

Functional outcome and prognostic implications in patellofemoral instability using Elmslie-Trillat and MPFL reconstruction procedures

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Abstract

Introduction. Patellofemoral instability is a troublesome condition that results in significant morbidity, frequently associated with persistent anterior knee pain, long-term osteoarthritis and reduced quality of life.

Purpose. The purpose of this study was to describe functional outcomes following surgical treatment of patients who underwent Elmslie-Trillat procedure and reconstruction of medial patellofemoral ligament (MPFL) correlated with Elmslie-Trillat in the treatment of recurrent patellar dislocation and subluxation.

Methods. We prospectively followed 23 patients (24 knees) with patellofemoral instability who underwent realignment surgery procedures between 2015 and 2017, 14 knees by the Elmslie-Trillat procedure (Group 1) and 10 knees by Elmslie-Trillat combined with MPFL reconstruction (Group 2). The patients were evaluated pre and postoperatively by clinical examination, knee radiographs, CT scans and functional outcome Kujala score.

Results. At a follow up period of 2 years, the apprehension sign remained positive in 6 knees in Group 1, and only one in Group 2. On the skyline radiographs and axial CT scans, stability was significantly better in group 2 than in group 1. The mean Kujala score was 65.2+/-9.39 points in group 1, and 87.1+/-6.43 points in group 2, at 2 years evaluation, significantly higher than before surgery. No patient developed osteoarthritis while being followed up.

Conclusion. Based on these findings, we were able to conclude that the reconstruction of the MPFL combined with the osteotomy of distal tuberosity is a useful treatment of recurrent patellar dislocation and subluxation. However, further studies are needed to assess the impact of the realignment procedures in the prevention of joint degeneration.

Keywords: patellofemoral instability, Elmslie-Trillat, MPFL, outcome

Introduction

Patellofemoral articulation plays a major role in the activities that involve flexion and extension of the knee joint. Proper articulation

and movement of the patella within the femoral trochlear groove are due to a complex mechanism of important static and dynamic soft tissue stabilizers, the bone architecture of the patellofemoral joint and the overall

alignment of the lower limb [1]. Abnormalities in one or more of these factors can result in clinically relevant patellofemoral instability [1,2].

Patellofemoral instability is defined as the movement of the patella out of its anatomical position. It is a common knee problem that results in significant morbidity and can be divided into dislocation and subluxation of the knee joint [2]. It is frequently associated with instability, persistent knee pain, decreased athletic performance, long-term osteoarthritis, and reduced quality of life [3]. The main cause of patellofemoral instability is lateral dislocation (rare cases of medial dislocation reported due to iatrogenic causes). The overall incidence of this injury seems to be around 6 per 100 000 as reported in literature [4], with the highest incidence occurring in the 2nd decade of life (around 30 of 100.000) and it becomes significantly lower after 30 years of age (about 2 of 100.000) [4,5]. The main risk factors were considered sedentary life, overweight, female gender, but most recent data have shown that most injuries occur in young athletic individuals, often males, during sports or physical activity participation [4].

Patellofemoral disorders can be divided into three main groups: objective patellar instability, potential patellar instability, patellofemoral pain [6]. Objective patellar instability includes patients who have experienced at least one episode of patellar dislocation or subluxation and who have at least one of the main factors of instability. It also includes patients with severe patellar instability (recurrent or permanent dislocations). Patients with potential patellar instability have never experienced a dislocation or subluxation, but their main symptom is pain and they also present at least one factor of instability. Finally, none of the principal factors of instability can be identified in patients with patellofemoral pain.

There are three main factors of instability: trochlear dysplasia, abnormal patellar height (patella alta), pathological tibial tubercle-

trochlear groove (TTTG) distance [4,5]. Trochlear dysplasia can be of varying degrees and it is identified in 96% of the cases with objective or potential patellar instability [7,8]. The incidence of abnormal patella height and pathological TT-TG distance is between 30% and 83% [9]. Other factors that are contributing to the instability are patholaxity of the medial and/ or lateral patellar soft tissue constraints, decreased constraint as a result of abnormal shape of the patella and/ or trochlea (trochlear dysplasia), abnormal skeletal alignment valgus and/ or torsion (excessive femoral anteversion, external tibial torsion, foot hyperpronation, genu valgum), and deficient proximal muscular strength and control that result in abnormal lower extremity motion [6,10]. The main factors of instability can be determined with high precision through an accurate instrumental evaluation, while the secondary factors can be identified initially clinically and defined by radiological, computed tomography or magnetic resonance imaging [11,12].

It is very important to understand the results of interventions for patellofemoral instability and the relation between limb alignment, congruity of osseous architecture, integrity and functional balance of muscles and soft tissues constraints that will influence the treatment of the pathology [9,13]. The initial management of patellofemoral instability includes physiotherapy and activity therapies, which include: patient education, muscle strength and conditioning, proprioception exercises, lateral releases/ iliotibial band stretches and patellar taping, although there is a lack of quality studies in the literature comparing treatment options [10,14]. The role of surgery in patellofemoral instability is controversial and varies according to the surgeon and center, but the decision is influenced, in a significant part of the surgeries, by the failure of conservative management and clinical or radiological evidence of structural abnormality (lateral tightness, increased Q angle, medial patellofemoral ligament rupture or bone

dysplasia) [15,16]. Surgical treatment plays an important role especially for the recurrent dislocator, because of the natural history of the condition and the relatively poor return to normal function. Distal tibial realignment has been the treatment of choice for patients with failed conservative treatment for patellar instability due to patella alta of trochlear dysplasia [10,17]. There are two tibial tubercle osteotomies that are most commonly used, the medial tubercle transfer (Elmslie-Trillat) or an anteromedial transfer (Fulkerson) [18]. The Elmslie-Trillat osteotomy is a distal realignment procedure that controls instability and lateral maltracking of the patella by medializing the tibial tuberosity with a lateral soft-tissue and possibly reefing of medial structures [19,20]. Recent biomechanical studies in literature showed that a flat osteotomy failed at a higher mean peak load and energy than an oblique osteotomy. It has been proven that although risk of failure is the greatest in the early postoperative period, it is relatively less in flat osteotomies [1,5,21]. Many studies with short-term follow-up have reported good outcomes in more than 80% of the patients who underwent Elmslie-Trillat surgery [22,23]. However, studies with longer follow-up describe deterioration of the joint and an increase in the incidence of osteoarthritis [22,24]. Proximal realignment is done to the soft-tissue stabilizers, and includes procedures such as medial retinaculum and MPFL imbrications, MPFL repair, and MPFL reconstruction [25]. Restoration of MPFL integrity and its anatomic insertion sites restores patellofemoral tracking to normal and stabilizes the patella. Surgical procedures for restoring MPFL integrity include imbrications/tightening of the elongated ligament, repair of the ligament, or reconstruction of the ligament [19,26]. The outcome of medial repair and imbrications procedures are good in some studies [27,28], showing a higher rate of return to pre injury activity level after arthroscopic

repair, compared to conservative management.

The aims of our study were to (1) evaluate the long term efficacy of the surgical treatment with Elmslie-Trillat procedure and the combination of Elmslie-Trillat and reconstruction of MPFL in the patellofemoral instability, (2) to evaluate functional outcome after realignment of the extensor mechanisms in patients with habitual or recurrent patellofemoral instability and (3) to evaluate the recurrence of patellar dislocation.

Materials and methods

We prospectively identified 23 patients (24 knees; 14 left and 10 right), with chronic patellar instability from January 2015 to December 2017 in the Department of Orthopedics and Traumatology, University Emergency Hospital Bucharest, Romania, and we followed them up to 2 years. The mean age at surgery for the entire group was 26.7 years (+/- 5.4 years), and 66.7% of the patients were females. From all 24 knees, 5 (20.8%) had a traumatic luxation with injury on the medial patellofemoral ligament (Fig. 1), 13 (54.2%) had patella alta, 6 (25%) had trochlear dysplasia with a lateral trochlear inclination less than 11 degrees and 18% had a TT-GO distance more than 20 mm (Fig. 2).

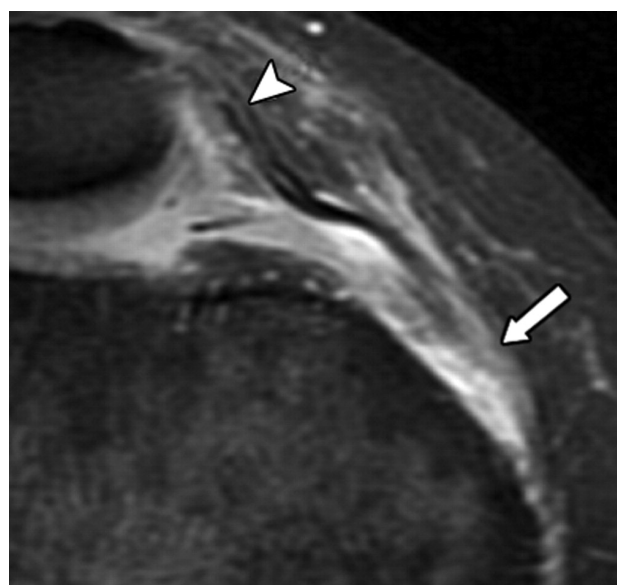


Fig. 1 Traumatic lesion of the MPFL

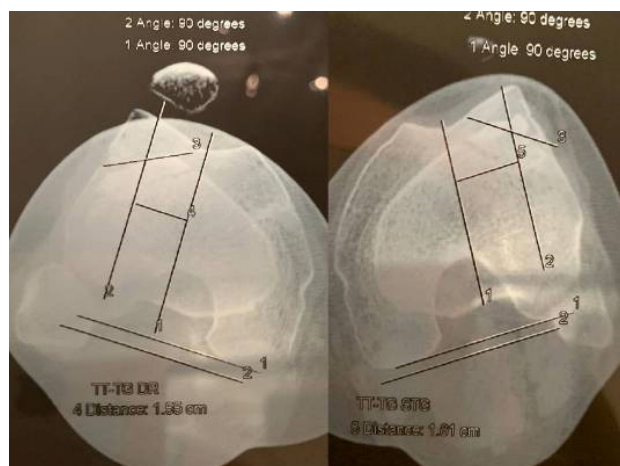


Fig. 2 CT images of the TT-GO distance

14 knees were operated by the Elmslie-Trillat procedure (Group 1) and 10 knees underwent the Elmslie-Trillat procedure consisting in osteotomy of distal tuberosity combined with medial patellofemoral ligament reconstruction (Group 2). None of the patients responded to the non-operative methods of treatment including taping, bracing, quadriceps, and gluteal muscle strengthening and physiotherapy rehabilitation. The exclusion criteria were: (1) patellofemoral osteoarthritis at the time of diagnosis, (2) patients who underwent previous surgeries on the same knee, (3) patients who underwent proximal realignment, (4) age younger than 18 years, (5) and follow-up less than 2 years after the first surgery. All patients were evaluated preoperatively by clinical examination, knee radiographs, and CT scan. Radiological assessment was made with a standard lateral view and Merchant skyline view at 30 degrees flexion, in order to obtain the tilting angle and the lateral shift ratio as shown in Fig. 3a and 3b. Axial CTs were also performed to measure the patellar tilt, patellar shift, and TTGO distance.

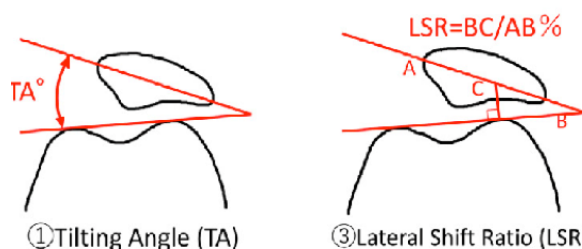


Fig. 3a,3b Radiologic mean tilt angle and lateral shift ratio

All the patients were evaluated with knee radiographs, clinical examination and functional outcome scores such as Kujala score at 12 months and 24 months postoperatively. All the patients were analyzed regarding the local recurrence, rate of complications and functional outcomes. Comparative statistical analysis was performed using IBM SPSS Statistics v20, using independent t-test, one-way Anova test, correlation, and linear regression. Statistical significance was defined as a p value of ≤ 0.05 . Statistical analysis of variance of Kujala score was performed using the one-way analysis of variance.

Results

Demographic assessment. In group 1, the mean age at the time of surgery was 27 years (+/- 7 years old) and 71% of the patients were females. 35.7% (5 patients) of those operated with Elmslie-Trillat procedure had patella alta and trochlear dysplasia while 28% (4 patients) had patella alta associated with TTGO distance more than 20 mm. In group 2, the mean age at the time of surgery was 26.2 years (+/- 4.2 years old), with 60% females. In this group, 40% of the patients who underwent the procedure combined Elmslie-Trillat and MPFL reconstruction, suffered from trochlear dysplasia, and 30% suffered from patella alta and TTGO distance more than 20 mm.

Clinical assessment. The apprehension sign was positive in 6 knees in group 1, and in only one patient in group 2. All patients achieved a full range of movement, within an interval of 3.2 ± 0.5 months in group 1 and 1.8 ± 0.8 months in group 2, respectively.

Radiological and tomographic findings. On radiological assessment, before surgery, the mean tilting angle was 14 ± 2.6 degrees in group 1, and 21.4 ± 2.2 degrees in group 2 respectively, while two years after the surgery, the mean tilting angle was 8.6 ± 1.98 degrees in the group treated by Elmslie-Trillat procedure, and 3.6 ± 1.07 degrees in the group treated by Elmslie-Trillat combined with MPFL

reconstruction (Fig. 4). There was a significant correlation between the type of the surgery and the tilt angle before the surgery ($p=0.0001$, 95% CI -9.44 - -5.21), and also after the surgery ($p=0.0001$, 95% CI 3.6-6.47). Furthermore, the mean lateral shift ratio before surgery in group 1 was 15.5%+/- 2.5, while in group 2 the mean lateral shift ratio was 21.3%+/- 1.47. At the two years' follow up, the mean lateral shift ratio in group 1 was 11.5%+/- 1.8, while in patients who underwent Elmslie-Trillat procedure and MPFL reconstruction was 6.2%+/- 1.31 (Fig. 5). There was also a significant correlation between the mean lateral shift ratio and the type of surgery before the surgery ($p=0.001$, 95% CI -7.72 - -3.97), and at the two-year follow up ($p=0.001$, 95% CI 3.89-6.70).

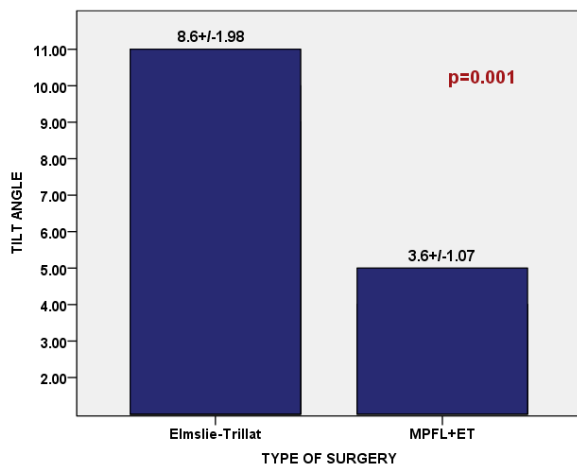


Fig. 4 Radiologic mean tilt angle at 2 years follow-up

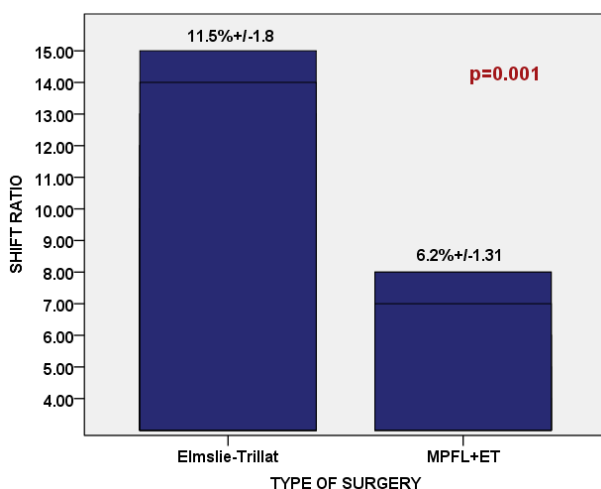


Fig. 5 Radiologic mean shift ratio at 2 years follow-up

On tomographic assessment, before surgery, the mean tilting angle was 13.4+/- 2.5 degrees in group 1, and 22.5+/- 2.26 degrees in group 2 respectively, while two years after the surgery, the mean tilting angle was 9.3+/- 2.1 degrees in the group treated by Elmslie-Trillat procedure, and 3.7+/- 1.41 degrees in the group treated by Elmslie-Trillat combined with MPFL reconstruction (Fig. 6). There was a significant correlation between the type of surgery and the tilt angle before the surgery ($p=0.0001$, 95% CI -11.1 - -6.98), and also after the surgery ($p=0.0001$, 95% CI 4.06-7.31). We also found a significant correlation with the mean lateral shift ratio in both groups, the mean lateral shift ratio before surgery in group 1 being 16.5%+/- 2.9, while in group 2, the mean lateral shift ratio was 23.1%+/- 1.57. At the two years follow up, the mean lateral shift ratio in group 1 was 11.75%+/- 2.39, while in patients who underwent Elmslie-Trillat procedure and MPFL reconstruction was 6.45%+/- 1.46 (Fig. 7). There was also a significant correlation between the mean lateral shift ratio and the type of surgery before the surgery ($p=0.001$, 95% CI -8.63 - -4.42), and at the two-year follow up ($p=0.001$, 95% CI 3.52 - 7.07).

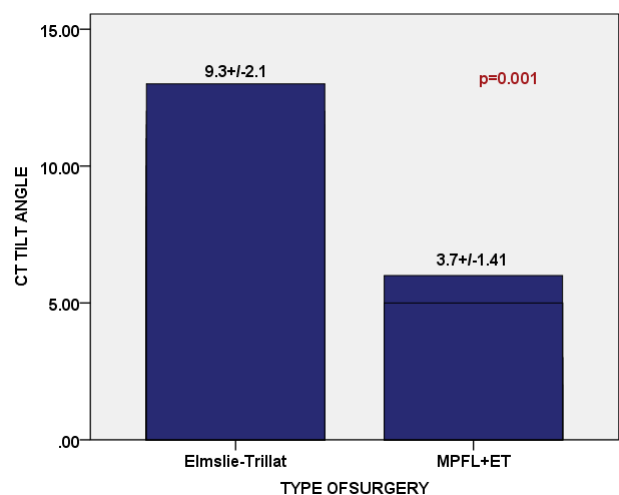


Fig. 6 Tomographic mean tilt angle at 2 years follow-up

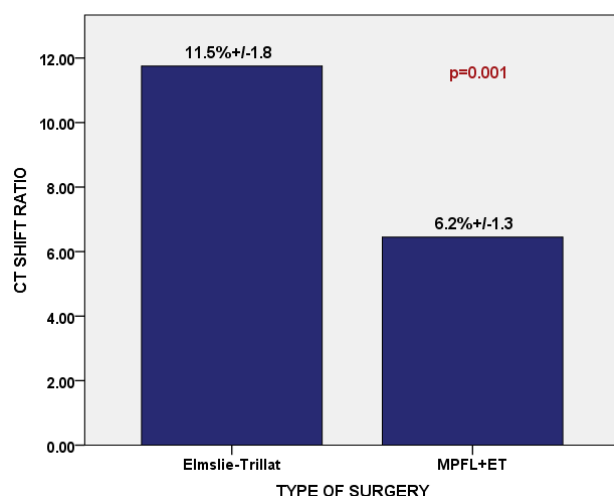


Fig. 7 Tomographic mean shift ratio at 2 years follow-up

Functional outcome. Before surgery, the average value of the Kujala score was 32.2 $\pm$ 7.5 points in group 1, and 30.5 $\pm$ 6.9 points in group 2 respectively. Furthermore, at the evaluation of 12 months, the mean value of the score was significantly higher among the patients operated by the combination of Elmslie-Trillat and MPFL reconstruction (56.4 $\pm$ 8.9 points in group 1 vs. 69.8 $\pm$ 5.24 points in group 2), with statistically significant correlation between the type of surgery and the Kujala score ($p=0.001$, 95% CI -19.9 - -6.79). We also evaluated all the patients at 2-years follow up, when the mean value of Kujala score was 65.2 $\pm$ 9.39 points in group 1, and 87.1 $\pm$ 6.43 points in group 2, respectively, also with significant correlation with the type of surgery ($p=0.001$, 95%CI -28.9 - -14.6).

Two years after the surgery, 7 knees (50%) showed full support without pain, 6 knees (42%) showed painful full support and one impossible full support in patients who underwent the Elmslie-Trillat procedure. In group 2, patients who underwent the combination of Elmslie-Trillat and MPFL reconstruction technique, 9 knees (90%) had full support without pain and one knee showed painful support. Regarding the walking ability, in group 2, 80% of the patients had unrestricted walking ability, while 2 patients could walk more than 2 km and in

group 1, 10 knees (71.4%) had some limitations of the walking ability, without, however, being able to walk less than two km ($p=0.87$) – Fig. 8. When asked about pain, 90% of the patients in group 2 had no pain, while 71.4% of the patients in group 1 had slight and occasional pain and in more than half (57.1%), the pain interfered with the sleep, significantly correlated with the type of procedure ($p=0.03$). 80% of the knees in group 2 performed jumps without difficulty, while only 42.8% (6 knees) in group 1 did the same ($p=0.02$) – Fig. 9. Furthermore, regarding the ability to run, 70% of the knees in group 2 had no difficulty in running, and 30% had pain after more than 2 km of running, while in group 1, 35.7% of the knees (5 knees) were able to run without difficulty, and 35.7% of the knees had a slight pain from the start and only 28.5% (4 knees) had pain after more than 2 km ($p<0.05$) – Fig. 10. Regarding the ability of going up and down the stairs, in group 1, 42.8% (6 knees) had slight pain when descending, while 28.5% (4 knees) had no difficulty, and in group 2, 70% (7 knees) had no difficulty, while 3 knees had slight pain when descending, no patients had pain both when ascending and descending or were unable to use the stairs (Fig. 11). There was a significant correlation between the type of surgery and the ability to use the stairs in the two groups ($p=0.04$).

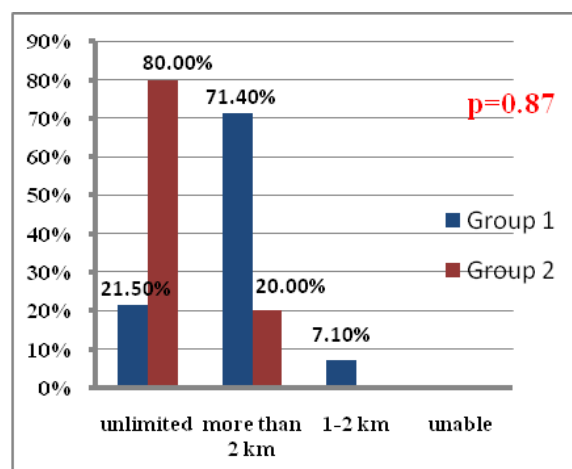


Fig. 8 Ability to walk at 2 years follow-up

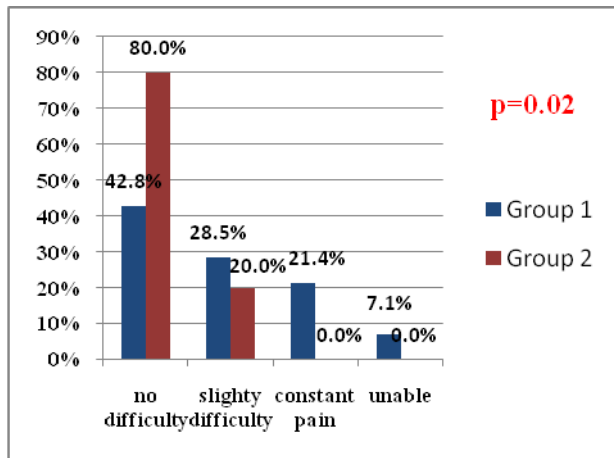


Fig. 9 Capacity of jumping at 2 years follow-up

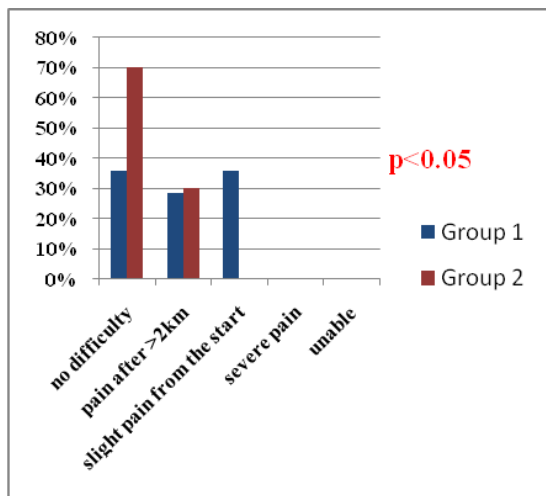


Fig. 10 Ability to run races at 2 years follow-up

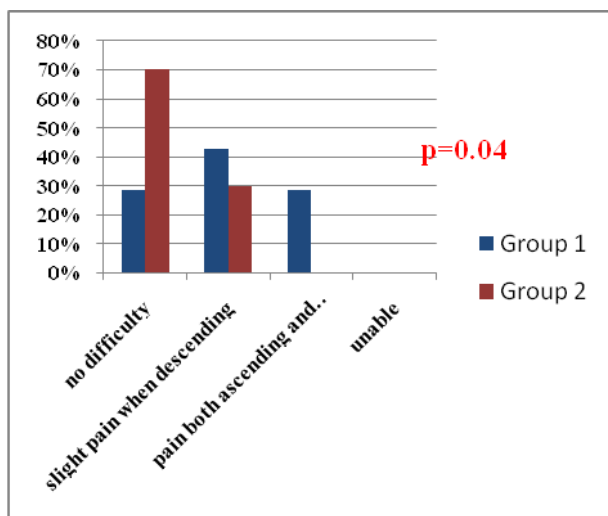


Fig. 11 Ability to go up and down the stairs after 2 years

Conclusion

For the treatment of patellar instability over the time, different surgical techniques have been developed but problems are still continually rising. In recent years, due to biomechanical studies, the medial patellofemoral ligament (MPFL) has been accepted as the primary restraint among the medial patellar stabilizers [29,30]. The Elmslie-Trillat technique was used for distal realignment, but due to the fact that some of the patients still had hyper mobility of the patella and complained of patella apprehension we added reconstruction of the MPFL to Elmslie-Trillat [29,31].

Our results showed improvements in both groups comparing the pre and postoperative measurements on the X-rays and CT scans and also regarding the Kujala score. However, the comparison of the two groups showed significantly better results in group 2 with the combined procedures at the values of patellar tilt angle and lateral shift ratio.

Our conclusion is that the MPFL reconstruction combined with distal realignment is a powerful tool in the treatment of recurrent patellar dislocation. We concluded that reconstruction of the MPFL is a useful adjunction to the treatment of recurrent patellar dislocation but many questions remain to be answered regarding the correct tension, position, location of fixation, the volume and length and also the resistance to rupture of the reconstructed MPFL. In the attempt to establish a surgical algorithm for recurrent lateral patellar dislocation, we can state that we recommend anatomic MPFL reconstruction in the situation of a disrupted ligament, combined with tibial tubercle realignment in the situation of an increased TT-TG distance and/ or patella alta, but for more impactful measurements we suggest that larger randomized and prospective studies are performed.

Conflict of Interest statements

Authors state no conflict of interest.

Informed Consent and Human and Animal Rights statements

Informed consent has been obtained from all individuals included in this study.

Authorization for the use of human subjects

Ethical approval: The research related to human use complies with all the relevant national regulations, institutional policies, is in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

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