Original Research

Clinical, Biomechanical, and Self-reported Health Status After ACL Reconstruction With Meniscal Repair in Soccer Players

Results at Minimum 1-Year Follow-up

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Background: Performing meniscal repair with anterior cruciate ligament reconstruction (ACLR) has been shown to contribute to the long-term preservation of knee health and gait biomechanics.

Purpose: To evaluate the role of meniscal repair in the performance of semiprofessional soccer players who returned to sport after ACLR.

Study Design: Case series; Level of evidence, 4.

Methods: This study included 51 male soccer players (mean ± SD age, 28.82 ± 5.33 years) who underwent ACLR at a single institution between July 2018 and July 2019. The players were divided into 3 groups according to surgery type: ACLR only (n = 30), ACLR with lateral meniscal repair (n = 9), and ACLR with medial meniscal repair (n = 12). Outcomes were evaluated through clinical examination, self-reported health questionnaires (Cincinnati Knee Rating System, Tegner activity score, Tegner Lysholm Knee Scoring Scale, Tampa Scale of Kinesiophobia, and ACL–Return to Sport After Injury), and biomechanical performance evaluations (balance, strength, coordination, and symmetry tests). Parametric and nonparametric tests were carried out for multiple comparisons.

Results: The mean ± SD follow-up time was 20.75 ± 9.38 months. Although no significant differences emerged in clinical and self-reported health status, almost all the physical parameters tested resulted in lower performance in players treated with ACLR and meniscal repair. Moreover, patients with ACLR with lateral meniscal repair reported higher pain and fear of reinjury, with lower outcomes in terms of strength, symmetry, and coordination as compared with the other 2 groups. Balance abilities were significantly affected in players who underwent meniscal repair as compared with those who underwent ACLR only.

Conclusion: The findings showed that biomechanical performance measures and fear of reinjury were significantly worse in soccer players with associated meniscal repair at a minimum 1-year follow-up, especially in those with a lateral meniscal tear.

Keywords: ACL injury; return to sport; motion analysis; wearable sensors; sports performance

Sports practice is considered an important part of a healthy life, and soccer is the most popular sport worldwide, with approximately 240 million active players.[29] At the same time, high sports injuries have been reported, with the knee as the most frequently affected joint for its central role in supporting large and rapidly changing external loads during activity.[8,19] Anterior cruciate ligament (ACL) and meniscal injuries are the most common knee lesions observed. ACL reconstruction (ACLR) remains the primary treatment option in patients willing to return to their previous activities.[4] Associated meniscal tears might occur. The surgery options include meniscectomy or suture according to the type of injury, the surgeon's experience, and the individual characteristics of the patient. The location of the most frequent lesion is the medial meniscus (MM), which usually occurs after injuries in which valgus stress with internal rotation acts on the knee. Hayes et al[10] observed lesions of the lateral meniscus (LM) when varus stress with external rotation is applied to the knee.

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The associated presence of meniscal and chondral damage influences patient outcomes, activity level, and return-to-sport rates after ACLR: The presence of an MM lesion was associated with significantly lower functional and quality-of-life scores as compared with the absence of meniscal injury.[31] Moreover, meniscal preservation has been shown to contribute to the long-term preservation of knee health[18] and gait biomechanics.[5] Sarraj et al[26] reviewed the literature to compare the clinical outcomes of ACLR with either meniscal repair or meniscectomy for concomitant meniscal injury at short and long follow-ups. They confirmed meniscal integrity as an essential factor in knee stability, showing that ACLR combined with meniscal repair results in decreased anterior knee joint laxity with evidence of improved patient-reported outcomes in the long term, as previously noted.[6,14,21] Also, Başar et al[1] observed that patients who underwent MM repair (MMR) had significantly better results at 1-year follow-up than those who underwent partial meniscectomy, thus indicating that ACLR with concomitant MMR (ACLR-MMR) resulted in better knee function and proprioception.

However, regarding return to preinjury activity levels, the presence of associated meniscal tears cannot be ignored, given the fundamental role of menisci as secondary stabilizers, especially in the presence of a damaged or reconstructed ACL.[9] The orthopaedic approach toward meniscal pathology has changed in the last 2 decades, from a more invasive one based on meniscectomy to a more conservative one based on meniscal repair and nonsurgical treatment.[2,22] A recent study estimated about 25% to 50% lower risk of consultation for knee osteoarthritis after meniscal repair than arthroscopic partial meniscectomy,[20] which may be higher considering the sports and competitive athlete population. Recently, Rodrìguez-Roiz et al[23] retrospectively studied medium- to long-term clinical results in patients involved in amateur sports activities who required meniscal repair, with or without ACLR, after knee injury. Their study demonstrated that patients who underwent meniscal repair showed good clinical outcomes in terms of return to sport and quality of life (as measured by Short Form–12 scores) and functional condition of the knee in the medium and long term.

Most of the studies focused on clinical outcomes. A few recent studies[5,14,15,21,27,30] attempted to clarify the effects of concomitant meniscal repair on postoperative outcomes after ACLR at short-term follow-up, indicating better outcomes for LM repair (ACLR-LMR) as compared with ACLR-MMR. However, a comprehensive approach for assessing different aspects of physical performance still needs to be included, although wearable technologies have opened new scenarios regarding reliable and noninvasive physical assessment[11,12] and preventive strategies.[7] In a preliminary study,[3] we investigated the value of technology-based biomechanical assessments in revealing underlying differences in recreational and competitive athletes regarding return to play after ACLR in a subgroup of the study sample. We found that competitive athletes performed better in strength, which was associated with good self-reported outcomes (Tegner Lysholm Knee Scoring Scale [TLKS], Cincinnati Knee Rating System [CKRS]), and a low fear of reinjury (Tampa Scale of Kinesiophobia [TSK]). However, all the athletes had a functional deficit in at least 1 subtest, and a safe return to sports could not have been recommended.

The purpose of the present study was to assess functional and subjective outcomes after ACLR with medial repair in semiprofessional soccer athletes who have returned to sport.

METHODS

Study Population and Design

Ethical clearance was granted for this study per the 1964 Declaration of Helsinki, and all included patients gave informed consent before enrollment. The study was also registered on ClinicalTrials.gov (NCT04129827).

For the present study, we recalled all the soccer players who played in elite and semiprofessional football activity (as assessed with the Tegner activity score[4]) who were referred to our institution between July 2018 and July 2019 with acute knee ACL injuries as documented by magnetic resonance imaging. Inclusion criteria were (1) age between 18 and 35 years, (2) unilateral meniscal tear where present, (3) return to sport, and (4) no reinjury at the latest follow-up. Exclusion criteria were (1) multiligamentous knee injury, (2) chronic knee anterior instability, (3) previous surgery in the same knee, (4) root lesion, (5) clinically relevant cardiovascular history, and (6) clinically relevant neurological and neuromuscular disorders. Sixty athletes who met the inclusion criteria were identified in the database: 7 were excluded for not matching the inclusion criteria and 2 refused to participate in the study, leaving 51 male soccer players included in the study.[3] The players were divided into 3 groups according to surgery type: ACLR only (n = 30), ACLR-LMR (n = 9), and ACLR-MMR (n = 12). The flowchart of patient selection is shown in Figure 1.

Surgical Technique and Rehabilitation Protocol

The ACLR procedures were performed through anteromedial and anterolateral arthroscopic portals[25] according to

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Ethical approval for this study was obtained from the Local Ethical Committee of University Hospital of Bari (No. LCA-40; ClinicalTrials.gov NCT04129827).

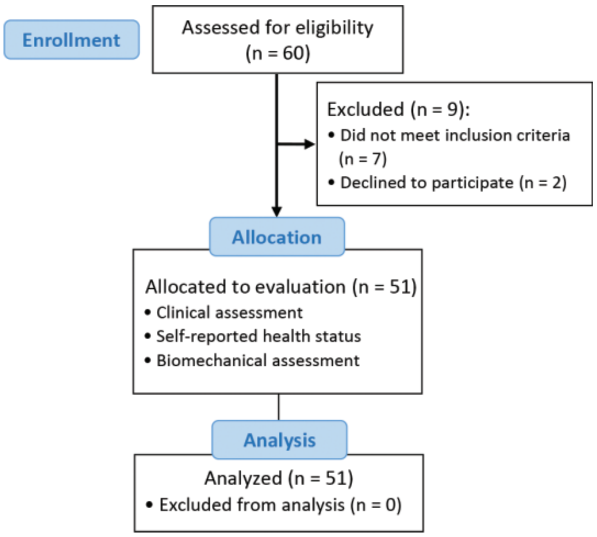

Figure 1. Phases of the study.

the all-inside technique,[17] using a quadruple semitendinosus autograft. Graft fixation was obtained with 2 second-generation cortical suspensory fixation devices: femoral TightRope (Arthrex) and tibial ACL TightRope–Reverse Tension (Arthrex).

Of the 21 meniscal tears diagnosed, 12 were involved in the MM and 9 in the LM. MM lesions occurred in the posterior horn of the meniscus, whereas 6 LM lesions were located in the posterior horn and 3 in the posterior part of the meniscal body extending to the posterior horn. All meniscal repairs were performed with an all-inside technique, using vertical or horizontal stitches (according to the nature of the lesion) and the Meniscal Cinch All-Inside Repair (Arthrex). All surgical procedures were performed by the same surgeon (L.M.), assisted by the same surgical and anesthesiology team, and conducted under spinal anaesthesia. Patients with bone bruises were treated with intramuscular chlodronate and pulsed electromagnetic field therapy for 40 days. In these cases, new magnetic resonance imaging was required 2 months after the beginning of the treatment to ensure the resolution of the bone bruises. All patients followed a standardized postoperative and rehabilitation protocol.

Assessment Battery

For the purpose of the present study, all tests were performed in the same place and by the same researchers (2 medical doctors, D.G.C. and M.D., and 1 biomedical engineer, I.B.). The battery consisted of 3 test sessions: medical check-ups, self-reported psychological questionnaires, and biomechanical assessments. Patients were invited to warm themselves up with 10 minutes of cycling to raise their muscle temperature before the biomechanical analysis began. Between tests, a 5-minute rest was allowed. A detailed description of each test session is given in turn.

The medical doctor filled in the demographic information (sex, age, weight, and height) in the observation book and reported the time from surgery, the ACLR surgeon, and the technique used. All the patients completed the CKRS[28] and TLKS.[4] For the CKRS, a total score of 100 represents the best/excellent knee function, and 0 represents the worst/poor knee function. For the TLKS, scores range from 0 (worse disability) to 100 (less disability).

Figure 2. Biomechanical testing setup.

The clinical check-up included a physical examination with the evaluation of active and passive range of motion, anterior drawer test as a measurement of knee laxity, and knee alignment.

The psychological status of the athletes was assessed with the TSK[13] and the ACL–Return to Sport After Injury (ACL-RSI) score.[24] For the TSK, a score of 17 is the lowest possible score and indicates no or negligible kinesiophobia. A score of 68 is the highest possible score and indicates extreme fear of pain with movement. The ACL-RSI survey consists of 12 items graded on a visual analog scale from 0 (extremely negative psychological responses) to 100 (no negative psychological responses).

The biomechanical tests involved 8 tasks to explore different physical domains: balance, strength, agility and velocity, symmetry, and fatigue. The setup consisted of a wearable inertial measurement unit with a sampling frequency of 300 Hz, a tilt board equipped with an accelerometer, speedy sticks to set up the exercises, and a laptop with the Back in Action Application (CoRehab) (Figure 2). The inertial measurement unit was attached with an elastic band to the back of the athlete (at the level of the hip), with data being sent to a personal computer. The tilting board was also connected to the computer. The acquisition software received the kinematic data from the sensor, and the custom-made algorithms extracted the variables described as follows.

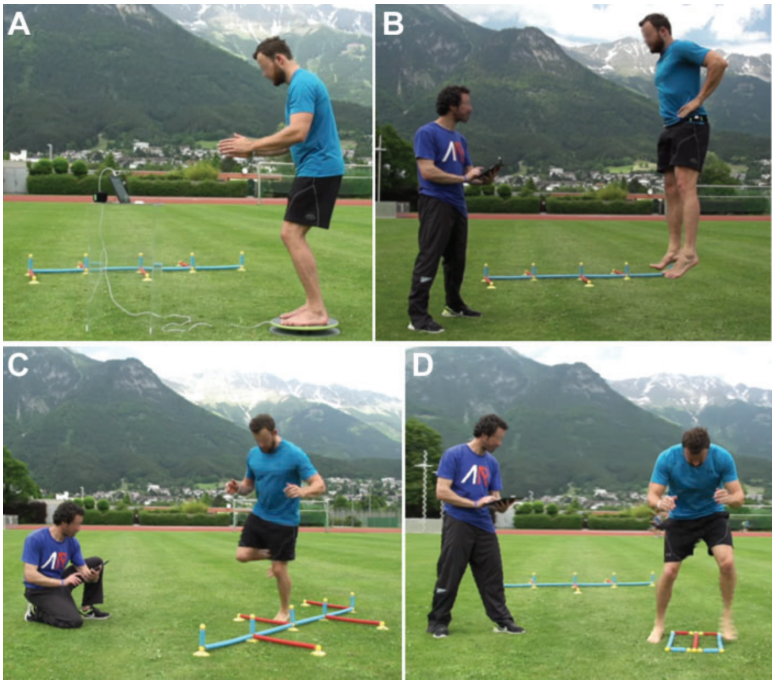

Figure 3. Demonstration of the different tests: (A) static balance, (B) jumps, (C) parkour test, and (D) quick feet test.

The BASS protocol (balance, agility, strength, speed) has been performed according to the test array described by Hildebrant et al[12] and validated by Herbst et al[11] and is composed of 7 tests, performed in mono- and bipodal standing (Figure 3):

- Stability tests (2- and 1-leg stability tests): players stood with 2 legs on a balance disc connected to a personal computer. They were instructed to keep their center of balance in the center of the disc and were not allowed to use their arms. The outcome measure was the level of stability, indicated as a number from 0 to 4.
- Jumps (2- and 1-leg countermovement jump, 2-leg plyometric jump): players wore a belt with a sensor of movements, capable of collecting the data. The outcome measures were jump height (centimeters) and power (watts per kilogram).
- Agility and velocity: the players had to (1) step in and out of a square hurdle with both feet for a total of 15 repetitions as quickly as possible (2-leg quick feet test) and (2) perform a forward-backward-forward jump and a sideways jump on 1 leg through a jump coordination path, in the shortest time, without resting during the performance (1-leg parkour test). The outcome measure was the time needed to accomplish each proposed task.

Data from the 1-leg tests were converted to a limb symmetry index (LSI; in percentages), in which the resulting absolute value of the injured leg was divided by the value of the nonaffected leg and multiplied by 100.

Statistical Analysis

The Shapiro-Wilk test was used to assess the normality of the data. Participant characteristics were reported as median and IQR for continuous variables and number and percentage for categorical variables. Differences in the prevalence exposure groups (ACLR-LMR, ACLR-MMR, ACLR only) were computed and then used to assess critical practical differences in the magnitude of association (effect size). The Wilcoxon effect size was performed for continuous variables and categorized as small (≤0.2), medium (≤0.5), or large (≤0.8) according to Cohen criteria. Data analyses were performed with RStudio software (Version 1.2.5042).

TABLE 1
Characteristics of the Study Sample (N = 51)

Characteristic	Median [IQR] or No. (%)
Age, y	30.0 [27-33]
Body mass index, kg/m^2	23.74 [21.45-26.58]
Dominant leg affected: right	34 (66.7)
Meniscal tear	
Overall	21 (41.2)
Medial	12 (57.1)
Lateral	9 (43.9)
Time from surgery, mo	19.50 [16-22.25]
Return to sport: Tegner score	
Same level	42 (82.3)
Lower level	18 (17.7)

RESULTS

The 51 patients had a mean ± SD age of 28.82 ± 5.33 years; the mean follow-up time was 20.75 ± 9.38 months. The

TABLE 2
Sociodemographic, Clinical, and Biomechanical Outcomes of the Study Sample for All the Groups[a]

	Soccer Players, Median [IQR]				Wilcoxon Effect Size (95% CI)		
	Overall (N = 51)	ACLR-LMR (n = 9)	ACLR-MMR (n = 12)	ACLR Only (n = 30)	LMR vs MMR	LMR vs ACLR Only	MMR vs ACLR Only
Sociodemographic							
Age, y	30.0 [27-33]	30.0 [22-34]	33.0 [30.5-25.2]	30 [26.0-32]	0.43 (0.08 to 0.79)	0.14 (–0.13 to 0.35)	0.50 (0.29 to 0.74)
Body mass index, kg/m^2	23.74 [21.45-26.58]	24.80 [23.7-26.8]	23.1 [21.3-25.2]	30 [20.1-26.6]	0.42 (0.07 to 0.76)	0.24 (0.01 to 0.48)	0.01 (–0.29 to 0.06)
Clinical							
CKRS	91 [85-96]	84.0 [74-91]	94.0 [91.8-96.5]	90.50 [85-96]	0.78 (0.68 to 0.91)	0.41 (0.16 to 0.68)	0.35 (0.12 to 0.59)
TLKS	96 [95-99]	95.0 [83.0-99]	96.0 [92.8-97.8]	96.0 [95-100]	0.21 (–0.14 to 0.50)	0.26 (0.01 to 0.54)	0.07 (–0.18 to 0.21)
TSK	26 [22-33]	34.0 [22-41]	24.0 [20.8-30.2]	25.50 [23-30]	0.42 (0.09 to 0.77)	0.31 (–0.01 to 0.64)	0.31 (–0.01 to 0.65)
ACL-RSI	90 [78-102]	95.0 [45-99]	98.0 [86-107]	88.0 [78-102]	0.28 (–0.08 to 0.61)	0.05 (–0.27 to 0.16)	0.27 (–0.02 to 0.55)
Biomechanical							
OL_{ST}							
Injured	3.4 [3.02-3.97]	3.48 [3.4-3.62]	4.01 [3.45-4.14]	3.13 [2.86-3.68]	0.31 (–0.06 to 0.65)	0.29 (0.06 to 0.53)	0.39 (0.16 to 0.66)
Contra	3.62 [3.16-3.89]	3.88 [3.62-3.95]	3.70 [3.44-3.87]	3.29 [2.90-3.80]	0.17 (–0.20 to 0.43)	0.32 (0.09 to 0.58)	0.52 (0.04 to 0.52)
TL_{ST}	3.8 [3.2-4.12]	4.0 [3.4-4.06]	3.95 [3.73-4.20]	3.48 [2.94-4.00]	0.30 (0.07 to 0.54)	0.22 (–0.2 to 0.46)	0.30 (0.07 to 0.54)
OL_{CMJ}, injured							
Height, cm	17.38 [14.86-20.84]	14.3 [13.1-15.9]	20.10 [15.7-25.5]	17.6 [15.8-20.9]	0.60 (0.35 to 0.89)	0.43 (0.22 to 0.66)	0.15 (–0.12 to 0.37)
Power, W/kg	31.1 [29-34.5]	28.2 [27.9-29.2]	32.6 [30.2-38.6]	32.4 [30.4-34.5]	0.67 (0.44 to 0.94)	0.46 (0.25 to 0.68)	0.11 (–0.17 to 0.29)
OL_{CMJ}, contra							
Height, cm	19.70 [16.7-22.2]	19.20 [17.7-21.3]	21.10 [19.0-25.7]	18.7 [15.8-20.9]	0.24 (–0.10 to 0.56)	0.08 (–0.15 to 0.22)	0.24 (–0.05 to 0.50)
Power, W/kg	33.5 [30.1-35.8]	34.0 [31.8-35.1]	35.0 [32.9-38.3]	32.13 [29.5-35]	0.16 (–0.19 to 0.41)	0.20 (–0.05 to 0.44)	0.27 (–0.01 to 0.57)
OL_{PT}, time							
Injured	12.5 [9.64-18.83]	26.0 [11.0-39.7]	12.2 [10.8-15.1]	12.3 [9.63-18.1]	0.19 (–0.25 to 0.49)	0.22 (–0.10 to 0.51)	0.01 (–0.27 to 0.06)
Contra	11.6 [10.5-14.6]	17.3 [11.4-23.5]	10.90 [10.5-16.2]	11.8 [9.53-14]	0.51 (0.17 to 0.90)	0.27 (–0.01 to 0.56)	0.03 (–0.24 to 0.13)
TL_{CMJ}							
Height, cm	29.35 [25.1-33]	25.25 [23.7-31.4]	28.9 [26.3-32.6]	31.1 [25.2-37.3]	0.34 (–0.04 to 0.70)	0.24 (–0.01 to 0.49)	0.01 (–0.27 to 0.09)
Power, W/kg	41.2 [37.8-43.9]	37.8 [36.5-42.2]	40.5 [38.7-44.2]	42.0 [38.1-47.6]	0.31 (–0.04 to 0.65)	0.29 (0.05 to 0.56)	0.04 (–0.23 to 0.14)
TL_{PJ}, time, s	1.98 [1.65-2.42]	1.92 [1.88-2.16]	2.37 [1.72-2.48]	2.1 [1.53-2.41]	0.07 (–0.33 to 0.25)	0.11 (–0.11 to 0.28)	0.15 (–0.08 to 0.36)
TL_{PJ}	17.7 [15.3-24.9]	15.50 [13.7-16.7]	15.70 [13.7-23.8]	20.80 [17.5-25.3]	0.15 (–0.15 to 0.39)	0.50 (0.31 to 0.72)	0.18 (–0.09 to 0.43)
TL_{QFT}	11.8 [10.4-13.2]	14.25 [12.2-14.2]	10.12 [10.0-11.8]	11.42 [10.5-13.2]	0.70 (0.50 to 0.93)	0.37 (0.15 to 0.63)	0.36 (0.10 to 0.64)
LSI, %							
OL_{CMJ}, contra							
Height, cm	95 [75.9-114.6]	74.20 [71.8-76.2]	94.38 [76.5-113]	103.38 [88.6-120]	0.51 (0.20 to 0.83)	0.55 (0.37 to 0.75)	0.10 (–0.17 to 0.28)
Power, W/kg	97.7 [88.9-106.8]	85.23 [81.3-87.7]	97.47 [90.5-108]	102.90 [94.4-109]	0.74 (0.59 to 0.93)	0.59 (0.43 to 0.78)	0.06 (–0.23 to 0.20)
OL_{PT}	112.2 [86.3-145]	135.36 [96.6-167]	109.63 [85.3-115]	117.74 [86.8-150]	0.21 (–0.26 to 0.53)	0.02 (–0.28 to 0.13)	0.17 (–0.06 to 0.38)
OL_{ST}	99.8 [86.5-113.2]	91.33 [84.8-99.8]	105.5 [99.5-114]	98.63 [86.7-113]	0.34 (–0.03 to 0.71)	0.15 (–0.10 to 0.35)	0.17 (–0.10 to 0.39)

[a]ACL, anterior cruciate ligament; ACL-RSI, ACL–Return to Sport After Injury; ACLR, anterior cruciate ligament reconstruction; CKRS, Cincinnati Knee Rating System; contra, contralateral leg (noninjured); LMR, lateral meniscal repair; LSI, limb symmetry index; MMR, medial meniscal repair; OL_{CMJ}, 1-leg countermovement jump; OL_{PT}, 1-leg parkour test; OL_{ST}, 1-leg stability test; TL_{CMJ}, 2-leg countermovement jump; TL_{PJ}, 2-leg plyometric jump; TL_{QFT}, 2-leg quick feet test; TL_{ST}, 2-leg stability test; TLKS, Tegner Lysholm Knee Scoring Scale; TSK, Tampa Scale of Kinesiophobia.

overall characteristics of the study sample are shown in Table 1. Seventeen patients (33.3%) had an ACL injury on the nondominant leg. Meniscal repairs were reported in 21 patients (41.2%): 12 occurred at the MM, all of which involved the posterior horn, and 9 at the LM, 6 of which involved the posterior horn and 3 the posterior part of the meniscal body extending to the posterior horn. Considering the similar biomechanical contribution of the LM parts and the same type of treatment for the lesions, all 9 lateral tears were evaluated as 1 kind of lesion. No chondral lesions that required surgical treatment were noted. All the athletes returned to the sport after surgery (Tegner score >7); however, 42 returned to the same preinjury level (82.3%), out of which 21 did not have a meniscal tear at the time of injury.

The patients who underwent ACLR-MMR were older (median, 33.0 years; IQR, 30.5-25.2 years). They reported lower levels of pain in daily activities when compared with the other groups (CKRS; median [IQR], 94.0 [91.8-96.5]), although median scores for all groups were above the threshold of a “good” rate. The players with ACLR-LMR showed a higher fear of reinjury than the other groups, as indicated by the TSK (24.0 [20.8-30.2]). No other significant effects were noticed among the examined groups regarding clinical and self-reported health status (Table 2).

Regarding balance (Figure 4), a medium effect was observed in all players who underwent meniscal repair, ACLR-MMR and ACLR-LMR, as compared with the players with ACLR only.

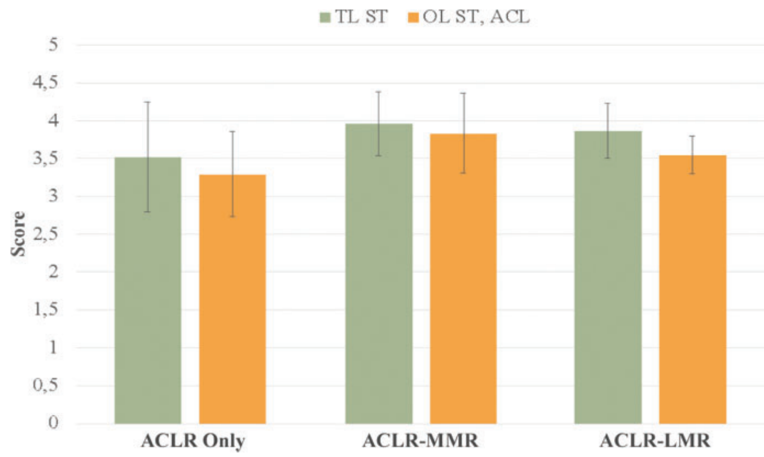

Figure 4. Score reached during the balance tests for the 3 groups: higher scores indicate worst abilities. Data are presented as median (IQR). ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; LMR, lateral meniscal repair; MMR, medial meniscal repair; OL_{ST}, 1-leg stability test; TL_{ST}, 2-leg stability test.

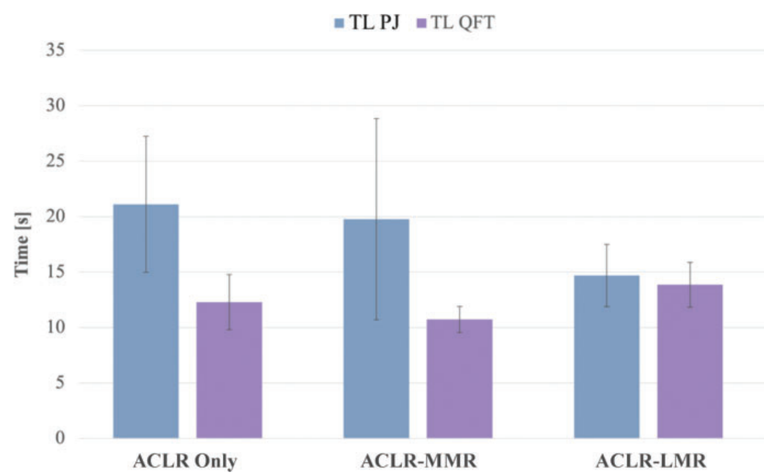

Figure 5. Time to accomplish the plyometric jump (TL_{PJ}) and quick feet test (TL_{QFT}) for the 3 groups. Data are presented as median (IQR). ACLR, anterior cruciate ligament reconstruction; LMR, lateral meniscal repair; MMR, medial meniscal repair.

Players with ACLR-LMR showed lower performances when compared with the ones treated with ACLR-MMR as far as strength (1-leg countermovement jump), symmetry (LSI for 1-leg countermovement jump), and coordination (2-leg quick feet test) were concerned (Figure 5).

DISCUSSION

The findings of the present study indicated that physical performance at a minimum 1-year follow-up was significantly affected by concomitant ACLR and meniscal repair when compared with ACLR only, with a particular decrease in athletes who underwent ACLR-LMR.

Some studies have suggested[6,15] that the decreased mobility of the MM as compared with that of the LM and the different insertion geometries of the MM and LM roots[16] might explain the better outcomes found for LMR than MMR after ACLR at short-term follow-up. However, other studies reported significantly better outcomes[26,31] or at least no difference in patients' self-reported knee status and quality of life for isolated ACLR as compared with meniscal repair.[21] In our study, players who underwent ACLR-MMR had lower pain levels in daily activities when compared with the other groups. However, it should be noted that almost all the clinical scores were above the threshold of "good," which may explain why we did not observe any other difference. We observed no differences in knee joint laxity in our population. However, previous studies reported a decrease in anterior knee joint laxity in the long term in players with ACLR combined with meniscal repair.[26]

According to self-reported health status, players who underwent ACLR-LMR had a higher fear of reinjury (TSK score) than the other groups. To our knowledge, no previous studies have investigated the psychological aspects of associated meniscal tears in return to sport after ACLR; thus, we could not compare our results. Finally, players who underwent ACLR-LMR showed worse physical outcomes in terms of strength (1-leg countermovement jump), symmetry (LSI for 1-leg countermovement jump), and coordination (2-leg quick feet test) than the ACLR-MMR and ACLR-only groups. A possible explanation may be the greater mobility of the LM than the MM. First, the LM is not as tightly attached to the capsule as the MM; second, the concave shape of the medial tibial plateau does not allow the posterior aspect of the MM to displace in deep flexion, whereas the convex form of the posterior part of the lateral tibial plateau allows the LM to displace posteriorly in deep flexion. Therefore, problems with the "lateral-bearing" structures are indicative of worse outcomes.[20]. The LM is also essential as a joint stabilizer opposing tibial translation during combined valgus and rotatory loads applied during a pivoting manuever.[21] Furthermore, it carries higher knee loads than the MM. Consequently, if removed, the slightly convex lateral tibial plateau will be exposed to relatively more cartilage contact stress.[22]

Limitations

This study is subject to certain limitations. First, to include a homogeneous sample, the present group was composed of male patients with ACLR via the all-inside technique using a quadruple semitendinosus autograft. Hence, the results do not address any potential sex or graft difference in these factors, which may reduce the generalizability of the present findings. Owing to the study design, the results demonstrate only the association between subjective and objective outcomes at minimum 12-month follow-up after ACLR; thus, the findings cannot reflect the long-term results after surgery. Third, meniscal tears were not classified, considering the lesion's shape or the meniscal zone. Future studies will surely provide a precise characterization of the lesion to analyze the possibility of different treatment strategies and functional outcomes.

CONCLUSION

Although no common guidelines have been reached in terms of what is the most suitable treatment option for meniscal tears associated with ACLR, our findings showed that self-reported health status and physical performances, as measured through wearable devices, were significantly worse in athletes with concomitant meniscal tears after a minimum 12 months after surgery, with a particular decrease in those who underwent ACL-LMR. Furthermore, accelerometer-based assessments can be easily applied in the clinical setting since they are noninvasive systems requiring a small amount of time to perform measurements.

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