are required. This injury is attributed to the concept of "hidden" fractures, and the absence of signs of bone damage on standard radiographs should not reassure surgeons.

Given the intra-articular and unstable nature of HF, the tactics of treating patients should be primarily operative. The choice of surgical approach and the method of fixation of the fracture is determined by several factors: the localization and nature of the fracture based on the existing classification, the premorbid background of the patient, the condition of the skin and soft tissues, the experience of the surgeon, as well as the technical capability of the medical institution. With a rough displacement of bone fragments, soft tissues interposition, multifragmental or combined injury to the knee joint area, arthroscopic technique is not always possible. However, in the surgical treatment of such patients, it is necessary to give preference to minimally invasive technologies.

The question of how to fix HF remains open, but the analysis of publications has shown that satisfactory results are achieved in the case of anatomical reduction and fixation with at least two compression screws passed strictly perpendicular to the fracture line.

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