Timing for Safe Return to Sport after Medial Patellofemoral Ligament Reconstruction: The Role of a Functional Test Battery

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J Knee Surg

Abstract

The purpose of this article was to analyze clinical and functional results after medial patellofemoral ligament (MPFL) reconstruction and to establish if a computer-assisted physical test battery could determine a "safe timing" to return to sport. We hypothesized that "time-based" criteria to declare safe return to sport could not be reliable to predict functional recover. Fifty-eight young athletic patients were selected after isolated reconstruction of MPFL. The minimum follow-up was 8 months. All the patients were evaluated subjectively with Kujala and Short Form 36 (SF-36) scores and objectively through a standardized computer-assisted physical battery of seven tests (Back in Action, Corehab). No patient was lost at the end point of follow-up and no recurrence of patellar dislocation was reported. At 8 months, 31 patients (53.4%) returned to sport at preoperative levels, and 23 (39.6%) participated in sports at lower levels. The subjective evaluation reported an increase of Kujala (60–92.7) and SF-36 score (28.6/25.4–52.2/53.6). At computer-assisted objective assessment, only 23 patients (39.6%) fulfilled the criteria for safe return to sport, while 31 (53.4%) got an insufficient outcome and 4 (6.9%) failed to complete the test. From our data, clinical scores after MPFL reconstruction provide only little insight into return to sport. The introduction of a computer-assisted objective analysis in the decision-making process for proper return to sport is necessary to evaluate functional recovery and dynamic knee stability.

Keywords
- MPFL reconstruction
- return to sport
- functional evaluation
- battery test

Medial patellofemoral ligament (MPFL) is the primary passive stabilizer to lateral patellar displacement providing 50 to 60% of the restraining forces between 0 and 30 degrees of knee flexion.[1–3] With lateral patellar dislocation, this structure is injured[4,5] and even if conservative treatment is well established, a redislocation rate has been reported from 30 to 70% in young athletes.[6] Recently, reconstruction of MPFL has gained popularity, particularly in cases of recurrent lateral patellar dislocations and chronic instability.[7] Many surgical techniques have been described with good clinical outcomes and low complication rates.[8–11] Although many clinical studies are reported in the literature, the evidence for proper timing and safe return to sports after MPFL reconstruction is still poor investigated.[12–14]

Clinical scores commonly used in the literature to evaluate results of MPFL reconstruction, such as Lysholm,[15] Kujala,[16]

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received
October 13, 2018
accepted after revision
July 15, 2019

DOI https://doi.org/10.1055/s-0039-1696647.
ISSN 1538-8506.

Tegner,[17] and SF-36,[18] are mainly related to the recovery of basic activities of daily living. However, these scores do not assess the knee function for advanced activity required for sport participation such as landing or jumping and do not provide any information regarding safe return to sport.

Establishing the correct timing for safe return to sport activity remains a challenge for surgeons with a lack of solid evidence in regard to criteria determining full recovery of knee function after isolated MPFL reconstruction. There is a current general consensus that at least 4 to 6 months are recommended before patients are allowed to return to contact or pivoting activities even if pre-established time-based criteria for safe return to sport are not recommended for use in the clinical practice.[13]

An individualized objective functional evaluation is mandatory to assess knee function recovery in order to evaluate both lower limb strength and core development in the setting of return to high activity level and sports participation.

In order to overcome this limit, some test batteries have been used to assess functional activity in athletic patients following anterior cruciate ligament reconstruction. Recently, some studies proved that the functional evaluation of patients with a test battery is a useful tool to assess neuromuscular property in order to estimate the optimal timing for a safe return to sports.[19]

In this study, we want to confirm whether the use of a battery test is a useful tool to evaluate the restoration of dynamic knee stability and predict safe return to sports for patients following MPFL reconstruction.

This study is novel in the fact that within a new computer-assisted physical test battery, it evaluates functional outcomes at 8 months following MPFL reconstruction and determines whether this timing is safe to predict return to sport. We hypothesized that time-based criteria to declare safe return to sport could not be reliable to predict functional recover after MPFL reconstruction.

Methods

Between 2014 and 2017, 103 reconstructions of MPFL in 98 patients were performed at the author's institution for recurrent patellar dislocation. Inclusion criteria were patients with "objective patellar instability" treated with isolated MPFL reconstruction, failure of nonoperative treatment program for at least 6 months, postoperative follow-up at least of 12 months, patients who practiced competitive sports (more than three training sessions per week).

Exclusion criteria were severe trochlear dysplasia (type B or D according to Dejour classification)[20,21] that required combined trochleoplasty and MPFL reconstruction, patella alta with an Insall–Salvati ratio more than 1.3 or increased tibial tubercle (TT)–trochlear groove (TG) distance more than 2.2 cm that required combined TT transposition and MPFL reconstruction, patients with valgus malalignment or with torsional deformity of the femur that requires distal femoral osteotomy or derotation osteotomy, postoperative follow-up less than 12 months, and patients who practiced recreational sports (less than three training sessions per week) before surgery.

Table 1 Patients' features

Variables	Value
Age at the time of surgery, y (range)	24 (18–32)
Male patients, *n*	18
Female patients, *n*	40
Follow-up, mo (range)	8 (8–35)
BMI, kg/m^2	22
Injured leg, *n*	23 left–35 right
Dominant leg, *n*	9 left–49 right
Preoperative dislocations, *n* (range)	6 (4–11)
Competitive sport activity, *n*	58

Abbreviation: BMI, body mass index.

Using these criteria, a cohort of 58 patients remained (40 females and 18 males) and was included in this study. The mean age at the time of surgery was 24 years (range, 18–32 years; standard deviation [SD] ± 3.7) and the minimum follow-up was 8 months (range, 8–35 months; SD ± 7.1) (►**Table 1**).

Surgical Technique

All patients received an isolated MPFL reconstruction using autologous redoubled gracilis tendon. The patient was placed in a supine position on a standard operating table. A tourniquet was then placed on the proximal thigh. An oblique incision was made along the pes anserinus and the gracilis tendon was harvested using a tendon stripper. The medial border of patella was then exposed subperiosteally, avoiding opening of the joint capsule. Two 2.3 mm guide wires were drilled tangential and parallel to each other at the patellar medial margin in the middle/upper third of this margin, with care taken not to fracture the patellar bone or perforate the chondral joint surface. A 4.5-mm cannulated reamer was then used to ream the patella to a depth of 2.5 cm. The two ends of the graft were then locked in the bony patellar sockets with two 4.75 mm tenodesis screws (Bio-SwiveLock screws, Arthrex, Naples, FL) (►**Fig. 1**). At 30 degrees of flexion, the area of the medial epicondyle and the adductor tubercle was digitally palpated and a 1- to 2-cm longitudinal skin incision was made upon this area. Because of the position of the femoral insertion of MPFL, it is essential to preserve proper biomechanics of the patellofemoral joint throughout the entire range of motion (ROM), the femoral insertion site of the MPFL was identified under fluoroscopic guidance, using the indirect radiographic method described by Schöttle et al.[22] With the use of fluoroscopic imaging, a guide wire was placed around the femoral anatomic insertion of the MPFL between the medial epicondyle and the adductor tubercle, across the femur and out through the lateral epicondyle (►**Fig. 2**). A half tunnel of about 6 mm in diameter (depending on the redoubled gracilis tendon harvested diameter) and 4 cm of depth was then created along the guide wire. After careful dissection, the loop of the graft was then passed from the medial patellar border to

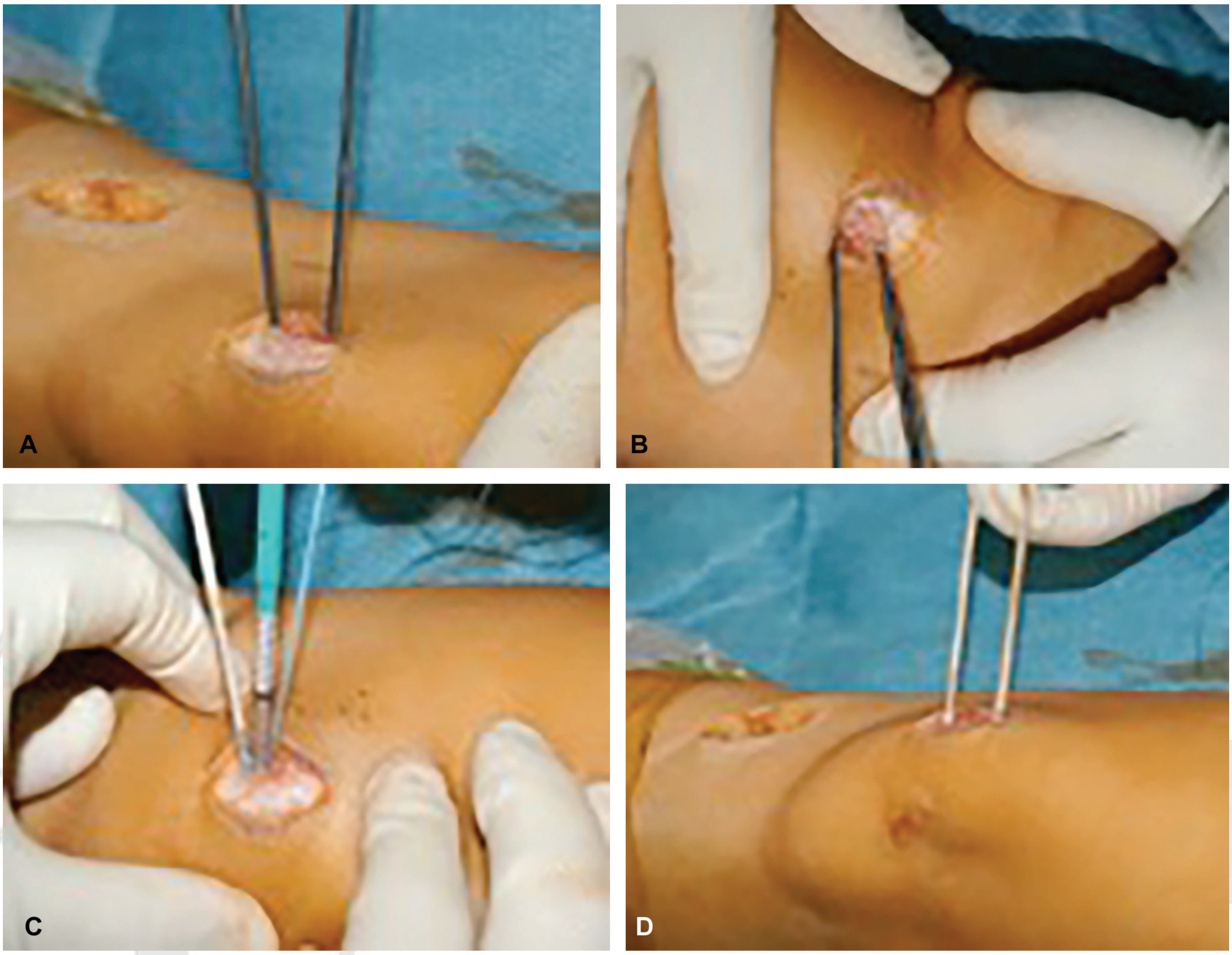


Fig. 1 The surgical passages required to fix the graft at the patellae. It is made up of four subfigures (figures "A"–"D"): (**A, B**) Placement of 2.3 mm K wires in the upper half of the medial border of the patellae and the subsequent 25 mm depth reaming with 4.5 mm reamer, (**C**) insertion of the extremities of the graft in the patella tunnels through the two 4.75 mm bio-SwiveLock screws, and (**D**) medial traction of the graft to fill the stability of its patellae insertion.

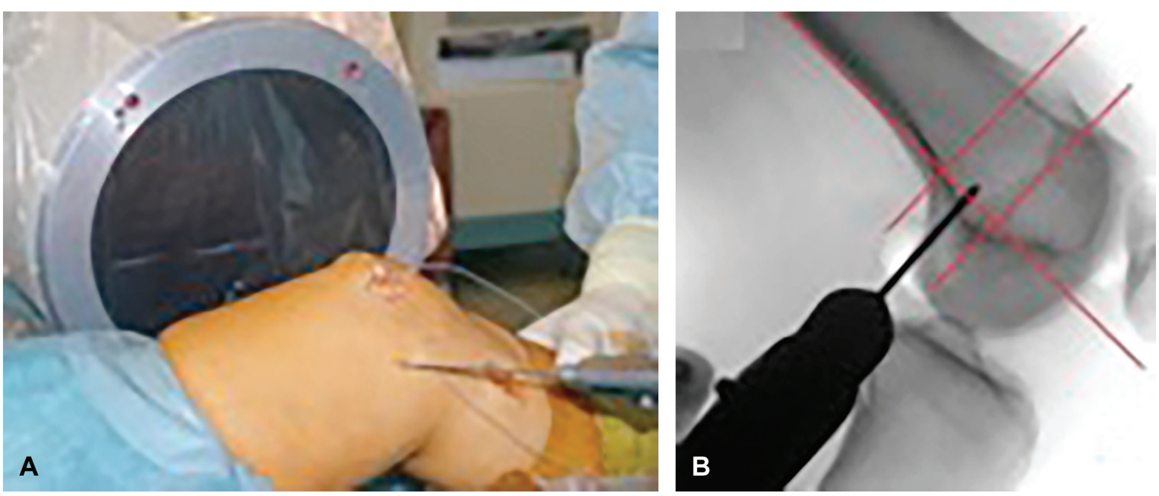


Fig. 2 The amplioscopic landmarks to follow to realize the femoral tunnel. It is made up of two subfigures (figures "A" and "B"): (**A**) Amplioscopic intraoperative assistance of femoral tunnel placement and (**B**) radiographic landmarks for femoral tunnel placement are followed to gain the isometric point as described by Schöttle et al.[22]

femoral insertion between the second and third layers of knee medial compartment. The loop of the graft was then pulled into the femoral socket and the isometric tension of the graft was evaluated by cycling the knee through the complete ROM. The tourniquet was then deflated and femoral fixation was performed at 30 degrees of flexion using a Bio-Composite Interference Screw (Arthrex, Naples, FL).

Postoperative Rehabilitation

Patients were discharged the day after surgery and were placed in a brace locked in extension with partial progressive weight bearing using crutches. Full weight bearing was permitted at 2 weeks. All the patients underwent the same rehabilitative program. During the first 6 weeks, physical therapy, with gradually increasing of ROM to 60 to 90 degrees in the first 2 weeks and to 120 degrees in the following 4 weeks, was performed regularly. After 6 weeks, for 2 months, all the patients underwent the same physiotherapist-supervised program with continual gradual progressive increment in ROM, gate drills, proprioceptive exercises, vastomedial muscle isometric, and biceps strengthening exercises were accomplished.

Clinical Evaluation

All patients underwent the same clinical knee assessment, performed preoperative and postoperative at 1, 2, 3, 8, 12 months, and then again at the final follow-up. Preoperative and postoperative clinical knee examination consisted of a thorough evaluation of symptoms and signs including patellofemoral crepitus, lateral retinacular tenderness, lateral or medial hypermobility, lateral patellar tilt, medial patellar glide, patellar apprehension, J tracking, and presence of pain with patellar compression. Additionally, all patients completed two subjective, self-administrated questionnaires to assess knee function. The Kujala score,[16] developed to evaluate subjective symptoms and functional limitations in patellofemoral disorder, provides knee symptoms correlated to 13 knee-specific items and is based on 100 possible points. The SF-36,[18] developed to survey health status, includes one multi-item scale that taps eight health concepts: physical functioning, pain, role limitations due to physical and emotional problems, general mental health, social functioning, energy/fatigue or vitality, and general health perceptions. All these domains result in two main summary scores, physical component summary (PCS) and mental component summary (MCS).

Functional Evaluation

At 8 months of follow-up after surgery, patients underwent an objective evaluation performed through a standardized computer-assisted system test battery, Back in Action, Corehab as described by Hildebrandt et al.[19] Before starting physical exercises, each patient completed a 10-minute warm-up followed by 5 minutes of individual stretching. The test battery included seven functional tests (►**Table 2**). On each station, the patient performed two trials to learn the exercise, then the test was completed until three or more approved trials (depending on the exercise), the best and the worst performances were excluded, and the remaining results were selected for this analysis. The test battery examined four physical dynamic parameters: balance, agility, speed, and strength. The computer-assisted system provided numeric objective results for each physical exercise.

The values of each exercise of the seven tests battery were even expressed in five categories: "very weak," "weak," "normal," "good," and "very good."[23] To obtain these five outcomes, the patients were categorized according to age- and gender-matched normal data obtained from healthy subjects and previously established on the software.[19] In addition, the system calculated the lower limb symmetry index (LSI) for one-leg stability (OL-ST) and countermovement test to register any differences between the dominant and nondominant legs.[19] The LSI defines the ratio of dominant leg score and contralateral leg score expressed as a percentage.[19] For a safe return to sport activities, a patient was required to obtain at least "normal" on any of the seven physical tests.

Radiographic Evaluation

Preoperative examinations of the knee included radiographic analysis: anteroposterior (regular standing knee and long leg weight-bearing radiographs) and lateral knee views to evaluate patellar height, presence of malalignment, and skeletal abnormalities. Patella height was measured using Insall–Salvati index.[24] All patients underwent magnetic resonance imaging (MRI) evaluation for operative planning and to exclude trochlear dysplasia, patellar malformation, pathological TT-TG distance, and other intra-articular pathologies. The trochlear dysplasia was evaluated using the axial MRI scans. The TT-TG distance was measured on superimposed transverse slices.[25]

All patients accepted the proposed treatment and follow-up after an adequate information and written consent. The study and follow-up, respecting the criteria of the declaration of Helsinki, have been approved by Institutional Review Board of Azienda Ospedaliera Universitaria Careggi, Department of Surgery and Translational Medicine.

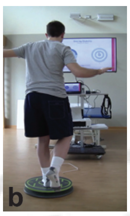
Statistical analysis was performed using SPSS statistics software (IBM, Armonk, NY). The normal distribution was tested and confirmed with the Kolmogorov–Smirnov's test for the metrical data and with the chi-squared test for the nominal data. The quantitative parameters (BIA [Back In Action] scores) were evaluated with the calculation of the mean and SDs due to the lack of test control at different periods of time.

Ultimately, the subjective analysis was performed using the Student's *t*-test, taking *p*-values of less than 0.05 as statistically significant with a 95% confidence interval, to assess the outcome of subjective evaluation.

Results

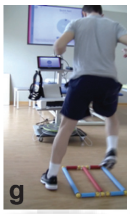
No patient was lost during the follow-up. The mean interval for return to their sport activities was 7.2 months (range, 6.4–10.2; SD ± 0.8).

Table 2 Seven exercises test battery[a]

Two-leg stability (TL-ST) One-leg stability (OL-ST)	Those tests evaluate “balance” The variable measured is the level of stability
 	Patients perform the tests without shoes to avoid the influence of different soles. TL-ST (Fig. a) and OL-ST (Fig. b) were performed on a balance board, free to move in all directions connected to the PC. The patient stands first with both feet and then alternating the right and the left feet in the center of the board maintain the balance for 30 s per trial. On the PC screen, the instant feedback about the position on the disc is projected
Two legs counter movement jump (TL-CMJ) One leg counter movement jump (OL-CMJ) Two legs plyometric jump (TL-PJ)	Those tests evaluate “strength, agility, and speed” The variables measured are “jump height” (cm), power (W/kg), ground contact time (ms), and reactivity (mm/ms)
  	The subject swears a belt around the waist. TL-CMJ (Fig. c): The subject starts from an upright standing position, makes a preliminary downward movement by bending at the knees, and then immediately jump vertically up off the ground as high as he can OL-CMJ (Fig. d): The same as above but performed by one leg. TL-PJ (Fig. e): The patient has to perform three two-leg jumps in a row trying to reach the maximum height and velocity
One leg speedy jump (OL-SY) test Two legs quickfeet test (TL-QFT)	Tests evaluate “agility and speed” The variable measured is time (s)

(*Continued*)

Table 2 (*Continued*)

 	OL-SY (Fig. f): The subject has to perform the test with one leg through the jump path in the picture. The subject performs a series of forward–backward–forward jumps through the course of each red hedge and a sideway jump of each blue hedge, for a total of 16 jumps in a row per trial TL-QFT (Fig. g): The subject has to step in and out with one foot (alternating boot feet) until 15 repetitions per trial without touching the sticks

[a]All the furniture (laptop, TV screen, belt, sensors, balance board, and the two jump paths) used to perform the various tests are provided by COREHAB, and all the data are processed by the Corehab Back in Action software.

Failures and Complications

In no cases did the recurrence of the dislocation occur. Three patients experienced an episode of subluxation, respectively, the first at 3 months, the second at 2 months, and the third patient at 3 months postoperatively. After an intensive postoperative neuromuscular program of 4 months, those patients experienced no further subluxations. Four patients developed a postoperative hematoma that did not influence the postoperative rehabilitation program. No infections, medial instability, or loss of ROM were recorded. All patients recovered a complete full ROM compared with the preoperative status. The mean extension at the final follow-up was 0 degree (mean 5 degrees hyperextension to 3 degrees of flexion) and the mean flexion of 140 degrees (range, 130–-165 degrees; SD ± 11.6). No other complications related to the surgical technique were registered.

Clinical Scores

The median Kujala score improved significantly from 60 preoperative (range, 40.0–80.0; SD ± 12.7) to 92.7 postoperative (8 months follow-up) (range, 85.0–100.0; SD ± 4.9), $p < 0.001$.

The mean SF-36 PCS score improved from 28.6 preoperative (range, 22.0–40.0; SD ± 5.8) to 52.2 postoperative (8 months follow-up) (range, 48.0–58.0; SD ± 2.6), whereas the SF-36 MCS score from 25.4 preoperative (range, 22.0–30.0; SD ± 3.1) to 53.6 postoperative (8 months follow-up) (range, 50.0–58.0; SD ± 3.1), $p < 0.001$ (►**Table 3**).

Functional Scores

The patients found the seven physical tests battery feasible and not one of them got injured performing the functional exercises. The average time, per patient, required to complete the test was 45 to 60 minutes, including 15 minutes of warm-up and individual stretching.

Table 3 Subjective results[a]

	Scores		
	Kujala	SF-36	
		PCS	MPS
Preoperative score	60.0 (40.0–80.0)	28.6 (22.0–40.0)	25.4 (22.0–30.0)
Postoperative score (6 mon follow-up)	92.7 (85.0–100.0)	52.2 (48.0–58.0)	53.6 (50.0–58.0)
p-Value[b]	< 0.001	< 0.001	

Abbreviations: FUMCS, mental component summary; PCS, physical component summary; SF-36, Short Form 36.
[a]Values are expressed as median (range).
[b]*p*-Values <0.05 were considered as statistical significance.

Four patients (6.9%) failed to complete the proposed physical test battery, while all the others reported good functional recovery at the computer-assisted objective assessment.

One of those four patients, who did not complete the test battery, suffered from low-grade type A hemophilia and before the MPFL reconstruction stopped the sport competition for 8 months. This low preoperative physical activity associated with a high weight generated in the subject a strong sense of fear of reinjury that stopped him to carry out the physical battery test. The other three referred a positive apprehension test to clinical examination and during the battery test exercises.

Only 23 of 58 patients (39.6%) obtained a high score in each functional test, fulfilling the criteria for a safe return to sport. The other 31 patients (53.4%) obtained a high score only for three of the four parameters evaluated, agility, speed, and strength.

The worst functional outcome recorded was the "balance" parameter, especially at OL-ST, that registered "weak" or "very weak" result in 36 patients (62%).

The mean values of one leg counter movement jump test showed better results for the injured leg compared with healthy leg. The injured leg provided a higher jump compared with the healthy leg for each trial. The same was for the power parameter where the injured leg produced more strength compared with the healthy leg for each jump. The same information was provided by the one leg speedy jump test. It measured the time to complete the jump path and showed better results of the injured leg compared with the healthy leg.

Finally, OL-ST exercises provided similar results in the two legs. The OL-ST test, that evaluated the balance, showed analogous values at the two trials performed. All results for single test are reported in ►**Table 4**.

Return to Sport

After surgery, 31 of 58 patients (53.4%) returned to sport at their preoperative levels, whereas 23 of 58 patients (39.6%) participated in sports at lower level preoperatively. The reasons for returning to sports at lower levels were unrelated to the surgery or clinical outcomes and rather were due to the patients' motivations. Fourteen of 23 patients reported as

Table 4 Objective computer-assisted results

Test and specifics	First Rep.	Second Rep.	Third Rep.	Fourth Rep.	Fifth Rep.	Rep.[a]	SI	Category[b]
TL-ST								
Results (level)	4.1 SD ± 0.8	4.7 SD ± 0.6	NP			4.4		Very weak
OL-ST								
Healthy leg (level)	3.3 SD ± 0.2	3.1 SD ± 0.3	NP			3.2	77%	Normal
Injured leg (level)	2.4 SD ± 0.3	3.5 SD ± 0.1	NP			3.0		Normal
TL-CMJ								
Height (cm)	52.2 SD ± 3.2	60.4 SD ± 3.4	63.3 SD ± 4.2	55.0 SD ± 5.1	58.2 SD ± 3.4	57.8		Very good
Power (W/kg)	61.0 SD ± 2.5	68.0 SD ± 3.6	70.0 SD ± 2.4	63.0 SD ± 1.9	66.0 SD ± 2.1	65.6		Very good
OL-CMJ								
Healthy leg height (cm)	32.1 SD ± 1.8	27.5 SD ± 1.5	27.4 SD ± 2.1	NP		29.0	88%	Very good
Injured leg height (cm)	33.9 SD ± 2.1	32.7 SD ± 2.4	32.8 SD ± 1.9	NP		33.1		Very good
Healthy leg power (W/kg)	43.0 SD ± 2.1	39.0 SD ± 1.4	39.0 SD ± 2.5	NP		40.3	91%	Very good
Injured leg power (W/kg)	45.0 SD ± 3.4	44.0 SD ± 2.9	44.0 SD ± 2.1	NP		44.3		Very good
TL-PJ								
Height (cm)	10.1 SD ± 2.4	18.5 SD ± 3.2	NP			14.3		Normal
Contact time (ms)	110.0 SD ± 12.6	126.0 SD ± 14.8	NP			118.0		Normal
OL-SY								
Healthy leg(s)	6.9 SD ± 0.4	6.7 SD ± 0.3	NP			6.8	79%	Very good
Injured leg (s)	6.0 SD ± 0.5	5.3 SD ± 0.4	NP			5.7		Normal
TL-QFT								
Results (s)	6.2 SD ± 0.6	6.7 SD ± 0.3	NP			6.5		Very good

Abbreviations: NP, not provided; OL-CMJ, one leg counter movement jump; OL-ST, one-leg stability; OL-SY, one leg speedy jump; Rep, repetition; SD, standard deviation; SI, symmetry index; TL-CMJ, two legs counter movement jump; TL-PJ, two legs plyometric jump; TL-ST, two-leg stability.
Note: Symmetry Index: comparison between the injured and the healthy leg. Repetition not provided for the protocol administered.
[a]Each value represents the average of all the values obtained by all the patients for each repetition of that single test.
[b]For a recommendation for a safe return to sport, a patient was required to score at least "normal" on any of the subtests. The software automatically generates the five categories ("very good," "good," "normal," "weak," and "very weak") by comparing them to normative values of healthy controls.[19]

main reason for limitation of their activity "fear of reinjury," while 9 reported "lack of time" in return to previous level. Four patients (6.9%) did not return to any sport because of decreased knee function.

Discussion

In this study, the role of a functional battery test was analyzed as a useful tool to evaluate the restoration of dynamic knee stability and predict safe return to sports for patients following MPFL reconstruction. To our knowledge, this is the first study that introduces functional evaluation with dynamic test as objective criteria to declare safe return to sport after MPFL reconstruction. We found that proper timing for safe return to sport could be different for each patient and determined using a functional test battery.

Isolated MPFL reconstruction for lateral patellar instability has showed in recent literature good clinical results with low incidence of complications, low reoperation rates, and low recurrence of dislocations.[13,26] Key factors that result in high successful procedures are appropriate patient selection and respect of surgical steps in order to obtain an anatomic and isometric reconstruction of the MPFL ligament.[25,27,28] Although numerous studies have assessed clinical results in terms of clinical score or recurrence of instability, we should consider that we are dealing with young athletic patients who have greater expectations in respect to this kind of operation than just return to daily activity. Some questionnaires such as Lysholm,[15] Kujala,[16] Tegner,[17] and SF-36[18] are used to analyze results after this procedure but is unclear how these scores are pertinent to evaluate high-level knee function recovery and competitive return to play. For these reasons, a test battery protocol is a necessary tool to provide more insight into knee function recovery in order to evaluate both lower limb strength and core development in relation to return back to high activity level and sports participation.

Although many studies reported clinical results following MPFL reconstruction, there are few studies that have reported data in relation to return to sports. Lippacher et al[29] investigated in detail the return to sport activity after MPFL reconstruction and reported that all patients who undertook sport activities before surgery returned to sport after surgery, but only 53% at the same levels and 47% at lower levels preoperatively. Panni et al[30] reported that 64% of the patients returned to play sport at the same level and that 16% reduced the level or changed sport for reasons unrelated to the surgery. Similarly, we found that MPFL reconstruction is a safe procedure with a high rate of return to sports competition with 53.4% of our patients who return to sport at their preoperative levels and 39.6% who participated in sports at lower levels preoperatively.

Establishing proper timing for safe return to sports after MPFL reconstruction is crucial in order to avoid reinjury, complication, and to define safe return to high activity level.

Many clinical studies suggested a "time-based criteria" for return to sport with 4 to 6 months as threshold.[13,31] However, from our study, we have pointed out that even at 8 months postoperatively, only 39.6% of the patients have reached a high level of core function that allow return to sport even if patients reported themselves to be ready for competition. An individualized evaluation with objective measurements tools is mandatory before returning to full sport activity. Menetrey et al[32] described an objective checklist for safe return to sport after surgery for patellar instability. Their criteria included (1) no pain, (2) no effusion, (3) no patellar instability, (4) full ROM, (5) 85 to 90% of strength from healthy side, and (6) excellent dynamic stability. However, to assess safe return to play proper criteria should include evaluation of sport-related activities that may replicate competitive play.

The introduction of some "functional criteria" could help objectively determine the proper timing for safe return to sports. Ménétrey et al[32] reported the need of physical test battery protocol as a necessary tool to evaluate physical dynamic parameters such as balance, agility, speed, and strength that could help clinicians in objective evaluation of the proper timing for return to sports. They concluded that functional and dynamic test to assess fine kinematics and neuromuscular control is essential for athletes to visualize any deficiencies in functional recovery and to measure progression in rehabilitation. Similarly, in our study, we highlight the importance of functional evaluation before to state return to sport. According to the criteria proposed by the physical test battery protocol software, we found out that more than 60% of our patients were classified as not ready to return to sport activity owing to the poor outcomes in the balance parameter, while the reported Kujala score and the SF-36 scores were excellent.

Some limitations were identified and need to be considered when interpreting these data. First is the patient cohort size that is relatively small. However, we should consider that the group of patients is selected for competitive sport participation and recurrent patellar dislocation that requires isolated MPFL reconstruction as single treatment. Some bias could be introduced when these inclusion criteria are applied, and for this reason, the data could not be applied to patients who require bony procedure associated with MPFL reconstruction or patients who are involved in recreational sport activities. Motivation to return back to sports and psychological status of an athlete who experienced patellar instability is also an important factor for guaranteeing a successful return to sport, and this variable could be underestimated using functional test battery.

Second, the test battery compares normative data of healthy controls to that of subjects who had patellar instability and undergo MPFL reconstruction. The patients who intended to return to competitive high-risk sports were required to score values that were at least regarded as "good" within the normative values. Using the normal population, even if matched for age and gender, as reference points could introduce some bias related to the heterogeneous group included for data collection in this system. However, the possibility of obtaining quantitative measurement of knee performance and comparing it with the healthy contralateral side in this system is an option to be applied to evaluate discrepancy in neuromuscular recovery after knee surgical procedures. Further work is needed in this field to better understand the true capability of computer-assisted functional analysis to evaluate the results of surgical procedures, to determine criteria for safe return to sports, and to investigate any lacks in the rehabilitation program.

Conclusion

From our study, we can conclude that isolated MPFL reconstruction is a safe procedure with excellent clinical outcomes and high grade of return to sport. The introduction of a test protocol battery in the decision-making process for proper return to sport is a potentially useful tool to evaluate functional recovery and dynamic knee stability. Even if many patients return to sport after 8 months postoperatively, the timing might be premature with respect to their functional abilities and strength recovery, and these factors might place patients at a significant risk of reinjury.

Conflict of Interest
None declared.

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