

Association Between ACL Injury and Restricted Hip Range of Motion Among Athletes: A Case Control Study

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Abstract

Background: Anterior cruciate ligament (ACL) rupture is the most common knee ligament injury worldwide, and it is considered as a public health problem because of its high incidence and both short- and long-term consequences. Recently, the scientific literature has shown a trend in the study of post-injury treatments and the possible risk factors associated with the causes of these injuries to facilitate the understanding of the mechanisms of this injury and assist in the elaboration of preventive measures, especially for athletes or practitioners of physical activities. This study compared the hip range of motion (ROM) measurements of athletes depending on the presence of ipsilateral ACL injury.

Methods: Athletes diagnosed with previous ACL injury were selected for the case group, and those with other injuries were selected for the control group. Data regarding participants' histories, ages, genders, and the sports practiced were collected. All participants underwent hip ROM measurements using a goniometer. Hip radiographs were taken to measure the Alpha (α) and Wiberg (w) angles. For the statistical analysis, the means and standard deviations were calculated for continuous variables, and frequencies (percentages) were calculated for dichotomous variables. A p -value less than 5% was defined as significant. Student's t -tests were used for continuous variables, and chi-square tests were used for categorical variables.

Results: A total of 77 participants were included: 47 athletes with ACL injuries and 30 with other musculoskeletal injuries. The mean age was 24.7 years, and 46.7% were female. No between-group differences were found with regard to the baseline characteristics. Most of the athletes played futsal (50.6%) followed by soccer (29.8%). The cases presented with significant reductions in hip internal rotation (IR; 24.1° versus 32.50° , $p < 0.0005$) and the internal rotation associated with external rotation (IR + ER; 69.9° versus 78.5° , $p = 0.005$) ROMs as well as a significant increase in the w radiographic angle (38.7° versus 32.4° , $p < 0.0005$).

Conclusion: ROM measurements of hip IR, IR + ER, IR values less than 30° , and the w radiographic angle might be associated with previous ipsilateral ACL injuries among athletes.

Trial registration: Registered at Brazilian Clinical Trials Registry (ReBec) as RBR-6g87mn on 04 August 2020 (retrospectively registered). <http://www.ensaiosclinicos.gov.br/rg/RBR-6g87mn/>

Background

ACL rupture is the most common knee ligament injury worldwide, and it is considered as a public health problem because of its high incidence and both short- and long-term consequences [1]. Recently, the scientific literature has shown a trend in the study of post-injury treatments and the possible risk factors associated with the causes of these injuries to facilitate the understanding of the mechanisms of this injury and assist in the elaboration of preventive measures, especially for athletes or practitioners of physical activities [2, 3].

The major contributing factors to the risk of ACL injury include proprioception deficiency, hormonal variations in women, bone changes, neuromuscular control, maturation, and changes in the kinetic chain of the lower limbs, which often have a secondary impact on the knee joint [1, 3, 4, 5]. A previous ACL injury is a potential risk factor for subsequent injury, which raises the question regarding the influence that certain individual structural characteristics might have on the mechanism of this injury [1].

Recent studies have shown that one of the structural changes that predispose certain athletes to the risk of an ACL injury is reduced hip range of motion (ROM) [1, 2, 12]. The hip joint is part of a complex kinetic chain and presents compensatory functions in the proximal and distal joints. Restriction of hip mobility causes excessive rotational stress on the knee, leading to ACL overload and subsequent injury. Furthermore, deformities in the anatomy of the acetabulum and proximal femur are frequent and often asymptomatic, especially in athletes, and might result in the secondary restriction of hip ROM [1, 7]. Athletes require torque in the joints and high peaks of strength for their high-demand tasks; thus, they increase the movement of the hemipelvis and lumbar spine to compensate for limitations in the hip [2, 8]. If this combination is detected after an initial injury, then a greater restriction in the hip rotation movements is expected in the case of a second injury [7, 9].

However, controversy remains regarding the correlation between the risk factors for ACL injury because far more studies have investigated its treatment than its prevention. In addition, few studies have included hip articulation in their biomechanical analyses.

The purpose of the present study was to evaluate the influence of restricted hip ROM on ACL injury compared with a control group of participants without ACL injury.

Methods

The study compares the ROM measurements of athletes, depending on the presence of an ipsilateral ACL injury. This case-control study was approved by the institution's research ethics committee. Athletes were selected from the Sports Trauma Group of the institution, between March 2018 and March 2019, with previous diagnosis of ACL injury were selected for the case group, and those with other injuries (shoulder, wrist and hands) were selected for the control group. Exclusion criteria were patients with a previous diagnosis of: lower limb fracture, inflammatory disease, femoroacetabular impingement syndrome, hip dysplasia, lower limb dysmetria or a history of previous knee surgery.

Relevant data including participant history, age, gender, and type of sport practiced were collected. The same examiner, staff knee surgeon, measured the hip ROM of all participants using a goniometer and a radiographic analysis. Radiographs taken from the anteroposterior (AP) view were used to measure the w angle [10] and from the Dunn view [11] to measure the α angle [12] (Fig. 1).

For the statistical analysis, the means and standard deviations were calculated for continuous variables, and frequencies (percentages) were calculated for dichotomous variables. A p -value less than 5% was

defined as significant. Student's t-tests were used for continuous variables, and chi-square tests was used for categorical variables.

Results

A total of 154 participants were selected. The sample included 94 athletes diagnosed with ACL injury caused without direct trauma (cases) and 60 athletes diagnosed with other musculoskeletal injuries (controls). Athletes were classified as those who practice at least 2 hours of activities for 4 days a week. The overall mean age of participants was 24.77 (\pm 5.41) years. Most participants in the case group were male, and most of those in the control group were female (Table 1).

Table 1
Sample characteristics

	Case Group	Control Group
Mean age (SD)	25.7 (6.3)	23.2 (0.7)
Gender (% women)	32	64.5
Sport practiced		
- Futsal	51.06%	46,66%
- Soccer	31,91%	33,33%
- Handball	4,25%	6,66%
- Basketball	4,25%	3,33%
- Jiu-Jitsu	2,13%	3,33%
- Rugby	2,13%	3,33%
- Running	2,13%	3,33%
- Taekwondo	2,13%	0
- Ballet	2,13%	0

Most athletes practiced futsal (50.64%), followed by soccer (29.87%); handball (5.19%); basketball (3.89%); jiu-jitsu, rugby, and running (2.59%); and taekwondo and ballet (1.29%). None of the participants were lost to follow up or withdrew from the study. Of the participants included, only 7.8% (n = 6) complained of hip pain; of these, all experienced a previous ACL injury.

When comparing the variables between the groups, a significant difference was observed with regard to hip internal rotation (IR), internal rotation associated with external rotation (IR + ER), and the α and w angles (Table 2):

Table 2
Mean comparisons of the variables between each group

	Case Group	Control Group	p-value
IR	24.15° ± 7.09	32.50° ± 6.26	p < 0.0005
IR + ER	69.68° ± 14.31	78.50° ± 10.43	p = 0.0005
α angle	65.83° ± 6.29	38.79° ± 8.00	p = 0.048
w angle	62.40° ± 6.29	32.43° ± 7.04	p < 0.0005

(1) IR means of 24.15° (± 7.09) in the case group and of 32.50° (± 6.26) in the control group (p < 0.0005);

(2) IR + ER mean of 69.68° (± 14.31) in the case group and of 78.50° (± 10.43) in the control group (p = 0.005);

(3) α angle mean of 65.83° (± 6.29) in the case group and of 62.40° (± 6.29) in the control group (p = 0.048);

(4) W angle mean of 38.79° (± 8.00) in the case group and of 32.43° (± 7.04) in the control group (p < 0.0005).

An analysis was performed comparing the percentage of specific categories between the participants across the two groups: IR below 30°, IR + ER above 75°, α angle above 50°, and w angle below 40°. The results showed that an IR reduction below 30° was associated with ACL injury (Table 3).

Table 3
Comparisons between specific aspects characterizing a deviation from normal

	Case Group	Control Group	p-value
IR < 30°	68.08%	23.35%	p < 0.0005
IR + ER < 75°	51.06%	36.66%	p = 0.305
α angle > 50°	93.61%	96.66%	p = 0.557
w angle < 40°	31.91%	6.66%	p = 0.006

Discussion

The sample consisted of young athletes, most of whom were soccer or futsal players. Significant increases were observed with regard to the hip IR, IR + ER (IR + ER), IR below 30°, and w radiographic angle measurements in the case group. These findings demonstrate a possible correlation between hip joint limitations and ACL injury.

Similarly, Gomes et al. [7, 9, 13] analyzed soccer players and showed that noncontact ACL re-ruptures might be related to restricted hip rotation. These authors recommended that hip ROM should be routinely examined to aid in clinical decision making, especially regarding athletes with knee instability. Furthermore, these three studies described the patients as asymptomatic, and they did not report pain or have difficulty performing sports movements. These data corroborate the findings of the present study in which only 7.8% of the participants complained of hip pain; importantly, all belonged to the case group and presented with prior ACL injury. What we cannot say is that the restriction of movement of the hip occurred in the past in an ACL injury, or that this injury developed as a compensatory cause to the ACL injury.

Gomes et al. [9] analyzed the radiographic findings of participants and found many bone abnormalities in athletes' hips. Similarly, the present study showed a significant increase in the radiographic measurements of the w angle in the case group with prior ACL injury. Larger w angles on the hip are related to an increase in acetabular coverage, which can be a cause of restriction of the hip's range of motion. Consequently, torsional stress on the knee is increased leading to an increased risk of ACL injury. The α angle results of the case group were superior to those of the control group. Bagherifard et al.[6] also observed this finding.

Despite the established consensus among researchers that changes in the trunk, hip, knee, ankle, and foot kinetic chain contribute to ACL injury, clinical practice continues to treat the knee without regard to its proximal and distal structures [14, 15] Soccer players with ACL injuries and the presence of restricted hip rotation ROM might present with bone changes that lead to the poor results associated with traditional ligament reconstruction techniques; therefore, new treatment protocols are necessary for these cases [9].

Because the reduction of hip IR can overload the knee joint, an adequate physical therapy program aimed at gaining strength and flexibility in the hip muscles, especially the rotators, might improve the conditions of these patients. In addition, ROM limitations diagnosed early can be treated with muscle stretching programs to avoid capsular stiffness [9].

The present study was limited by its small sample size and the retrospective nature its design. In addition, gender was not equally distributed between the groups because more men were in the case group; therefore, it was not possible to determine the influence of this factor on the results.

It is recognized that women have some factors that can increase the risk of ACL injury, among them: the morphology of the knee joint, family history, hormonal fluctuation and difference in neuromuscular control [5, 16]. It has been shown that on landing, women have less recruitment of the gluteus maximus in relation to the rectus femoris and have greater hip adduction angles. Neuromuscular control of the trunk and hip expresses a greater range of motion in women, which leads to less torsional stiffness causing an increased risk of ACL injury [5].

In summary, despite the lack of studies on this subject to date, a trend toward the inclusion of hip mobility assessments (including ROM and radiographic examinations) exists as a prophylactic measure

to define the risks related to sports practice, especially soccer. Thus, an understanding of the correlation between hip movement restriction and ACL injury not only improves the treatment of these patients but also helps to prevent these injuries. Additional studies with larger and more homogeneous samples are required to support these results.

Conclusion

Measurements of the hip IR and IR + ER ROMs as well as the α and W radiographic angles are associated with ipsilateral ACL injury in athletes. Reduced hip IR (specifically below 30°) is also associated with ACL injury.

Abbreviations

ACL - Anterior cruciate ligament

ROM – Range of motion

α – Alpha angle

w – Wiberg angle

IR – Internal rotation

ER – External rotation

AP – Anteroposterior

Declarations

Ethics approval and consent to participate

Procedures, associated risks, and potential benefits of participation were explained to each participant and written informed consent was obtained prior to commencement of the study. This case-control study was approved by the research ethics committee of Santa Casa de Misericórdia de São Paulo under protocol number 86625717.8.0000.5479

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

DE collected, analyzed and interpreted the data. LGBG and MVL interpreted the data and wrote the manuscript. ADJ and PBJ assisted in the bibliographic research and editing of the manuscript. CS contributed to the review of the data and the writing of the manuscript. All authors read and approved the final manuscript.

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Not applicable

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Figures

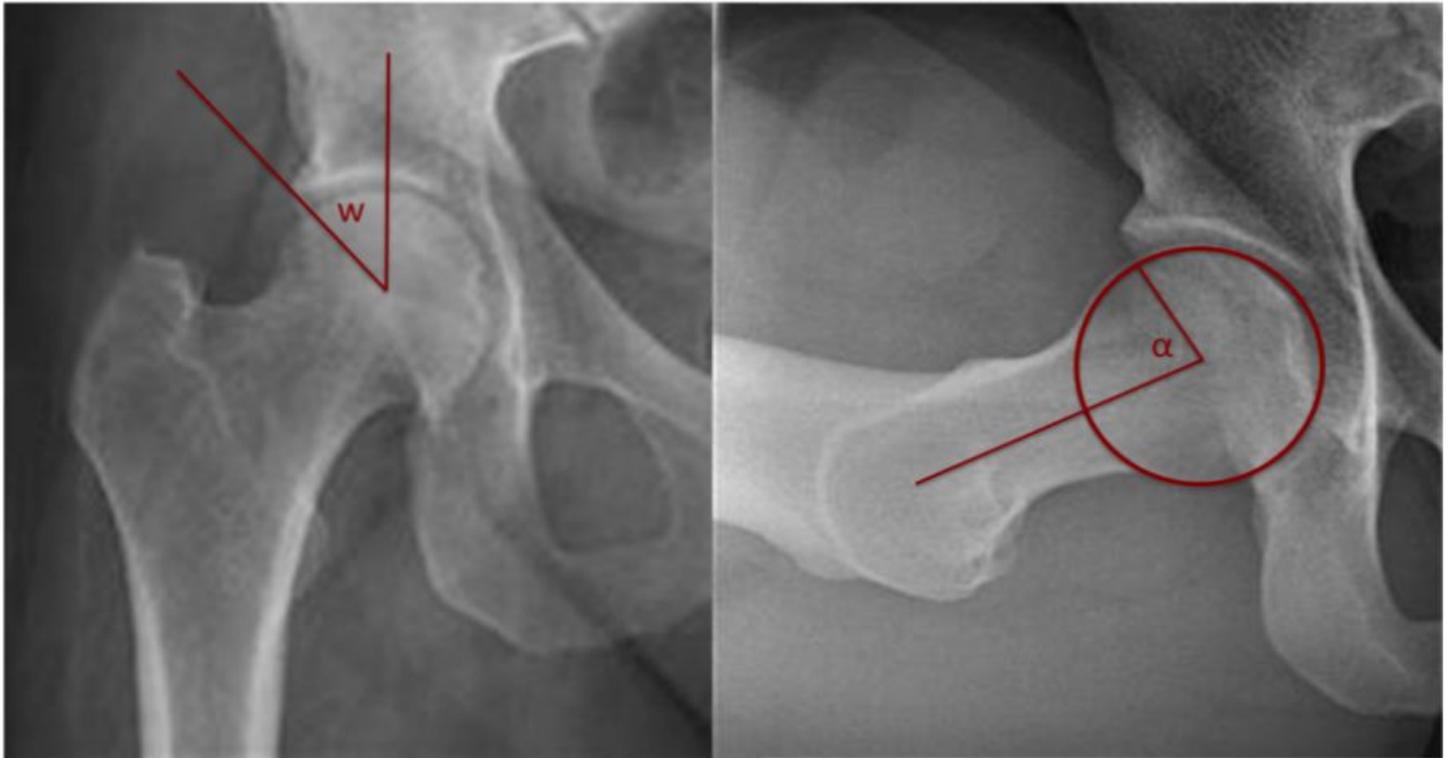


Figure 1

Example measurements of the w angle from the anteroposterior (AP) radiographic view and the α angle from the Dunn radiographic view

Supplementary Files

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- [STROBEchecklistcasecontrol.doc](#)