

## **Glenohumeral rotation range deficit in professional rugby players: A cross sectional study**

## **Déficit en el rango de rotación glenohumeral en jugadores de rugby profesional: Un estudio de corte transversal**

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### **Abstract**

The aim was to evaluate the internal rotation, external rotation and total range of motion of shoulder in professional rugby players and associated factors. 104 rugby players and 30 healthy volunteers were interrogated and clinically examined. 19.23% of the rugby players were excluded by history of shoulder luxation or surgery. 84 rugby players with  $24.28 \pm 5.37$  years old were finally included in the study. The groups were analyzed with Mann-Whitney test, Fisher's exact test, Linear Regression and a Logistic Regression. It was found that professional rugby players had less internal, external and total range of glenohumeral rotation compared with control group. In the Logistic Regression, the age is a risk factor for external rotation range deficit (Odds Ratio= 1.58). Instead, the years of experience are a protector factor (Odds Ratio= 0.63). We can conclude that glenohumeral rotation range is diminished in professional rugby players and is associated with age and years of experience.

**Key words:** rugby; shoulder; glenohumeral rotation range deficit; collision sports.

### **Resumen**

El objetivo de este estudio fue evaluar la rotación interna, rotación externa, el rango total de movimiento del hombro y factores asociados en jugadores de rugby profesional. 104 jugadores de rugby y 30 voluntarios sanos fueron interrogados y examinados clínicamente. Un 19.23% de los jugadores de rugby fueron excluidos por historial de luxación o cirugía de hombro. 84 jugadores de rugby, con  $24.28 \pm 5.37$  años de edad fueron finalmente incluidos en el estudio. Los grupos se analizaron con la prueba de Mann-Whitney, la prueba exacta de Fisher, regresión lineal y regresión logística. Se encontró que los jugadores profesionales de rugby tienen menos rango de rotación interna, externa y total en comparación con el grupo control. En la regresión logística, la edad es un factor de riesgo de déficit de rotación externa (OR = 1.58). En cambio, los años de experiencia son un factor protector (OR = 0.63). Podemos concluir que el rango de rotación glenohumeral está disminuido en jugadores de rugby profesional y se asocia con la edad y los años de experiencia.

**Palabras clave:** rugby; hombro; déficit de rotación glenohumeral; deportes de colisión.

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## Introduction

Rugby is one of the most popular professional team sports in the world, but it also has one of the highest reported incidences of injury (Brooks, Fuller, Kemp, and Reddin, 2005; Gabbett, 2008; Quarrie, and Chalmers, 2001; Darrow, Collins, Yard, and Comstock, 2009; Fuller, Ashton, Brooks, Cancea, Hall, and Kemp, 2010; Headey, Brooks, and Kemp, 2007; McIntosh, 2005; Kaplan, Flanigan, Norwig, Jost, and Bradley, 2005). The nature of the game consists in intermittent sprints, tackling and recovering periods (Gabbett, 2008). As a result of the high number of physical collisions and intense nature of the game, musculoskeletal injuries are common (Gabbett, 2008).

Shoulder injuries are frequent in rugby (Brooks, Fuller, Kemp and Reddin, 2005; Headey, Brooks, and Kemp, 2007; Kaplan, Flanigan, Norwig, Jost, and Bradley, 2005). Epidemiological studies have shown that the incidence of this type of injury is increasing (Herrington and Horsley, 2009). Rugby league players over four competitive seasons, have presented shoulder lesions as the most incident injury (15.6 [8.2-23] lesions per 1000 playing hours)<sup>3</sup>. The main shoulder injuries are acromioclavicular dislocation, glenohumeral dislocation/instability and rotator cuff impingement (Brooks, Fuller, Kemp, and Reddin, 2005).

There are well-known risk factors for injury in rugby players (Fuller, Ashton, Brooks, Cancea, Hall, and Kemp, 2010; Brooks, Fuller, Kemp, and Reddin, 2005). High speed going into the tackle, high impact force, collisions and contact with a player's head/neck are identified as risk factors (Fuller, Ashton, Brooks, Cancea, Hall, and Kemp, 2010). Also, midfield backs are more prone to injury when tackling than other players (Fuller, Ashton, Brooks, Cancea, Hall, and Kemp, 2010). Higher training volumes (more than 9,1 hours per week) did not increase the incidence of match or training injuries. However, higher training volumes did increase the severity of match injuries (Brooks, Fuller, Kemp, and Reddin, 2005). Fitness testing, defense, rucking and mauling were identified as being high-risk training activities (Brooks, Fuller, Kemp, and Reddin, 2005).

The glenohumeral rotation deficits are well-known risks factors for shoulder injuries in throwing sports (Dwelly, Tripp, Tripp, Eberman, and Gorin, 2009; Torres and Gomes, 2009; Thomas, Swanik, Swanik, and Kelly, 2010; Nakamizo, Nakamura, Nobuhara, and Yamamoto, 2008; Burkhart, Morgan, and Kibler, 2003). An altered interaction between the dynamic and passive stabilizers may predispose to an increased incidence of joint injury (Herrington and Horsley, 2009). Precise motor acquisition and rapid reaction time are important in preventing injury (Cain, Mutxhler, Fu, and Lee, 1987).

Tackling or being tackled is the responsible for the majority of the shoulder injuries in rugby players (Wilson, Quarrie, Milburn, and Chalmers, 1999). During the tackle, the shoulder is part of a kinetic chain of energy, in which the force is transmitted from the legs to the shoulder, developing deceleration forces that should be attenuated by a coordinated recruitment of the muscles (dynamic stabilizers) (Herrington and Horsley, 2009).

Herrington and Horsley (2010) have suggested that shoulder rotator muscles activation is essential in the tackle, based on electromyographic analysis of this movement. Edouard, Frize, Calmels, Samozino, Garet, and Degache (2009) have studied the rotators strength imbalances in rugby players by comparing internal rotation and external rotation strength between rugby players and nonathletic subjects. They have reported no rotators muscles imbalance in rugby players.

Our research group hypothesized that glenohumeral rotation deficits may be a treatable condition associated with an increased incidence of rugby lesions.

The primary objective of our research team is to evaluate the internal rotation, external rotation and total range of motion of shoulder in rugby players compared with control group. The secondary objective was to evaluate associated factors to the glenohumeral rotation range alterations.

## Materials and methods

### *General description*

104 rugby players and 30 healthy volunteers were interrogated and clinically examined in January 2009 - December 2009, searching for glenohumeral rotation deficits and associated factors. The interrogation was performed based in a survey questionnaire designed for this study. Informed consent was obtained prior to data collection, accordingly to Declaration of Helsinki.

### *Subjects*

The inclusion criteria for all subjects were age between 18 and 50 and current participation in the Chilean Rugby Professional League. The exclusion criteria for all subjects were a history of cervical or thoracic pathology, previous shoulder surgery or luxation, and presence of shoulder pain that prevented the correct execution of the tests. 19.23% of the rugby players were excluded. 84 rugby players with a mean±SD (standard deviation) age of 24.28±5,37 years old were finally included in the study. The general information is summarized in Table I.

Table I. General Information

	Rugby	Forward	Backs	Control
N	104	43	61	30
Age	24.3±5.36	24.5±6.01	24.2±4.95	23.4±2.7
BMI	27.3±2.74*	27.97±3.24*	26.9±2.3*	23.9±1.8
Right : Left Side dominance	1:0.11	1:0.12	1:0.11	1:0.09
Years of experience	4.9±4.62	5±4.94	4.8±4.46	-
History of injury	41.35%	37.21%	44.26%	-
Right : Left Side injury	1:0.92	1:1	1:0.86	-
Shoulder surgery	25%	15%	32.14%	-
Luxation	39.58%	30%	46.43%	-
Acromioclavicular dislocation	35.42%	30%	39.29%	-
Clavicle fracture	6.25%	5%	7.14%	-
SLAP lesions	8.3%	10%	7.14%	-
Others	20.83%	25%	17.86%	-

\* Significant difference versus control group (p<0.05)

(BMI: Body Mass Index)

### *Survey*

All participants filled in a self-administered questionnaire under researcher and coach supervision. The topics included:

- a) General Information: Age, Weight and Height.
- b) General Rugby Information: Years of practice and position.
- c) History of Shoulder Injuries: History of shoulder surgery, luxation, acromioclavicular dislocation, clavicle fracture, SLAP lesions and others.

### *Apparatus and evaluator*

Isomed © goniometer (Analog Inclinator Level, Isomed Inc., Portland, Oregon) was used to measure joint rotation range. Measurements were performed by a single evaluator with previous experience in this technique, minutes before workout in gym or practice. Double measurements were performed on each patient, with an interval of two weeks. The final range corresponded to the average of both measurements. For the measurement of external rotation was calculated Intraclass Correlation Coefficient (ICC) of 0.95. For the measurement of internal rotation, the ICC was 0.92.

### *Clinical examination*

Bilateral internal and external humeral rotations were measured by a single examiner. The information obtained in the questionnaire was unknown by the examiner at the time of the measurements.

- Internal rotation (IR): IR was measured with the patient's shoulder in 90° abduction and the elbow in 90° flexion while the examiner stabilizes the scapula. The endpoint of internal rotation was taken as the point at which the scapula begins to rotate (Figure 1) (Cain, Mutxhler, Fu, and Lee, 1987).
- External rotation (ER): Subjects lay supine with their shoulder and elbow in 90° of abduction and flexion. The starting position consisted of placing the forearm approximately perpendicular to the floor. In this position, the examiner passively externally rotated the shoulder while stabilizing the scapula. End range of external rotation was defined as a cease of rotation or when scapular movement was appreciated (Figure 1) (Cain, Mutxhler, Fu, and Lee, 1987).

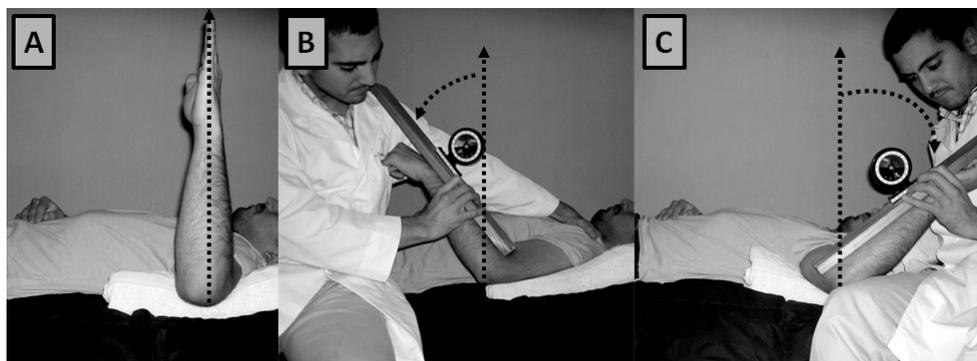


Figure 1

Figure 1A shows the subject supine on a table with the shoulder and elbow in 90° of abduction and flexion, respectively. The humerus was supported on a towel to ensure the neutral horizontal position with the forearm approximately perpendicular the floor. Figure 1B shows the passive internal rotation realized by the evaluator, while stabilizing the scapula. Figure 1C shows the passive external rotation with scapular stabilization.

### Statistical Analysis

The data obtained was processed with STATA 9®. The groups were compared with a non-parametric test (Mann-Whitney) for means and Fisher's exact test for proportions. The differences between groups were considered significant with a  $p < 0.05$  (Table II).

Subsequently, we realized a linear regression between the age, BMI and years of experience playing rugby versus the different rotation ranges (Table III).

Finally, to define the importance of age and years of experience in the development of glenohumeral rotation deficit, we realized a logistic regression, including the independent variables age, history of injury, years of experience and position. The dependent variable was binary: "With or without deficit". The deficit was defined by 2 SD from normal ER of the control group.

## Results

The history of injury is prevalent in professional rugby players. The 41.35% presented a history of shoulder injury and the 25% of this group had been intervened surgically to resolve it (Table I). There were no differences between backs and forwards. Luxation was the more common injury in this sample.

Professional rugby players have less internal, external and total range of glenohumeral rotation compared with control group (Table II). The forwards have normal internal rotation; indeed, they have better internal rotation than backs (Table II).

Table II. Glenohumeral rotation ranges

	Rugby	Forward	Backs	Control
n	84	36	48	30
IR <sub>R</sub>	67.8±8.09*	69.89±6.74 <sup>#</sup>	66.23±8.7* <sup>#</sup>	74.07±10.19
ER <sub>R</sub>	94.16±10.29*	92.25±10.12*	95.55±10.3*	106.27±10.76
TR <sub>R</sub>	161.78±12.99*	162.31±11.41*	161.39±14.15*	180.33±16.93
IR <sub>L</sub>	69.9±7.41*	71.5±6.77 <sup>#</sup>	68.71±7.7* <sup>#</sup>	76±11.86
ER <sub>L</sub>	97.42±9.18*	96.5±9.46*	98.09±9.02*	106.53±11.73
TR <sub>L</sub>	167.11±12.12*	168.25±11.94* <sup>#</sup>	166.27±12.31* <sup>#</sup>	182.53±17.96

\* Significant difference versus control group ( $p < 0.05$ )

<sup>#</sup> Significant difference between forward versus backs group ( $p < 0.05$ )

(IR: Internal rotation; ER: External rotation; TR: Total range; R: Right; L: Left)

In the Linear Regression Analysis, the age and the years of experience have a negative correlation of 29% approximately with the external and total range of glenohumeral rotation (Table III).

Table III. Linear Regression Analysis

Variables	R	r <sup>2</sup>	P value
Age – IR <sub>L</sub>	-0.00181	3.275 x 10 <sup>-6</sup>	0.988
Age – ER <sub>L</sub>	-0.3584*	0.1285	0.0023
Age – TR <sub>L</sub>	-0.271	0.07345	0.0232
Age – IR <sub>R</sub>	-0.05074	0.002574	0.6721
Age – ER <sub>R</sub>	-0.3247*	0.1054	0.0061
Age – TR <sub>R</sub>	-0.2872	0.08251	0.0159
BMI – IR <sub>L</sub>	0.1607	0.02583	0.1775
BMI – ER <sub>L</sub>	-0.1366	0.01866	0.2594
BMI – TR <sub>L</sub>	-0.002961	8.768 x 10 <sup>-6</sup>	0.9806
BMI – IR <sub>R</sub>	0.02452	0.0006013	0.7226
BMI – ER <sub>R</sub>	-0.1418	0.0201	0.2417
BMI – TR <sub>R</sub>	0.1214	0.01473	0.3169
Experience – IR <sub>L</sub>	-0.07662	0.005871	0.5224
Experience – ER <sub>L</sub>	-0.2576*	0.06635	0.0313
Experience – TR <sub>L</sub>	-0.2398*	0.05751	0.0455
Experience – IR <sub>R</sub>	-0.1559	0.02432	0.1908
Experience – ER <sub>R</sub>	-0.2943*	0.08659	0.0134
Experience – TR <sub>R</sub>	-0.3313*	0.1098	0.0051

(IR: Internal rotation; ER: External rotation; TR: Total range; R: Right; L: Left; BMI: Body Mass Index)

\*Significative association (p<0.05)

In the Logistic Regression Analysis, the age is a risk factor (Odds Ratio= 1.58) for external rotation range deficit. Instead, the years of experience are a protector factor (Odds Ratio= 0.63) (Table IV).

Table IV. Logistic Regression Analysis

Variable	Odds Ratio (95% Confident Interval)	P value
ER <sub>R</sub> - History of Injury	0.98 (0.25 – 3.86)	0.972
ER <sub>R</sub> – Age	1.15 (0.89 – 1.49)	0.289
ER <sub>R</sub> - Years of Experience	0.84 (0.62 – 1.15)	0.281
ER <sub>R</sub> – Position	0.79 (0.2 – 3.05)	0.731
ER <sub>L</sub> - History of Injury	0.71 (0.08 – 6.32)	0.755
ER <sub>L</sub> – Age	1.58 (1.09 – 2.3)*	0.016
ER <sub>L</sub> - Years of Experience	0.63 (0.41 – 0.98)*	0.042
ER <sub>L</sub> – Position	2.6 (0.32 – 21.28)	0.373

(IR: Internal rotation; ER: External rotation; TR: Total range; R: Right; L: Left)

\*Significative Odds Ratio (p<0.05)

## Discussion

Pain and injury of shoulder are increasing among rugby players (Brooks, Fuller, Kemp, and Reddin, 2005; Headey, Brooks, and Kemp, 2007; Kaplan, Flanigan, Norwig, Jost, and Bradley, 2005). However, the glenohumeral rotation range has not been evaluated in this sport yet. Indeed, the deficit of glenohumeral rotation range can be a risk factor for shoulder injury (Herrington and Horsley, 2009; Dwelly, Tripp, Tripp, Eberman, and Gorin, 2009; Cain, Mutxhler, Fu, and Lee, 1987).

Edouard et al. (2009) have studied the rotators strength imbalances in rugby, but not the glenohumeral rotation range. They found that strength values are higher for rugby players than control group, but if peak torque was normalized to body weight, there were no significant differences.

In our research, we found that glenohumeral rotation range was diminished in professional rugby players compared with control group in both sides. The backs group had a decrease of internal and external rotation, but the forwards group had only external rotation deficit. This difference cannot be explained by differences of age, BMI, years of experience or history of injury, because the backs and forwards did not present any difference on these variables. Probably, this can be related with the increase intensity and frequency of tackling in backs (Fuller, Ashton, Brooks, Cancea, Hall, and Kemp, 2010). Also, may be related to a greater amount of weight training (Fuller, Ashton, Brooks, Cancea, Hall, and Kemp, 2010).

We analyze a variety of causes for decrease of glenohumeral rotation range in rugby players: age, years of experience, position, BMI and history of injury. In our study, the age seems to be the only risk factor associated with external rotation deficit. This could be related with the aging of the glenohumeral soft tissues, accelerated by training and injuries associated to rugby.

Instead, the years of experience result to be a substantial protective factor. We have to consider that those older rugby players, who began their training early, have a higher sensitivity and proprioception of their shoulder's position, because they are more resistant to fatiguing tasks as tackling, which would protect them from a decrease in joint ranges. Those players who have less experience, but an older age, do not possess these characteristics, resulting in decrease of glenohumeral rotation ranges.

Herrington, Horsley, Whitaker, and Rolf (2008) have found that shoulder joint position sense was reduced following a fatiguing task as tackling. If the mechanoreceptors are unable to accurately report shoulder position due to repetitive tackling, then there is a potential for sensorimotor system deficits. These deficits are proposed to contribute to overuse injuries and micro-instability of the glenohumeral joint which may be related to the increasing rate of shoulder injuries in rugby.

We can conclude that glenohumeral rotation range is diminished in professional rugby players and is associated with age and years of experience.

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