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Original Study Article

Improving surgical treatment of patients with patellar instability

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ABSTRACT

BACKGROUND: The high frequency and recurrence of chronic patellar instability and the lack of unified treatment techniques indicate the need for a comprehensive individualized approach in the diagnosis and surgical treatment of patellar instability.
AIM: To develop an algorithm and compare the anatomical and functional results of its use with those of traditional surgical treatment of patients with patellar instability.
MATERIALS AND METHODS: The functional results of the treatment of 194 patients with patellar instability were compared. Two groups of patients were formed. The surgical treatment techniques of the main group (n = 93) were based on the results of the preoperative examination, considering risk factors of instability development, established as a result of retrospective analysis of the control group (n = 101). The effectiveness of the algorithm was compared with the techniques of patellar stabilization used from 2010 to 2015. The Kujala, IKDC 2000, and Lysholm scales were used to assess the functional results of treatment.
RESULTS: Surgical treatment of instability aims to eliminate risk factors such as anomalies of the extensor apparatus of the knee joint and to repair or reconstruct damaged structures. Plasty of the medial patellofemoral ligament is the method of choice for patellar stabilization. In the case of dysplastic changes in the patellofemoral joint, combinations of proximal and distal knee joint surgeries were performed. Rotational lower-limb deformities were treated by corrective derotational osteotomy of the femur. Trochleoplasty was performed in cases of type B or D femoral block dysplasia. Patients with stiff lateral patellar retention underwent lateral release or extension tenotomy. In both groups, the functional status of the patients significantly ($p < 0.05$) improved 12 months postoperatively. The mean values of the functional scales increased because of the increased number of patients with excellent and good scores in the group. Higher values were recorded in the main group (Kujala, $p = 0.038$; IKDC 2000, $p = 0.021$; Lysholm, $p = 0.032$). Patellar dislocation recurred in 2 (1.9%) patients in the control group ($p = 0.172$).
CONCLUSIONS: The proposed algorithm helped verify the degree, type, and etiology of patellar instability and helped obtain better anatomofunctional treatment results in patients.

Keywords: knee joint; patellar instability; medial patellofemoral ligament plastic surgery; femoral trochlear dysplasia; trochleoplasty; osteotomy of the tibial tuberosity.

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Оригинальное исследование

Совершенствование хирургического лечения пациентов с нестабильностью надколенника

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АННОТАЦИЯ

Обоснование. Высокая частота рецидивов и хронической нестабильности надколенника, отсутствие единой тактики лечения указывают на необходимость комплексного индивидуального подхода в диагностике и хирургическом лечении рассматриваемой патологии.

Цель — разработать алгоритм и сравнить анатомо-функциональные результаты его применения с традиционной тактикой хирургического лечения пациентов с нестабильностью надколенника.

Материалы и методы. Проведено сравнение функциональных результатов лечения 194 пациентов с нестабильностью надколенника. Сформированы две группы. Тактика хирургического лечения основной группы (n = 93) основывалась на результатах предоперационного обследования, учитывающего факторы риска развития нестабильности, установленные в результате ретроспективного анализа контрольной группы (n = 101). Эффективность алгоритма сравнивали с эффективностью методик стабилизации надколенника, применявшихся с 2010 по 2015 г. Для оценки функциональных результатов лечения пациентов использовали шкалы Kujala, IKDC 2000 и Lysholm.

Результаты. Основу хирургического лечения нестабильности составляет устранение предрасполагающих факторов в виде аномалий развития разгибательного аппарата коленного сустава и восстановление или реконструкция поврежденных структур. Пластика медиальной надколенника-бедренной связки — метод выбора при стабилизации надколенника. При диспластических изменениях в бедренно-надколенниковом сочленении прибегали к комбинации операций на проксимальном и дистальном отделах коленного сустава. Ротационные деформации нижней конечности устраняли путем корригирующей деротационной остеотомии бедренной кости. Трохлеопластику выполняли при дисплазии блока бедренной кости типа B или D. При ригидном латеральном удерживателе надколенника проводили его латеральный релиз или удлиняющую тенотомию.

Функциональное состояние пациентов значимо (p < 0,05) улучшилось через 12 мес. после операции в обеих группах. Средние значения функциональных шкал возросли за счет увеличения отличных и хороших результатов в основной группе. Более высокие значения зафиксированы в основной группе (p = 0,038 по Kujala, p = 0,021 по IKDC 2000, p = 0,032 по Lysholm). Рецидив вывиха надколенника произошел только у 2 (1,9 %) пациентов контрольной группы (p = 0,172).

Заключение. Предложенный алгоритм обеспечивает верификацию степени, вида, этиологии нестабильности надколенника и помогает получить лучшие анатомо-функциональные результаты лечения.

Ключевые слова: коленный сустав; нестабильность надколенника; пластика медиальной надколенника-бедренной связки; дисплазия блока бедренной кости; трохлеопластика; остеотомия бугристости большеберцовой кости.

Как цитировать

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BACKGROUND

Patellar instability is one of the most common knee joint pathologies in young people who play sports or lead an active lifestyle [1]. Most cases of patellar instability are associated with sports injury and account for >30 cases per 100,000 population per year [2, 3]. Post-traumatic instability in the patellofemoral joint (PFJ) occurs in 20%–80% of cases resulting from trauma associated with dysplasia of the knee joint and lower limb [3]. Acute instability is registered approximately equally among boys and girls; however, chronic instability is nearly three times more common in girls [4, 5]. Among adolescents, in >40% of cases, relapse of patellar dislocation occurs after conservative treatment [4]. In adults, instability resulting from primary patellar dislocation varies depending on sex and age in the range of 6–112 cases per 100,000 people per year [2]. In 37% of cases, the cause of dislocation is ordinary household stress.

Outward patellar dislocation occurs when the patella is forced out of the groove of the femoral trochlea, with an amplitude of approximately 30° of flexion in the knee joint [6]. In the case of a dislocated patella, the medial patellofemoral ligament (MPFL) is primarily damaged, with its complete or partial rupture. M. Kluczynski et al. established that MPFL damage in 37.1% of patients occurred at the site of attachment to the medial patellar edge and in 36.8% in the femoral area. Combined ruptures occurred in 25.1% of cases and 15.6% in the middle third of the ligament. Most MPFL injuries in the patellar area were detected in patients aged <16 years (39.3%) and at the site of attachment to the medial condyle of the femur in patients aged >16 years (47.2%) [7]. An intra-articular osteochondral fracture in the medial facet of the patella, which occurs in 44% of dislocation cases [8], is caused by the collision of the medial articular surface of the patella and the lateral condyle of the femur.

Because of the multifactorial etiology of patellar instability, an integrated approach is necessary to determine the treatment approach aimed at correcting the main causes of the pathology. The biomechanical features of the PFJ and individual characteristics of patients that predispose them to the development of pathology, such as dysplastic variability of the anatomical structures of the knee joint extensor apparatus, valgus deformity of the lower limb, rotational displacement of the femoral condyles, external torsion of the tibia, age, sex, and physical activity level, must be considered [9–11].

Primary patellar dislocation has traditionally been treated conservatively, although surgical stabilization is becoming an increasingly popular treatment of choice in adolescents and young adults, which is associated with a lower recurrence rate after surgery (22%) compared with nonoperative treatment (30%–50%) [12–13]. Experts also do not have a common view on the approach to treating chronic patellar instability, which is mainly due to the polyetiological nature of the pathology and the individual preferences of surgeons. R. Steensen et al. and S. O'Sullivan et al. noted that the following risk factors for recurrent instability are indications for surgical stabilization of the patella after acute injury: a high patellar position, lateralization of the tibial tuberosity, trochlear dysplasia, failure of the structures of the medial retinaculum, and a concomitant decrease in the quality of life in patients with primary dislocation, who received conservative treatment [9, 14].

Recently, most international researchers have pointed out the main directions for treating patellar instability. They can be systematized, and the leading ones can be identified, such as prevention of redislocation and residual instability, development of patellofemoral arthrosis, and earlier return to intense activity and physical loads [15, 16].

More than 150 surgical interventions aimed at stabilizing the patella are known. However, the variability of the anatomical structure of the PFJ, together with dysplastic changes in the bone structures of the lower extremities, determine the need for a differentiated approach to the selection of pathogenetically based surgical treatment to obtain better functional results, which can be achieved through a thorough preoperative examination and identification of all predisposing risk factors for the development of patellar instability [17].

Currently, anatomical reconstruction of the MPFL, which leads to good functional outcomes with a relatively low incidence of complications, particularly in patients with low functional demands, is one of the most common patellar stabilizing surgeries. However, recent publications on this problem have shown that the postoperative treatment results of such patients directly depend on the correct formation of the bone tunnels of the MPFL graft and consider the associated risk factors for the development of patellar instability, including anatomical anomalies of dysplastic origin, and upon its identification, reconstruction ligaments must be supplemented with osteoplastic surgery on the extensor apparatus of the knee joint [18–22]. Isolated reconstruction of the MPFL provides satisfactory restoration of knee joint function in no more than 40% of cases, whereas the relapse rate reaches 35% [23–26]. In addition to instability relapse, persistent joint contracture (22.2%), which can provoke the early development of deforming arthrosis in the PFJ, is the main complication leading to repeated surgery [27].

The most accurate location of the fixation sites for the MPFL graft on the proximal half of the medial patellar edge enables the restoration of the correct anatomical relationships of the articular surfaces in the PFJ and establishment of the pattern of patellar movements while influencing the oblique medial head of the quadriceps femoris tendon, which is involved in the formation of the medial retinaculum complex of the patella. Y. Yang et al. considered two main methods of such fixation. In case 1, the ends of

the graft are immersed in bone tunnels, whereas in case 2, the graft is located in the bone groove along the medial patellar edge. In both cases, the graft is fixed using interference screws, anchors, or transosseous sutures [28]. V.A. Raoulis et al. compared these techniques and revealed no significant differences in the degree of graft fixation rigidity in the patellar area using three types of implants; however, further clinical use of suture and anchor methods can improve functional results by minimizing the risk of patellar fractures at the tunnel level and reducing pain in the anterior knee joint area postoperatively [29].

Considering these features, we proposed a method for fixing the MPFL graft on the outer patellar edge through additional incision and alternately tying four non-absorbable threads together using which the ends of the graft are sutured [30].

The most important factor that influences the poor outcomes of treating patellar instability during isolated MPFL reconstruction is a common anatomical anomaly in femoral trochlear development and the extensor apparatus of the knee joint, which result in the disruption of the normal kinematics of the patella and an imbalance of the muscles and PFJ capsular-ligamentous apparatus [31].

For such patients, simultaneous reconstruction of the MPFL and correction of concomitant pathology by tibial transfer, deepening trochleoplasty, and derotational supracondylar osteotomies of the femur were recommended. However, these surgeries are associated with increased risk of postoperative contractures, stiffness, and early patellofemoral arthrosis [32]. S. Zaffagnini et al. reported that unjustified trochleoplasty in patients with dysplasia of femoral trochlear types A and C according to D. Dejour did not significantly reduce the relapse rates of instability, and in such patients, traditional plastic surgery of the MPFL in an isolated version or in combination with tibial transposition is recommended. However, in types B and D of dysplasia, the combination of trochleoplasty with the reconstruction of the MPFL contributes to better treatment outcomes in both revision and primary surgeries [20].

Despite progress in treating patellar instability, accumulated experience and research data to date have not enabled reaching a consensus on the approach and scope of surgical interventions depending on the pathology, nature, and individual characteristics of the patient.

The presented data were used to formulate an algorithm for choosing the surgical treatment method in patients with patellar instability, considering the degree of damage to its medial retinaculum and concomitant dysplastic changes in the anatomical structures of the PFJ and lower limb as a whole (Fig. 1).

The study aimed to develop an algorithm and compare the anatomical and functional results of its use with the traditional surgical treatment of patients with patellar instability.

MATERIALS AND METHODS

To achieve this goal, a retro- and prospective cohort non-randomized study was performed based on a comparison of the functional results of treatment of 194 patients with patellar instability, who were treated at the H.I. Turner Military Traumatology and Orthopedics Clinic of the S.M. Kirov Military Medical Academy from 2010 to 2021. The inclusion criteria were confirmed patellar dislocation based on radiography or magnetic resonance imaging (MRI) of the knee joint, accompanied by clinical manifestations. The study did not include patients with acute or chronic instability of the knee joint, gonarthrosis of stages III–IV according to the R.E. Outerbridge classification, persistent joint contractures, and hematological, endocrine, metabolic, and rheumatological diseases, as well as previous knee surgery. Concomitant pathologies of the PFJ such as patellofemoral arthrosis and lateral patellar hyperpression syndrome were not a reason to exclude patients from the study.

Depending on the surgical approach, all patients were distributed into two groups. The main group (I) included 93 patients who underwent surgery in accordance with the developed algorithm for choosing the surgical approach to treating patellar instability using an improved method of fixing the MPFL graft on the outer patellar edge [30]. The control group (II) consisted of 101 patients in whom the surgical approach was determined in accordance with the approach used in the clinic until 2016. A diagnostic sanitation arthroscopy of the knee joint was performed with the removal of a free intra-articular osteochondral fragment or its refixation with plastic surgery of the medial patellar retinaculum with local tissues. In the case of acute patellar instability, stabilization was performed using arthroscopic percutaneous suture of the medial retinaculum following the Yamamoto technique. The high position of the patella, identified with an increased Catton–Deshamps (>1.3) and Insall–Salvati (>1.2) indices, was used as an indication for distal correction surgeries such as medializing the transposition of the tibia according to Elmslie–Trilat or medializing–distalizing transfer of the tibia. In cases of rigid lateral retinaculum, surgery was supplemented with an arthroscopic lateral patellar release procedure. The functional results of the treatment of the comparison group were assessed retrospectively, and the main group was examined prospectively. All patients were of working age. Owing to the specifics of the medical organization, men prevailed among patients with this pathology in both groups. In addition, 157 (80.9%) of the 194 patients included in the study were men [n = 83 (80.9%) in the main group; n = 74 (73.3%) in the control group]. The average age at the time of surgery was 22.30 [20.00; 29.80] years in the main group and 22.00 [20.50; 25.30] years in the control group. Acute instability was detected in 45 (48.4%) patients in the main

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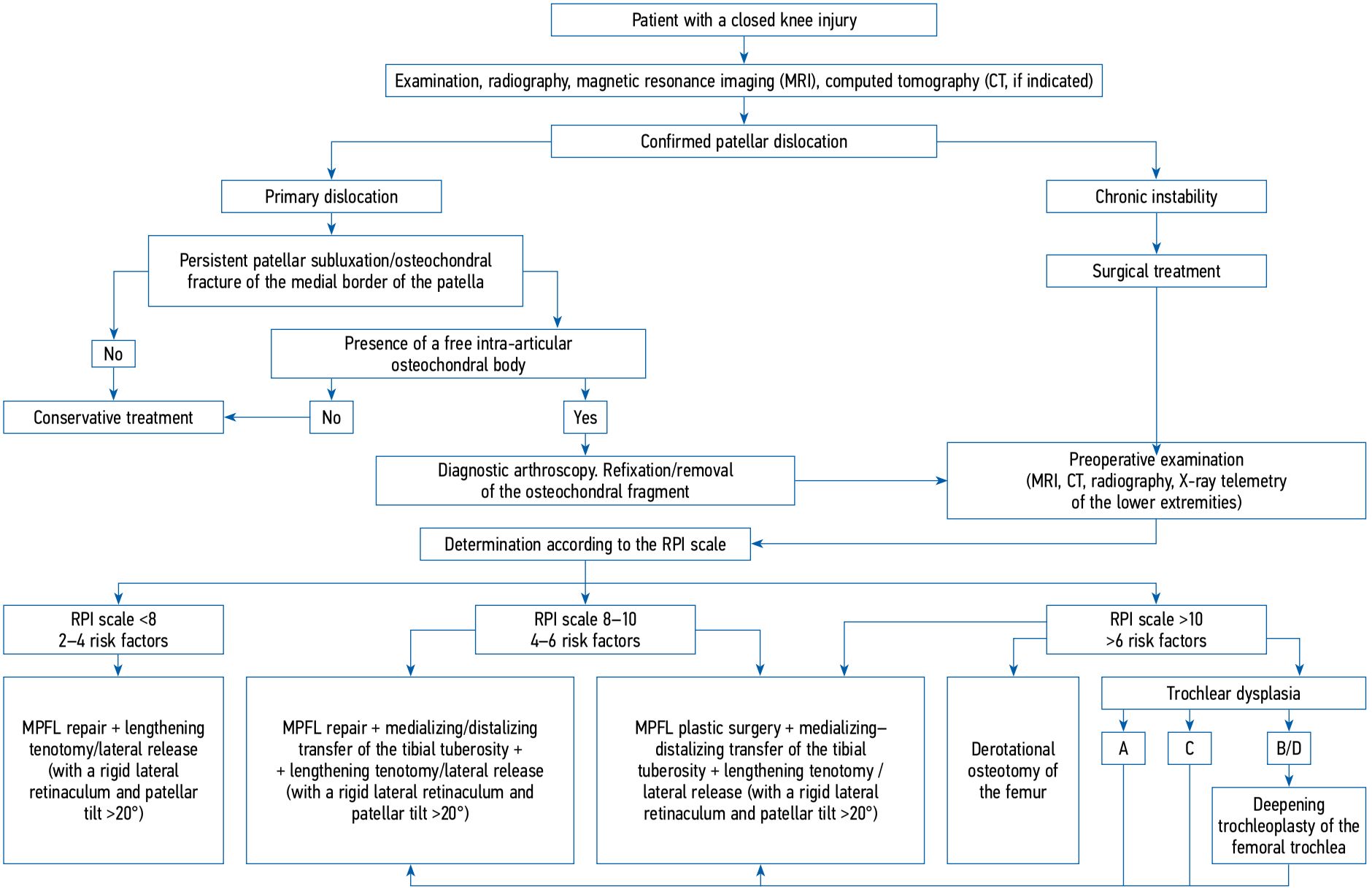

Fig. 1. Algorithm for choosing the approach for surgical treatment of patients with patellar instability. CT, computed tomography; MPFL, medial patellofemoral ligament; MRI, magnetic resonance imaging; RPI, risk of patellar instability

group and 53 (52.4%) in the group 2. Recurrent dislocation was noted in 9 (9.7%) and 14 (13.9%) patients, respectively. Chronic instability was diagnosed in 39 (41.9%) subjects in the main group and 34 (33.7%) in the comparison group. Both groups were comparable in terms of sex, age, and presence of clinical and instrumental signs of patellar instability ($p > 0.05$) (Table 1).

Examination

In both groups, upon admission, all patients underwent a general examination for the assessment of local orthopedic status and performance of the Fairbanks functional tests (moving patellar apprehension test) [33] and the Bassett test [34] to confirm the PFJ pathology.

According to the Beighton criteria, joint hypermobility syndrome was assessed by performing five movements, namely, passive extension of the finger V by >90°, passive pressing of finger I to the inner side of the forearm, hyperextension of the knee and elbow joints by >10°, and pressing the palms to the floor with straightened legs and front bending the body [35]. Hypermobility syndrome was diagnosed with a score of 4–9 points.

To identify and evaluate incongruity in the PFJ, including persistent lateral subluxation of the patella and osteochondral fracture of the inner patellar edge and the lateral condyle of the femur, both groups underwent comparative radiography of the knee joints in direct and lateral views and a special axial view according to Merchant [36]. X-ray images of the knee joints in a strictly lateral projection at a flexion angle of 30° enabled the assessment of the height of the patellar position by calculating the Caton–Deschamps, Insall–Salvati, and Blackburn–Peel indices [37–39].

Knee joint MRI revealed more accurately the level and degree of damage to the medial retinaculum of the patella and confirmed the presence or absence of free osteochondral bodies in the joint cavity.

Computed tomography (CT), for the most accurate assessment of bone structures, was performed to obtain data on the signs of dysplasia of the femoral trochlea according to the D. Dejour classification and type of patella according to the classification of Wiberg and Grelsamer [40]. The degree of tibial lateralization was determined from axial CT sections by calculating the TT–TG index [41].

Changes in the rotational profile of the lower extremities in the main group were assessed using CT by capturing adjacent joints (hip and ankle), which revealed excessive internal rotation of the femoral condyles of ⩾30° and external torsion of the tibia of ⩾35° [42–45] (Table 1).

The indications for choosing the extent of surgical intervention for the main group were determined in accordance with the developed risk scale for patellar instability. The basis was the patella instability threat index scale [42], which was modified and considered the category, sex, age, physical activity level, and presence of dysplastic changes in the anatomical formations of the lower extremities, contributing to the development of PFJ instability (Table 2).

This scale is used in the developed algorithm for surgical approach (Fig. 1). During the preoperative examination, risk factors indicated in the scale were identified, and depending on the number of points obtained, the patients were distributed into groups; group 1 scored <8 points, group 2 scored 8–10 points, and group 3 scored >10 points, which subsequently determined the scope of surgical treatment.

Follow-up period

Control examinations of the main group were performed 6, 12, and 24 months after surgical treatment, and that of the comparison group was performed 9–42 months after surgical stabilization of the patella (average of 14 months). It included a traditional clinical examination of the local status, testing using the Kujala, IKDC 2000, Lysholm scales, MRI, CT of the knee joint, and radiography of the knee joints.

Statistical analysis

Data were recorded in Microsoft Excel spreadsheets. Statistical data analysis was performed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA). Analysis of the normality of distribution was performed using the Shapiro–Wilk test. The distribution of most of the studied numerical variables differed from normal; thus, nonparametric methods of statistical analysis were used. Quantitative parameters in two independent groups were assessed using the Mann–Whitney *U* test. As is customary when using nonparametric methods, quantitative data were presented as median and lower and upper quartiles. Relationships between quantitative parameters were determined using the Spearman correlation coefficient. Frequency characteristics of nominal data were compared using the χ^2 test (with Yates correction for small cohorts).

RESULTS

In a comparative analysis of the functional state of 93 patients in the main group and 101 in the control group before surgery, no statistically significant differences were revealed between the average values on the Kujala, IKDC 2000, and Lysholm scales.

The lateral release of the patella was performed in 23 (24.7%) patients in the main group and in 73 (72.3%) in the control group ($p < 0.05$). In the main group, the MPFL was reconstructed using the proposed method of fixing the graft on the outer patellar edge. In the control group, the medial retinaculum of the patella was reconstructed using a suture following the Yamamoto method in 69 (68.3%) cases.

Table 1. Characteristics of groups

Characteristics		Group I	Group II	*p*
Number of cases		93	101	
Number and proportion of men (*n*, %)		83 (80.9)	74 (73.3)	0.582
Age, years; Me [LQ; UQ]		22.3 [20.0; 29.8]	22.00 [20.5; 25.3]	0.120
When playing sports: intense physical activity (*n*, %)		46 (49.5)	53 (52.3)	0.647
During daily activities (*n*, %)		47 (50.5)	48 (47.7)	0.337
Acute instability (*n*, %)		45 (48.4)	53 (52.4)	0.568
Recurrent instability (*n*, %)		9 (9.7)	14 (13.9)	0.368
Chronic instability (*n*, %)		39 (41.9)	34 (33.7)	0.234
Dysplasia of the femoral trochlea according to D. Dejour (*n*, %)	A	18 (19.4)	23 (22.8)	0.562
	B	38 (40.9)	46 (45.5)	0.509
	C	36 (41.9)	29 (28.7)	0.142
	D	3 (3.2)	3 (3.0)	0.920
Patella high position (*n*, %)		51 (54.8)	56 (55.4)	0.936
Excessive patella tilt (*n*, %)		25 (26.9)	21 (20.8)	0.317
Rigid lateral patellar retinaculum (*n*, %)		23 (24.7)	37 (36.6)	0.073
Valgus deformity of the lower extremities >10° (*n*, %)		21 (22.6)	32 (31.7)	0.156
Femoral anteversion ⩾30° (*n*, %)		10 (10.8)	13 (12.9)	0.646
External tibial torsion ⩾35°–40° (*n*, %)		7 (7.5)	9 (8.9)	0.726
TT–TG ⩾ 20 mm (*n*, %)		34 (36.6)	46 (45.5)	0.204
Hyperelasticity of the capsular–ligamentous apparatus (*n*, %)		30 (32.3)	25 (24.8)	0.246

Table 2. Patellar instability risk score

Risk factors	Score
Age	
>18 years	0
⩽18 years	1
Physical activity	
Casual	0
Increased physical activity (gym exercises and fitness)	1
Professional athlete/military servant	2
History of dislocation on the contralateral limb	
No	0
Yes	1
Femoral trochlear dysplasia	
No	0
A	1
B–D	2
High position of the patella	
ISI ⩽ 1.2; CDI ⩽ 1.3; BP ⩽ 1; 0.125 ⩽ PTI ⩽ 0.28	0
ISI > 1.2; CDI > 1.3; BP > 1; PTI > 0.28	1
Lateralization of the tibial tuberosity	
TT–TG ⩾ 20 mm	0
TT–TG > 20 mm	1
Patella tilt	
<20°	0
⩾20°	1
Rotational changes in lower extremity (femoral anteversion ⩾30° and/or external tibial torsion 20–40°)	
No	0
Yes	1

End of the Talbe 2 / Окончание табл. 2

Risk factors	Score
Sex	
M	0
F	1
Joint hypermobility	
No	0
Yes	1
Body mass index	
<30 kg/m^2	0
⩾30 kg/m^2	1
Angle Q	
<14° for men; <17° for women	0
⩾14° for men; ⩾17° for women	1
Moving patellar apprehension test, Fairbanks test	
No	0
Yes	1
Bassett test	
No	0
Yes	1
J-symptom	
No	0
Yes	1
Patellar dysplasia	
Wiberg types 1–2 / Grelsamer type 1	0
Wiberg types 3–4 / Grelsamer types 2–3	1

In 8 (7.9%) patients, plastic surgery of the MPFL was performed with local tissues.

In this study, 120 (61.9%) of the 194 patients with patellar instability underwent osteoplastic surgery in the knee joint. The identified tibial lateralization (TT–TG ⩾20 mm) in 87 (44.8%) patients was indicated for its Elmslie–Trilat medializing transposition. Thus, this surgery was used in 23 (24.7%) patients in the main group and 31 (30.7%) in the control group. Osteotomy of the tuberosity with its distal transposition was performed with a high position of the patella in 13 (14.0%) patients of the main group and 7 (6.9%) of the control group. A combined surgery of medializing–distalizing tibial transfer was performed in 23 (24.7%) patients of the main group and 10 (9.9%) in the control group, in whom both factors under consideration were identified. In 4 (4.3%) cases from the main group, deepening trochleoplasty using the Arthrex method was performed in patients with dysplasia of femoral trochlea types B and D according to the D. Dejour classification, and 10 patients from the same group underwent distal supracondylar derotational osteotomy of the femur with condylar rotation of ⩾30°, whereas in one case a combined surgery of trochleoplasty and femoral osteotomy was performed.

In both groups, a statistically significant improvement in functional outcomes was found 12 months after surgical treatment according to the Kujala, IKDC 2000, and Lysholm scales using both improved and traditional algorithms for choosing a surgical approach. The average Kujala scale score increased from 43.00 [36.00; 54.00] to 96.00 [90.00; 98.00] in the main group and from 42.00 [32.00; 52.00] to 88.00 [84.00; 96.00] in the control group. The total average IKDC 2000 and Lysholm scale scores also increased significantly, that is, from 63.10 [43.60; 68.30] to 97.80 [94.70; 98.90] and from 68.00 [52.00; 72.00] to 96.00 [93.00; 98.00] in the main group and from 47.30 [31.10; 61.30] to 92.30 [88.90; 94.30] and from 54.00 [28.00; 66.00] to 90.00 [86.00; 96.00] in the control group, respectively. When comparing the average score of the functional scales 24 months after surgery, significantly better ($p < 0.05$) results were obtained in the main group (Figs. 2–4).

The postoperative course was complicated by recurrent patellar dislocation in 2 (1.9%) patients in group II, whereas no such cases were noted in group I ($p = 0.172$). Relapse of instability was caused by the ineffectiveness of the surgical treatment, which did not take into account associated risk factors, which subsequently required a thorough preoperative examination and revision surgery. Thus, in case 1, a high position of the patella (Caton–Deshamps index 1.42; Insall–Salvati 1.34) and tibial lateralization (TT–TG of 21 mm) were diagnosed. Consequently, MPFL autoplasty was performed using an improved

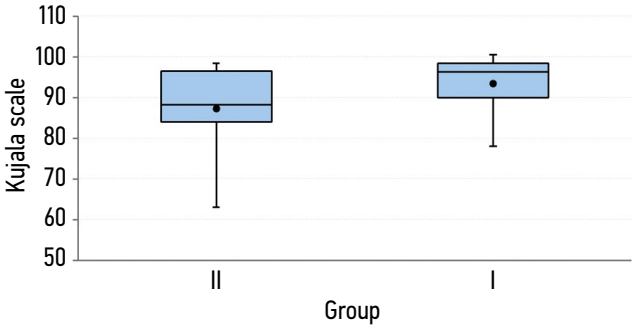

Fig. 2. Kujala scale score 24 months after surgical treatment ($p < 0.05$)

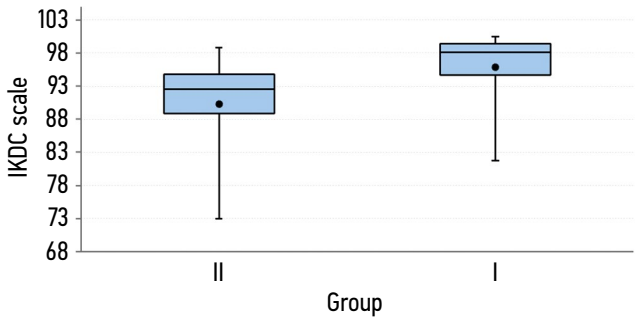

Fig. 3. IKDC scale score 24 months after surgical treatment ($p < 0.05$)

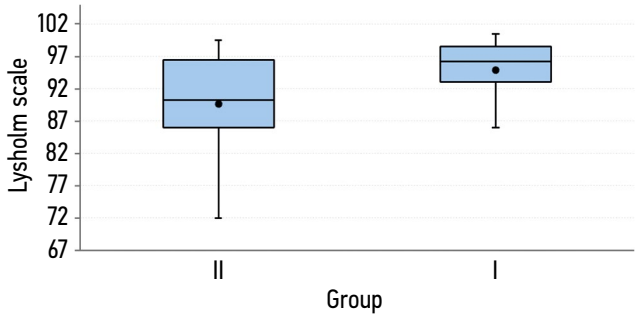

Fig. 4. Lysholm scale score 24 months after surgical treatment ($p < 0.05$)

technique, supplemented using distal–medializing transfer of the tibia. In case 2, in addition to tibial lateralization (TT–TG of 23 mm), dysplasia of femoral trochlea type D according to the D. Dejour classification was established, which was an indication for deepening trochleoplasty of the femoral trochlea in combination with plastic surgery of the MPFL and medializing transposition of the tibia according to Elmslie–Trilat. Despite the longer rehabilitation period, after 24 months of follow-up in these two patients, a satisfactory functional result was achieved (on average 78 points on the Kujala scale, 82 points on the IKDC 2000 scale, and 80 points on the Lysholm scale).

DISCUSSION

Determining the treatment approach for patients with patellar instability is difficult because no unified approach has been established for the selection of a treatment method that considers the main characteristics of dysplastic changes in the extensor apparatus of the knee joint. S.H.Sh. Tan et al. and S. Zaffagnini et al. indicated that in patients with patellar instability, which is rarely accompanied by severe femoral trochlear dysplasia, the MPFL reconstruction in combination with the transposition of the tibia is more rational, and in the case of severe valgus deformity of the limb at the knee joint level, a varus osteotomy of the femur or its derotational osteotomy should be performed. Moreover, in the case of a rigid lateral retinaculum, this combination can be supplemented with the lateral release or lengthening tenotomy of the external retinaculum of the patella with subsequent elimination of the stressful rotational load on the extensor apparatus of the knee joint; if this condition cannot be met, external fixation of the patella with a special brace is employed [20, 46–47].

The results of the analysis of the treatment outcomes of patients with patellar instability and data from modern world literature enabled us to identify errors in surgical approach and formulate a pathomorphologically based algorithm for diagnostics and surgical treatment of patients. It considers risk factors for the occurrence of this pathology such as anomalies in the development of anatomical structures of the knee joint and the lower limb as a whole. Clinical testing and comparison of the results of using the proposed algorithm with the traditional treatment approach was performed based on the analysis of Kujala, IKDC 2000, and Lysholm functional scale scores, which are subjective and specific questionnaires developed to assess treatment outcomes in patients who underwent surgery for knee joint diseases and injuries. The Kujala scale has long established itself as a reliable tool for assessing the severity of anterior knee joint pain based on an impressive international scientific base of patients who have undergone stabilizing surgeries on the patella [48].

The data obtained enabled us to determine the best functional results 24 months after surgery in patients of the main group according to functional scales.

Thus, this study confirmed the high efficiency of a pathomorphologically based algorithm for the surgical treatment of patients with patellar instability. However, an exhaustive examination of patients is needed, including radiography in standard and special settings, CT, if necessary, including adjacent joints, and MRI. If prerequisites for relapse of instability are identified, surgical treatment should not be limited to MPFL reconstruction; however, it should be supplemented with surgical correction of dysplastic changes in the anatomical structures of the lower limb such as tibial transfers, corrective derotational osteotomy, and deepening trochleoplasty of the femoral trochlea.

CONCLUSION

The proposed algorithm assumes a comprehensive preoperative examination, which enables us to verify and consider risk factors for the development of patellar instability and pathogenetically based surgical approach, which determines the best anatomical and functional results in these patients.

ADDITIONAL INFORMATION

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Ethics approval. The study was approved by the independent ethics committee at the S.M. Kirov Military Medical Academy (Minutes No. 258 of December 21, 2021). Patients gave voluntary informed consent to participate in the study and publish clinical cases.

Author contributions. *V.V. Khominets* created the study concept and design and wrote the text; *D.A. Konokotin* collected and processed the materials, performed surgical treatment, diagnostic studies, wrote the text, and reviewed the literature; *A.O. Fedotov* performed data analysis, surgical treatment, diagnostic studies, and wrote the text; *A.S. Grankin* wrote and edited the article; *A.S. Vorobyev* collected and analyzed the data and prepared the literature review.

All authors made significant contributions to the study and preparation of the article, they read and approved the final version before its publication.

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