RESEARCH ARTICLE

Analysis of the functional performance of the shoulder in swimming athletes with and without a history of injury

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ABSTRACT:

Background: Swimmers have a significant potential for shoulder injuries due to the unique nature of the different styles involved in swimming, as well as the high volume of repetitions required during training, which arise through repetitive strain and microtrauma. Injuries are the most frequent due to the repetitive use of the upper limb in overhead movements and factors related to Range of Motion (ROM) and strength. **Objective:** To analyze the performance of the shoulder of swimming athletes and to verify if there is a difference between athletes with and without a history of injury, as well as to verify the transmission between the performance of this joint with ROM and strength values. **Methods:** 24 competitive swimmers were evaluated, with an average age of 20 years (± 7.9). The glenohumeral internal rotation deficit (GIRD) and internal and external rotation ROM of the shoulder were evaluated using goniometry. Shoulder functionality was assessed using the closed kinetic chain test for upper limbs (CKCUEST). Handgrip strength was also evaluated with a dynamometer. SPSS software, version 21.0, was used and data were analyzed using Pearson's collaboration test and Student's t test for independent samples. **Results:** Athletes with a history of injuries had a higher weekly training load, although they did not differ in terms of the number of years practicing the sport. The performance in the CKCUEST was higher in the group without a history of injury ($p=0.04$) and there was no difference between the groups regarding the variables of total ROM and GIRD, as well as for grip strength. There was change only between the CKCUEST power values with the grip strength ($p<0.05$, $r=0.677$). **Conclusion:** The functional performance of the shoulder is greater in athletes without a history of injury.

Keywords: Shoulder Joint; range of motion; athletes; swimming.

BACKGROUND

Swimming is an overhead sport, that is, it uses movements above the head, requiring mainly the upper part of the body for propulsive force, with 90% of the driving force provided mainly by the torque generated by the shoulder. To compete at an elite level, each swimmer must cover between 60,000 and 80,000 meters per week, equivalent to 30,000 strokes per upper limb (1). Swimmers have a significant potential for shoulder injuries due to the unique nature of the different styles involved in swimming, as well as the high volume of repetitions required during training, which arise through repetitive strain and microtrauma(2-4).

Among the main injuries in the sport, the most recurrent are rotator cuff tendinopathies, impingement syndrome, labral injuries, and instability secondary to ligament laxity or muscle imbalance that results in a decrease in the athlete's performance(5-7). Injuries in sports can be considered the main factor in athletes leaving their sport. This absence is harmful, as it directly influences their physical and technical performance, in addition to possible psychological damage, with changes in cognitive, behavioral, and affective responses(8,9).

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Since one of the main risk factors is due to the repetitive use of the upper limb in overhead movements and factors related to range of motion (ROM) and strength, it is clinically important to use practical methods for analysis and evaluation constant of the athlete to prevent injuries and criteria for returning to sport after absence(10).

A widely used instrument for analyzing shoulder functional performance is the closed kinetic chain test for upper limbs, also known as the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST), as it is a validated, simple to apply and low-cost test that can be easily inserted into the clinical or sporting context and which has a good correlation with measures of muscular strength, in addition to showing excellent reliability(11).

Handgrip strength has been used as an indicator of the body's general muscular strength, is significantly associated with other muscles' functioning and the upper limb's function, and is even considered a biomarker(12,13). In the context of sport, grip strength is important to optimize performance and potentially prevent injuries (14).

In overhead sports, it is common to observe a reduction in the internal rotation ROM of the dominant upper limb when compared to the non-dominant limb, verified based on the assessment of the glenohumeral internal rotation deficit or the Glenohumeral Internal Rotation Deficit (GIRD). This clinical condition is closely related to an important risk factor for chronic pain and injuries to the shoulder joint(15-17).

This study aimed to analyze the shoulder performance of swimming athletes and verify whether there was a difference between athletes with and without a history of injury, as well as verify the relationship between the performance of this joint with ROM and strength parameters. The study hypothesis was that athletes with a history of shoulder involvement would present lower performance during the functional test.

METHODS

The study was approved by the Research Ethics Committee of the Faculty of Philosophy and Sciences of UNESP Marília, under protocol nº 1.841.672, and carried out by the standards of the National Health Council. Anamnesis was carried out and data on age, body mass (in kilograms), height (in meters), body mass index (BMI), hours of weekly training, and history of shoulder joint injury. Competitive male swimming athletes aged between 18 and 30 years were included in the study. As non-inclusion criteria, positive Cozen and Phalen tests were adopted, which could interfere with strength and performance results(18).

To perform internal and external rotation goniometry of the athlete's shoulder, a universal goniometer (Arktus®, São Paulo, Brazil) was used. The athlete was positioned in the supine position, with 90 degrees of shoulder abduction and 90 degrees of elbow flexion to ensure stabilization of the scapula and trunk. The goniometer was positioned with the fixed arm perpendicular to the floor, the axis positioned on the olecranon and the movable arm positioned along the forearm with the styloid process of the ulna as a reference point and following the rotational movements. Passive internal and external rotation movements of the glenohumeral joint and three range of motion measurements were performed(19,20). Internal and external rotation ROM was analyzed bilaterally to evaluate GIRD, as can be seen in Figure 01.

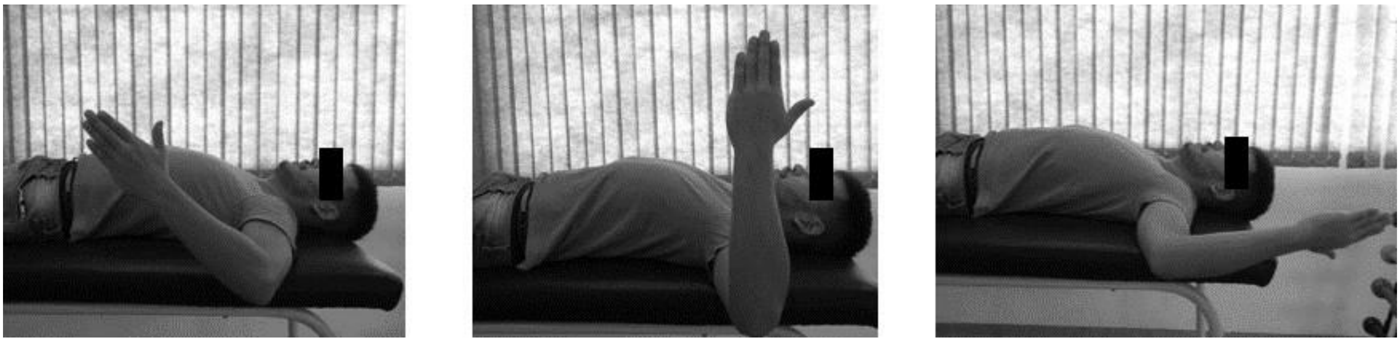

Figure 01: Positioning for GIRD assessment through internal and external rotation.

To analyze handgrip strength, a hand-held hydraulic dynamometer (JAMAR®, TBW Importadora LTDA, São Paulo, Brazil) was used. The volunteer was positioned seated, with feet flat on the ground, with elbow flexion at 90 degrees, forearm in a neutral position, with the wrist varying from 0 to 30 degrees of extension and ulnar deviation from 0 to 15 degrees. The dynamometer was positioned with the reader facing the evaluator. An attempt was made to familiarize the test, followed by three valid repetitions of maximal isometric contraction with a 60-second interval between them.

The average value of the attempts was calculated in kilogram-force (Kgf)(21).

To carry out the athlete's shoulder performance test, the CKCUEST was performed based on the protocol by Goldback and Davies (2000), where two 3.8cm tapes were positioned parallel to the floor with a distance of 91.44cm between them. The volunteers were instructed to stay in the “push-up” position with their hands on the tapes, as can be seen in Figure 2. After the examiner's command, the volunteer removed the palm and placed it on the back of the contralateral hand in Then he returned to the starting position and performed the same movement with the other side(22).

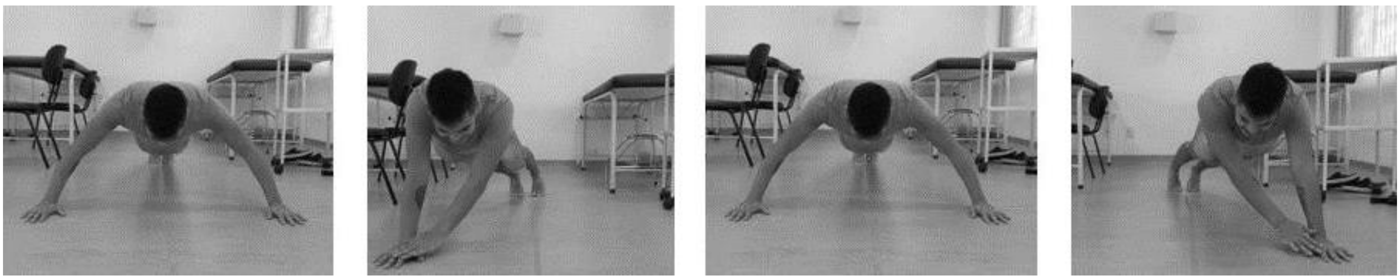

Figure 02: Positioning to perform the CKCUEST.

Two examiners performed the CKCUES test. The first examiner counted the number of touches made by the participants. The second examiner was responsible for checking the digital timer and verbally informing the first examiner and the participant of the start and end times of the test. The test was performed four times for 15 seconds with 45 seconds of rest between each repetition, the first being familiarization, trying to give as many touches as possible within the estimated time. The average of the three maximum tests was then obtained and the volunteers' test scores were calculated. Athletes' performance was measured using the formula: average number of touches/height in inches; and the power according to the formula: 68% of the weight in kilograms x average number of touches / 15(23).

Statistical analysis

The convenience sample was used. All analyses were performed using SPSS version 21 (SPSS, Inc., Chicago, IL, USA). Normal distribution was verified using the Shapiro-Wilk test. The Student's t-test for independent samples was performed to verify the difference between swimming athletes with and without a history of injury about anthropometric variables, time in the sport, range of movement, and shoulder performance in the closed chain test. Then, the Pearson correlation test was calculated to evaluate the association between CKCUEST, GIRD, and strength values. A significance level of 0.05 was considered.

RESULTS

24 competitive swimming athletes, with an average age of 20 years (± 7.9), of competitive level, were evaluated, divided into two groups: with a history of injury (n=10) and without a history of injury (n=14). Table 01 shows the values found about age, anthropometric data, and physical activity of the research volunteers. It was possible to observe that the sample was homogeneous about the variables, showing a significant difference (p<0.05) only in the hours of weekly training.

Table 01. Sample characterization.

	Total (n=24)	Without injury (n=14)	Whit injury (n=10)	p
Age (years)	20± 7,9	20,4± 9,4	19,4± 5,6	0,23
BMI (kg/m²)	24± 3,2	23,8± 2,7	23,5± 3,9	0,42
Sports practice time (years)	9± 5,1	9,2± 5,7	8,8± 4,3	0,68
Training hours (Weekly)	9± 3,2	8,79± 4,0	10,60± 2,5	0,01*

***Note:** Mean values ± standard deviation; (p): significance level. *: significant difference; BMI: Body Mass Index.

Table 02 shows the performance values in the CKCUEST, internal rotation deficit, and hand grip strength for both groups. It can be seen that the values of CKCUTEST were statistically significant between the groups in terms of the number of touches and the mean. However, there was no significant difference about the GIRD score and grip strength. The Pearson correlation test demonstrated that there was only a positive and moderate correlation between the power values of the CKCUTEST test and grip strength. However, there was no correlation between the CKCUTEST values and the GIRD, as can be seen in Table 03.

Table 02. Values of GIRD, CKCUEST and handgrip strength in athletes.

	Total (n=24)	Without injury (n=14)	Whit injury (n=10)	p
GIRD (degrees)	7,7± 8,12	6,5± 7,3	9,6± 9,9	0,76
CKC Ringtones	31,06 ± 6,62	33,14± 4,4	30,6± 2,71	0,04*
Average CKC	28,79± 6,09	30,75± 3,8	28,33± 2,3	0,04*
CKC performance	0,42± 0,09	0,44± 0,05	0,40± 0,04	0,05
CKC Power	211,66± 57,31	222,4± 47,7	221,94 ± 51,53	0,54
Grip strength (Kgf)	56,18± 26,39	63,77± 25,18	47,88±27,2	0,58

***Note:** Mean values ± standard deviation; (p): significance level. *: significant difference; GIRD: Internal Rotation Deficit; CKC: closed kinetic chain test for upper limbs.

Table 03. Coefficients of the two-sided Pearson Correlation analysis.

	GIRD	Handgrip strenght
CKCtoque	-0,065	0,192
CKCmedia	-0,007	0,340
CKCperformance	-0,23	0,178
CKCpower	0,109	0,677*

*p<0.05; CKC: closed kinetic chain test for upper limbs.

DISCUSSION

The present study aimed to analyze the performance and ROM of the shoulder joint of swimming athletes and verify whether there is a difference between athletes with and without a history of injury, partially confirming the initial hypothesis. CKCUTEST values were significantly higher in the group without a history of injury in terms of the number and average of touches. This finding corroborates the work of Tucci and collaborators, who evaluated performance in the CKCUEST in people with and without shoulder impingement syndrome, demonstrating that individuals with a history of injury obtained inferior results compared to healthy individuals(24). A possible justification could be that the CKCUEST is a high-level performance test, which requires an exacerbated demand on the shoulder joint, and its results may be limited by kinesiophobia and pain when performing the movements.

On the other hand, the findings of the present study showed no significant difference in GIRD values between the groups. Swimming's main sporting gesture is movements performed bilaterally above the head. Therefore, one hypothesis for the findings would be that the internal rotation deficit would also occur bilaterally since GIRD values in swimming athletes are lower when compared to other types of overhead athletes(25).

About weekly training time, athletes in the group with a history of injury had a statistically greater training volume compared to the group without injury. Ristolainen and collaborators demonstrated through a retrospective study of

12 months with 154 adolescent and adult swimmers, injured swimmers reported swimming more than uninjured swimmers, with 1612 kilometers and 1380 kilometers, respectively (p= 0.04)(26).

In this study, it was possible to observe a positive correlation between power values in the CKCUEST and handgrip strength. Handgrip is closely related to the function of the upper extremity and is an action that facilitates rotator cuff movements. Similar results were found in the study by Lee et al., which demonstrated high positive correlations for both the right hand (0.79) and the left hand (0.78)(27).

This study did not evaluate the methods that were used to treat athletes with a history of injury, as well as the type of injury suffered, which could contribute to a better understanding of their impact on the performance of the athletes evaluated. The limitations of the present study also include the sample size and future studies should be conducted on a larger population, as well as monitoring the types of injuries suffered and the treatment methods used at the time of the trauma.

CONCLUSION

The present study demonstrated that swimming athletes without a history of shoulder injury have a greater closed kinetic chain functional performance compared to swimmers with a history of injury. Regarding ROM and strength parameters, there was no significant difference between the groups.

Authors' contribution: ICS, MVGS, MTK and CRP contributed to the elaboration of the design of the study; MTK development of the study and data acquisition. ICS, MVGS, MTK, MNK and CRP contributed to article design and data tabulation. ICS and CRP contributed to the critical review, correction and approval of the final version.

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