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Associated ACL Reconstruction and Meniscal Repair do not Affect the Evolution of Isokinetic Parameters in Professional Athletes: A Prospective Study with a One-Year Follow-Up

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SUMMARY

Background. Anterior cruciate ligament (ACL) tear is the most frequent ligament injury in athletes and is often accompanied by a traumatic meniscus tear. When a patient is submitted to a concomitant ACL reconstruction and meniscal repair, early rehabilitation caution might slightly delay knee function progress, potentially affecting gains in range of motion, strength recovery and subsequent return to sports. Therefore, in this study, we investigated the evolution of isokinetic parameters in professional athletes who underwent ACL reconstruction, with and without concomitant meniscal repair.

Methods. Isokinetic parameters of fifty-eight professional athletes were assessed at the pre-surgery stage, 3-6, 6-9, 9-12, and +12 months post-surgery. Employing linear mixed-effect models, the effects of time and meniscal repair on knee extensors and flexors peak torque, bilateral asymmetry index, and hamstrings-to-quadriceps ratio were analyzed.

Results. There was a main effect of the time on the peak torque outcomes in the injured side and bilateral asymmetry index of the knee extensors and flexors. However, the main effect of meniscus repair was not significant for all outcomes. Concurrently, there was no main effect of any factor on the hamstrings-to-quadriceps strength ratio.

Conclusions. Generally, our analysis revealed that associated meniscal repair did not influence the recovery of muscle strength in athletes. Additionally, athletes require a minimum of 9 months to exhibit significant enhancement in isokinetic parameters compared to their preoperative performance.

KEY WORDS

ACL injury; bilateral asymmetry; H/Q ratio; knee function; meniscal repair; return to sports.

INTRODUCTION

Anterior cruciate ligament (ACL) tear is the most frequent ligament injury in athletes (1-3) and is often accompanied by a traumatic meniscus tear in the range of 40-65% (4). In the context of concurrent damage, an appropriate intervention is surgical meniscal management in conjunction with ACL reconstruction (5). Among the operative options, meniscal repair, when appropriate, is the main choice considering the increased risk of knee osteoarthritis following meniscectomy (6). Therefore, since ACL and meniscus play essential roles in

providing knee stability (7, 8), the main purpose of performing ACL reconstruction and meniscal repair in athletes is to restore joint stability and knee function, offering a safe return to sports, as well as preventing future complications.

Regarding the return to sports after ACL reconstruction, objective clinical assessment, subjective questionnaires, and functional tests are crucial to minimize the risk of injury recurrence (2, 9-11). Additionally, among the objective measures, the evaluation of strength deficits is the most reported criterion for return to sports (2, 12), and the isokinetic dynamometer is the gold standard tool used in clinical settings (13). Isokinetic assessments can provide several parameters related to muscle performance such as maximal strength, strength asymmetries between homologous muscular groups, and agonist/antagonist ratios (2, 14). Monitoring these variables over time provides valuable information about a patient's condition and the effectiveness of rehabilitation programs before returning to sports competitions (15).

In this scenario of preparing the patient for return to sports, when concomitant ACL reconstruction and meniscal repair are performed, progressions in range of motion and weight-bearing activities in the early rehabilitation stages may be slightly slower, requiring additional time to reintroduce patients to running or jumping tasks (16). Previous studies have hypothesized that these initial cautions in the rehabilitation program may culminate in later functional recovery and a consequent delay in return to sports activities (17, 18). Considering the frequent co-occurrence of meniscal injuries with ACL ruptures among athletes (4), it becomes crucial in the context of strength assessment to comprehend the influence of meniscal intervention on isokinetic outcomes following ACL reconstruction. However, although the effects of combined ACL reconstruction and meniscal repair on isokinetic parameters have already been explored in the general population, demonstrating no significant effects (18), little is known about muscle performance recovery in professional athletes who receive both interventions. Additionally, the evolution of isokinetic strength measurements across multiple stages post-surgery remains an open question, as most studies investigating the effect of associated meniscal repair and ACL reconstruction have been limited to evaluations at a single post-surgery time point (17, 19, 20).

Thus, in this study, we investigated the evolution of isokinetic parameters after ACL reconstruction, with and without concomitant meniscal repair. Specifically, we assessed changes in the knee extensors and flexors peak torque, bilateral asymmetry index, and hamstrings-to-quadriceps ratio in athletes who underwent only ACL reconstruction or concurrent ACL reconstruction and meniscus repair. If meniscal repair has a negative effect on muscle performance evolution throughout the rehabilitation process, we expect that athletes who receive both surgical interventions may require a longer period to achieve the desired level of improvement in isokinetic parameters.

METHODS

Study design

This prospective study analyzed the evolution of isokinetic parameters over time. The isokinetic evaluation was intended to be performed at five-time points: pre-surgery, three, six, nine, and 12 months after ACL reconstruction. Preoperative isokinetic evaluations were performed during the hospitalization phase at least 12 hours before surgical intervention. Follow-up assessments were scheduled for the same day as other outpatient procedures, avoiding additional visits.

Subjects

Fifty-eight athletes from several sport modalities, including soccer, basketball, volleyball, rugby, judo, and handball, were recruited to participate in this study (21 females; mean ± SD age: 23.12 ± 6.79 years; body mass: 72.28 ± 11.65 kg; height: 172.68 ± 8.80 cm, at pre-surgery timepoint), after providing written, informed consent. These athletes were recruited from the Sports Medicine Center Program. The inclusion criteria were being an athlete enrolled at a national or international level competition and scheduled for primary surgical ACL reconstruction. The exclusion criteria were bilateral ACL injury, previous ACL or meniscus tears in both limbs, failure to attend two or more follow-up assessments.

Ethical approval

All the procedures and methodologies applied in this project were rigorously reviewed and have received approval from the National Institute of Traumatology and Orthopedics ethics committee (CAAE: 15653519.2.000.5273 – date of approval: April 07, 2019).

ACL surgical technique

All subjects underwent the same surgical technique using autologous quadruplicated semitendinosus tendon graft, performed by the same group of surgeons. Briefly, the femoral tunnel was strategically located at the central portion of the footprint of the native ACL, accessed through the far anteromedial portal. To harvest the graft, a longitudinal incision of approximately 4 cm was made beneath the tibial insertion point of the knee flexor tendon. A guide wire was then carefully inserted into the proximal tibia, reaching the intra-articular space at the insertion point of the native ACL. This wire served as a guide for creating the tibi-

al tunnel, which was done using a cannulated drill with a diameter matching the thickness of the graft. To position the graft correctly, a transport wire was inserted into the femoral tunnel and then pulled through the tibial tunnel using retriever forceps, forming a loop. The graft was securely fixed in place, with an endobutton at the proximal edge and a bioabsorbable interference screw at the distal edge. Notably, the interference screw had a diameter 0.5 mm or 1 mm larger than the tibial tunnel to ensure robust fixation.

Isokinetic strength assessment

Participants were seated in an isokinetic dynamometer (Humac Norm II, CSMI, USA) with both knees and hips at ~90° and the trunk stabilized by seatbelts. The dynamometer rotation axis was visually aligned with the axis of the tested knee joint, and the lever arm of the device was fixed two centimeters above the medial malleolus. With continuously provided real-time visual feedback of the torque signal, participants first performed a warm-up/familiarization set of five progressive concentric/concentric knee extensions and flexions at an angular velocity of 60°/s and a range of motion of 90° (full extension at 0°). Subsequently, they were asked to perform five repetitions of maximal voluntary concentric/concentric knee extension and flexion at 60°/s while receiving strong verbal encouragement. Both sides (involved and contralateral) were tested in a randomized order, with 5 min of rest (21).

At each testing time-point, the hamstring-to-quadriceps conventional strength ratio (H/Q_{con}) and bilateral asymmetry index were calculated from the normalized peak torque (instantaneous peak torque value divided by the total body mass) obtained for the knee extensors and flexors. Specifically, H/Q_{con} was calculated as the ratio between knee flexion concentric peak torque and knee extension concentric peak torque (14, 22). The asymmetry index was computed using the following equation (23): *Asymmetry index(%) = (PT contralateral - PT involved)/(max (PT contralateral, PT involved)) × 100*.

Statistical analysis

Ideally, isokinetic evaluation was intended to be performed at five-time points, as described in the study design section. However, not all patients were able to return to the laboratory at a specific time point and complete all five assessments. To circumvent this issue, the data were agglutinated in the following ranges: pre, 3-6 months, 6-9 months, 9-12 months, and 12 months. Therefore, to deal with missing data and torque variability between subjects, linear mixed-effect models (LMM) were applied to test the significance of time and the interaction of meniscal repair on isokinetic parameters assessed before and after ACL reconstruction. The categorization of patients based on whether they underwent meniscal repair or not was simplified into a binary variable, either "with" or "without", without distinguishing between the specific compartments of the meniscus. A random intercept model was built with time (pre, 3-6 months, 6-9 months, 9-12 months, and +12 months), associated meniscal repair and their interaction as fixed effects, and participants as random effects (*i.e.*, *isokinetic parameter ~1 + time + meniscus + time × meniscus + (1 | participant)*). The assumption of normality of the residuals was assessed using Q-Q plot inspection. The model was implemented using the lmerTest package (24) with the Kenward-Roger method to approximate the degrees of freedom and estimate the P-value. In the *post-hoc* test, the Estimated Marginal Means (emmeans) package was used for multiple comparisons and to determine estimated marginal means with 95% confidence intervals, and the Bonferroni method was used to adjust the P-value obtained from the multiple comparisons. Unless otherwise stated, data are presented as mean ± standard deviation. All statistical analyses were performed using R software (version 4.2.2) in the RStudio environment.

RESULTS

Changes in isokinetic peak torque

Due to the non-significant time and meniscus interaction effect, data are pooled in **figure 1** and **figure 2** for clearer visualization. **Table I** presents median (min-max) values for ACL reconstruction alone and meniscus repair with ACL reconstruction. As observed in **figure 1**, there was a main effect of time point on the involved knee extensors peak torque (Panel A - LMM; $F = 6.226$; $p < 0.001$), and for the involved knee flexors peak torque (Panel B - LMM; $F = 4.830$; $p = 0.0015$), revealing an increase in performance over time. However, in both the involved knee extensors and flexors peak torque, the effect was not significant for the "*time* × *meniscus*" interaction (LMM; $F < 0.334$; $p > 0.774$ for all cases) and the main effect for "meniscus repair" was not significant (LMM; $F < 1.841$; $p > 0.179$ for all cases), indicating that the associated meniscal repair and ACL reconstruction did not affect the knee extensor and flexor peak torque changes over time. The normalized peak torque performed on the involved side throughout time points pre-ACL reconstruction, between 3-6 months, between 6-9 months, between 9-12 months, and +12-months post-surgery, was respectively (mean ± SD) 2.27 ± 0.72 Nm/kg; 2.00 ± 0.88 Nm/kg; 2.20 ± 0.47 Nm/kg; 2.67 ± 0.71 Nm/kg; 2.93 ± 0.65 Nm/kg for the knee extensors, and 1.53 ± 0.47 Nm/kg; 1.65 ± 0.45 Nm/kg; 1.45 ± 0.37 Nm/kg; 1.77 ± 0.35 Nm/kg; 1.75 ± 0.42 Nm/kg for the knee flexors.

Table I. Median (min-max) isokinetic parameter values observed in each timepoint separated by group.

Isokinetic parameter	Timepoint									
	Pre (n = 58)		3-6 months (n = 12)		6-9 months (n = 31)		9-12 months (n = 23)		+12 months (n = 14)	
	ACL (n = 39)	ACL+ Meniscus (n = 19)	ACL (n = 9)	ACL+ Meniscus (n = 3)	ACL (n = 21)	ACL+ Meniscus (n = 10)	ACL (n = 18)	ACL+ Meniscus (n = 5)	ACL (n = 9)	ACL+ Meniscus (n = 5)
Normalized PT KE Involved (Nm/kg)	2.47 (0.66-3.43)	2.12 (1.04-4.17)	1.61 (0.95-3.61)	1.70 (1.34-2.74)	2.29 (1.19-3.37)	2.15 (1.07-2.50)	2.56 (1.49-3.76)	2.15 (1.82-3.84)	2.92 (2.06-3.61)	2.47 (2.26-4.14)
Normalized PT KE Contralateral (Nm/kg)	2.92 (1.22-4.14)	2.89 (1.25-4.50)	2.74 (2.32-4.32)	2.26 (1.76-2.80)	2.92 (2.24-4.17)	2.66 (1.88-3.64)	3.25 (1.79-4.26)	2.62 (2.21-3.73)	3.28 (1.04-3.93)	2.74 (1.37-3.96)
Normalized PT KF involved (Nm/kg)	1.46 (0.66-2.65)	1.46 (0.24-2.50)	1.88 (1.40-2.15)	1.07 (0.63-2.06)	1.58 (0.83-2.15)	1.19 (0.77-2.18)	1.77 (1.13-2.35)	1.55 (1.37-1.88)	1.70 (1.25-2.38)	1.58 (1.16-2.41)
Normalized PT KF Contralateral (Nm/kg)	1.85 (0.69-2.83)	1.61 (0.80-2.65)	1.88 (1.70-2.80)	1.67 (0.77-2.15)	1.82 (1.34-2.65)	1.46 (1.16-2.24)	1.92 (1.55-2.41)	1.73 (0.92-2.12)	1.85 (1.04-2.44)	1.94 (1.37-2.12)
KE asymmetry index (%)	18.5 (-22.97-71.18)	25.84 (-12.6-61.6)	30.6 (-5.6-69.06)	23.86 (2.14-24.78)	20.93 (-5.88-57.04)	23.43 (3.56-52.23)	20.68 (-52.39-32.87)	15.09 (-17.19-17.94)	8.14 (-64.38-21.04)	3.7 (-40.95-12.74)
KF asymmetry index (%)	16.29 (-15.93-49.37)	13.04 (-18.1-78.76)	14.36 (-13.11-28.57)	18.18 (4.19-35.93)	17.28 (-1.7-39.88)	21.11 (0-33.62)	3.56 (-16.38-28.48)	10.4 (-32.85-23.94)	1.42 (-25.71-31.32)	4.38 (-12.03-20.55)
H/Q involved	0.64 (0.4-1.76)	0.67 (0.22-1.31)	1.04 (0.55-1.98)	0.63 (0.47-0.75)	0.64 (0.4-1.66)	0.56 (0.44-0.94)	0.65 (0.48-1.32)	0.64 (0.49-0.85)	0.61 (0.48-0.83)	0.56 (0.5-0.66)
H/Q contralateral	0.66 (0.42-0.86)	0.59 (0.41-0.71)	0.69 (0.56-0.81)	0.74 (0.44-0.77)	0.66 (0.46-0.81)	0.54 (0.38-0.73)	0.59 (0.45-1.02)	0.59 (0.35-0.81)	0.57 (0.53-1)	0.56 (0.52-1)

PT: peak torque; KE: knee extension; KF: knee flexion; H/Q: hamstrings to quadriceps ratio.

Regarding the contralateral side, as observed in **figure 1** (Panels A and B), there was no main effect of any factor (LMM; $F < 3.23$; $p > 0.07$ for all cases), indicating that the peak torque of the contralateral knee extensors and flexors remained constant after surgery. The normalized peak torque throughout time points pre-ACL reconstruction, between 3-6 months, between 6-9 months, between 9-12 months, and +12-months post-surgery, was respectively 2.95 ± 0.63 Nm/kg; 2.75 ± 0.65 Nm/kg; 2.90 ± 0.51 Nm/kg; 3.11 ± 0.71 Nm/kg, and 2.94 ± 0.92 Nm/kg for the knee extensors, and 1.77 ± 0.44 Nm/kg; 1.89 ± 0.45 Nm/kg; 1.76 ± 0.37 Nm/kg; 1.86 ± 0.35 Nm/kg, and 1.81 ± 0.37 Nm/kg for the knee flexors.

Changes in bilateral asymmetry index and hamstrings to quadriceps conventional ratio

As observed in **figure 2**, there was a main effect of the time point on the bilateral asymmetry of the knee extensors (Panel A, LMM; $F = 7.026$; $p < 0.001$) and knee flexors (Panel A, LMM; $F = 4.633$; $p = 0.002$), revealing a decrease in bilateral asymmetry throughout time. For bilateral asymmetry of both knee extensors and flexors, the effect was not significant for the "*time* × *meniscus*" interaction (LMM; $F < 0.827$; $p > 0.511$ for all cases) and the main effect for "meniscus" was not significant (LMM; $F < 0.637$; $p > 0.427$ for all cases), indicating that the associated meniscus and ACL repairs did not affect the bilateral asymmetry of the knee extensors and flexors over time. The bilateral asymmetry calculated throughout time points pre-ACL reconstruction, between 3-6 months, between 6-9 months, between 9-12 months, and +12-months post-surgery, was respectively 22.56 ± 19.76%; 27.72 ± 22.77%; 23.18 ± 15.90%; 14.48 ± 18.20%; 0.76 ± 23.70% for the knee extensors, and 13.27 ± 19.03%; 12.60 ± 13.87%; 17.50 ± 11.17%; 4.60 ± 15.15%; 3.33 ± 15.06% for the knee flexors.

The H/Q_{con} throughout time points pre-ACL reconstruction, between 3-6 months, between 6-9 months, between 9-12 months, and +12-months post-surgery, was respectively 0.71 ± 0.27; 0.93 ± 0.43; 0.69 ± 0.24; 0.70 ± 0.20, and 0.60 ± 0.10 for the involved side, and 0.60 ± 0.10; 0.69 ± 0.10; 0.61 ± 0.12; 0.62 ± 0.16, and 0.66 ± 0.18 for the contralateral side. As shown in **figure 2**, there was no main effect of any factor (LMM; $F < 2.389$; $p > 0.127$ for all cases), indicating that the H/Q_{con} of both the involved and contralateral sides remained constant after surgery.

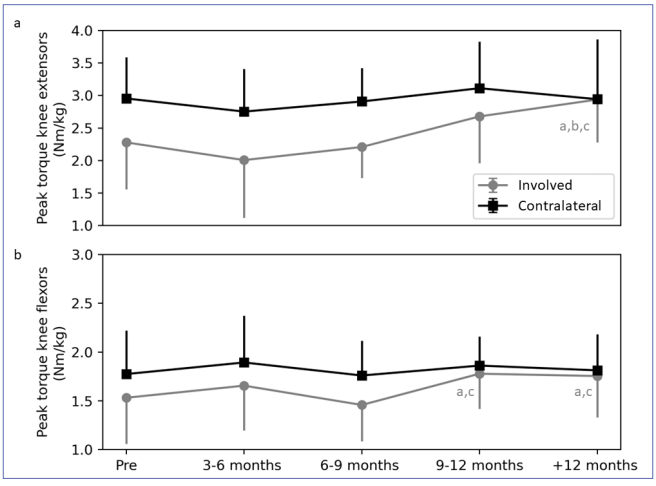

Figure 1. Changes in knee extensors and flexors isokinetic peak torque.

[a]Denotes significative difference from Pre; [b]denotes significative difference from 3-6 months; [c]denotes significative difference from 6-9 months.

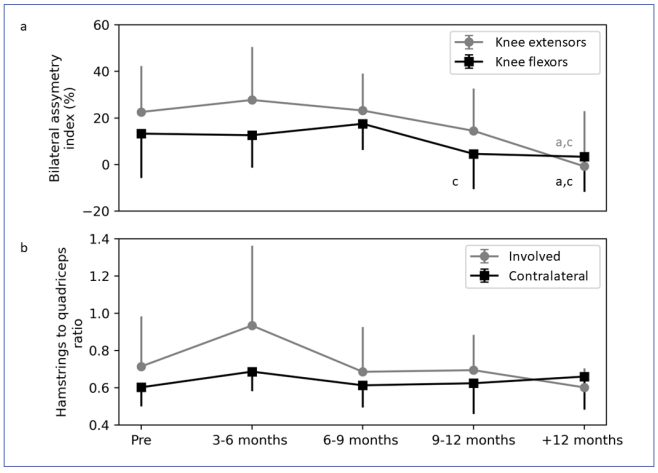

Figure 2. Changes in strength balance isokinetic parameters.

[a]Denotes significative difference from Pre; [c]denotes significative difference from 6-9 months.

DISCUSSION

The primary objective of this study was to investigate the potential impact of concurrent ACL reconstruction and meniscal repair on isokinetic parameters progression. Contrary to our hypothesis, our analysis revealed that associated meniscal repair did not influence the recovery of muscle strength in athletes. Furthermore, athletes require a minimum of 9 months to exhibit significant enhancement in isokinetic parameters compared to their preoperative performance.

Effect of meniscal repair

Considering our hypothesis, athletes who undergo both ACL reconstruction and meniscal repair may experience delayed enhancement of isokinetic parameters. This hypothesis was raised from a potential slower progression in range of motion

and weight-bearing activities during the initial stages of rehabilitation in patients who receive meniscal repair (17, 18), which may require additional time for the gradual reintegration of athletes into running or jumping tasks (16). However, for all isokinetic outcomes investigated in this study, our analysis indicated that performing meniscal repair in conjunction with ACL reconstruction did not affect the evolution of knee extensors and flexors peak torque, bilateral asymmetry index, and H/Q_{con} compared to athletes who underwent ACL reconstruction alone. These findings suggest that both groups can achieve similar muscle strength and balance improvements at the same rate during the first-year post-surgery.

In agreement with these results, previous studies have reported similar findings at 6 months (18), 6-8 months (17), and 9-11 months (19) post-surgery. While Mesnard *et al.* (17) and Wenning *et al.* (18) compared isokinetic performance in general patients, Byrne *et al.* (19) focused on athletes engaged in multidirectional sports such as Gaelic football, soccer, hurling, and rugby. Although Byrne *et al.* (19) also investigated athletes, isokinetic parameters were assessed only at 9-11 months after surgery, without a pre-surgery assessment for comparison. This approach limits the comprehension of the rate of recovery of muscle strength and balance, which precludes investigation into whether patients undergoing ACL reconstruction and meniscal repair indeed present worse or later knee joint functional restoration. Compared to previous research, a strength of the present study lies in the assessment of isokinetic parameters at several time points throughout approximately 12 months, which may be more appropriate for understanding the performance recovery behavior after surgery.

Peak torque outcomes

Regardless of whether associated meniscus repair was performed, we observed that athletes need approximately 9-12 months to experience a significant improvement in knee isokinetic parameters compared to pre-ACL reconstruction performance. Regarding the peak torque outcomes, a group pooled analysis (**figure 1**) shows that injured knee extensors need at least 12 months to exhibit a significant improvement, while this improvement was observed at 9-12 months for knee flexors. When comparing the results from before and 6 months after surgery, Wenning *et al.* (18) also observed improvements in knee extensors and flexors peak torque, without significant differences between the ACL reconstruction and ACL plus meniscal repair groups. Additionally, Lepley *et al.* (20) did not observe differences in quadriceps activation, as well as knee extensors isokinetic and maximal isometric torque between these groups at a time when individuals were able to return to sport. Together, this evidence indicates that meniscal repair does not significantly affect the quadriceps and hamstrings strength recovery for athletes who undergo concurrent ACL reconstruction. Therefore, athletes who undergo ACL reconstruction and meniscal repair can reasonably expect, in the short to medium term, to regain their pre-injury muscle strength at a rate comparable to athletes who undergo ACL reconstruction alone.

Strength balance outcomes

Since the main goal of ACL reconstruction is to restore mechanical joint stability and functional capability, two key isokinetic parameters play significant roles in assessing these outcomes: the bilateral asymmetry index (25) and the hamstring-to-quadriceps strength ratio (26). Monitoring the bilateral asymmetry index, which reflects the strength discrepancy between the injured and uninjured sides, is a fundamental approach to gauging the progress of recovery. In this scenario, the bilateral asymmetry index may provide useful information to facilitate a return to the pre-injury performance level after ACL reconstruction (27). Since we did not observe significant changes over time in both knee extensors and flexors peak torque on the non-injured side, a significantly lower bilateral asymmetry index identified around 12 months can be attributed to the strength improvement in the injured limb. Additionally, we observed that after 9 months, both knee extensors and flexors presented a mean bilateral asymmetry index below 15%. This is a well-expected outcome since a strength symmetry greater than 85% between the injured limb and the contralateral side is a widely required return to sports criterion (28, 29).

The hamstring-to-quadriceps strength ratio is another metric used to assess mechanical knee joint stability and the overall strength balance between the opposing muscle groups (30). For both the involved and contralateral knee, we do not observe significant changes over time in this isokinetic parameter. Since this variable is calculated from the peak torque ratio of knee flexors to knee extensors, we do not expect significant changes in this outcome due to the strength fluctuations over time of these muscle groups, mainly attributed to quadriceps arthogenic inhibition and the use of hamstring tendon graft. With the exception of the 3-6-month post-surgery assessment on the injured side, the mean H/Q_{con} in all other measurements, including both limbs, was around 0.6-0.7, indicating an appropriate knee flexors and extensors strength balance when this joint is assessed at slow to intermediate angular velocities (12-180°/s) (33). Similarly, Wenning *et al.* (18) also observed no significant changes in hamstring-to-quadriceps strength ratio before and after 6 months of ACL reconstruction in both the ACL reconstruction alone and ACL plus meniscal repair groups. This result suggests that even with an improvement in hamstrings and quadriceps torque on the injured side, the strength balance

between these muscles was maintained, indicating a proportional force increase. Given these findings, it is essential to exercise caution when interpreting the hamstring-to-quadriceps strength ratio in isolation, as an optimal ratio may not necessarily imply functional improvement.

Limitations

While our study makes a valuable contribution to the field by examining the effects of associated ACL reconstruction and meniscal repair in professional athletes, as well as the evolution of isokinetic parameters assessed over several time points, there are some limitations that should be highlighted to provide a comprehensive view of the research findings. A crucial aspect of assessing postoperative strength and functional recovery is understanding the rehabilitation process that patients undergo (31, 34). Although our study did not incorporate comprehensive monitoring of the rehabilitation protocol, all patients received a specific guideline previous reported (2). However, the variations in rehabilitation approaches, exercises, and timelines may have influenced the recovery trajectory and subsequent outcomes. Another limitation pertains to the absence of data regarding the time elapsed between injury occurrence and the surgical intervention. This timeline can significantly impact the initial condition of the knee joint functionality, influencing pre-surgery muscle strength and potentially affecting post-surgery recovery rates (12, 32). Incorporating this information would provide a better understanding of how the injury-to-surgery timeline interacts with the outcomes observed in our study. Finally, the sample comprises individuals from various sports modalities. Each sport entails distinct movement patterns, biomechanics, and physical demands, which can introduce a level of variability in the study's results. Additionally, different sports may place varying stressors on the knee joint, potentially impacting the rate and extent of recovery. Therefore, future studies could consider focusing on specific sports to minimize this source of variability.

CONCLUSIONS

In conclusion, our study underscores that athletes who underwent simultaneous meniscal repair and ACL reconstruction can achieve similar enhancements in knee extensor and flexor muscle strength, as well as strength balance, when compared with those who solely undergo ACL reconstruction. These outcomes hold significant implications for patients throughout the rehabilitation process and are consistent with prior research that have explored the combined effects of ACL reconstruction and meniscal repair on isokinetic performance.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

RAG, VRAC: conceptualization, experiments design. CTL, VRAC, AMSP: data collection, JCSA, CTL, TL: analysis of data. JCSA, CTL, SCS, TL: interpretation of data. JCSA, CTL, AMSP, MM, SCS, RAG, VRAC, TL: writing – original draft, writing – review & editing.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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