Regular Article

Title:

Effects of a Rugby-Specific Concussion Awareness Program on Collegiate Rugby Union Players

Running Title: Effects of a Rugby-Specific Concussion Awareness Program

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Abstract

This study assessed the effects of a rugby-specific concussion awareness program on improving the recognition of relevant symptoms and knowledge of concussion in male collegiate rugby union players. Thirty-one collegiate rugby union players from Japan were offered a concussion awareness program; they responded to a questionnaire assessing symptom recognition and knowledge of concussion three times (before, immediately after, and four weeks after the implementation of the program). Immediately after the program, the recognition score of suspected concussion symptoms was higher compared with before and four weeks later, when it was still higher than before but not statistically significant. In addition, more players selected the correct answers about rugby-specific concussion topics after the program. Our findings suggest that while concussion awareness is expected to improve immediately, this effect was not maintained after four weeks. Therefore, concussion awareness opportunities should be scheduled regularly, such as at the start of each season, before the beginning of the competition season, and when new players join the team.

Keywords: rugby union, sport-related concussion, concussion awareness

ラグビー選手に向けた脳振盪啓発プログラム実施効果の検証

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抄録

本研究は、ラグビー特有の脳振盪啓発プログラムを実施することによって、選手の脳振盪が疑われる症状の認識や脳振盪に関する知識が向上するかを明らかにすることを目的とした。大学ラグビー選手 31 名を対象とし、ラグビー特有の脳振盪啓発プログラムを 1 回実施し，実施前、実施直後、また実施 4 週間後に脳振盪の症状認識、知識に関するアンケートを実施した。選手の症状認識スコア（SRS）、知識の理解度を比較した。啓発プログラム導入で、SRS は実施直後が実施前、実施 4 週間後に比べて有意に高かった。一方で、実施 4 週間後の SRS は実施前と比べて高値を示したが、統計的に有意な差ではなかった。また、ラグビーで脳振盪が多く発生するプレーや技術要素の関わりについて、正しく回答

した選手の割合が有意に増加した。本研究の結果は、脳振盪の啓発は脳振盪の認識を改善する即時効果が期待される一方で、継続的な啓発が必要であることが示唆している。そのため、各シーズンの開始や、試合期に入る前、新入生・新加入選手が合流するタイミングなど、脳振盪啓発の機会を継続的に設けることが重要である。

Introduction

Previous studies have reported that rugby union (RU) has a higher incidence of concussion than other contact/collision sports.[1,2] Reporting a concussion by the players themselves or detecting the symptoms by those around them is necessary for the medical staff to check the players and adapt a gradual return-to-play protocol to their needs. Therefore, previous research has focused on whether RU players experienced or reported concussions. In RU, 25.0-69.0% of players experienced concussions,[3-5] of which 46.6-52.5% did not report suspected symptoms.[4,5] In a study of collegiate RU players in Japan,[6] 94.2% of participants experienced at least one suspected concussion symptom, and 29.9% of them did not report to others. These results indicate that most Japanese collegiate RU athletes report suspected concussion symptoms to others, but there are still some cases of unreported symptoms.

Suspected concussion symptoms can be divided into two categories: (1) those that others can detect and (2) those that the individual needs to recognize. If players do not know the concussion symptoms, they cannot recognize them. Therefore, concussion education is important not only for teachers and coaching staff but also for the RU players themselves. Previous studies have investigated and shown that concussion education immediately improves concussion knowledge in various players.[7,8] However, the effects do not always persist in the long term,[7] and increasing players' knowledge does not necessarily improve their reporting behavior too.[9] The addition of sports-specific information, such as situations in which concussions are likely or unlikely to happen, to educational interventions will increase the likelihood that players themselves and those around them will recognize that a concussion has happened. Therefore, this study aimed to determine the effects of a rugby-specific concussion awareness program on improving

the recognition of suspected symptoms and knowledge of concussion in male collegiate RU players.

Materials and Methods

Participants

A total of 31 male collegiate RU players from one university in Japan participated in the study. This team belonged to the regional league Division 1 when conducting the study. The Research Ethics Committee at the Nagoya Gakuin University approved the study (reference number 2022-01). All subjects provided written informed consent before participating.

Study protocol

Questionnaires were administered before, immediately after the concussion awareness program and four weeks later to determine the effects. A priori power analysis indicated that in order to achieve a power (1-β) of 0.80 with a confidence level of 95% (α = .05) and an effect size of 0.25 in a repeated measures analysis of variance, an estimated total sample size of 28 subjects would be required.

Contents of the concussion awareness program

The intervention program was composed of the following information based on the latest consensus statement on concussion in sport at the time when this study was conducted [10] and the previous studies about rugby-related concussions:[11-17] (1) what is a concussion (definition, knowledge and symptoms thereof); (2) what to do after concussions occur; (3) rugby-related concussions (incidence rate, mechanism, and

situations in which concussions are likely or unlikely to happen); and (4) procedures for returning to play after a concussion. This program took around 15 minutes to complete.

Assessing the effectiveness of the concussion awareness program

Online questionnaires were administered to participants using Google Forms before, immediately after the concussion awareness program and four weeks later to determine its effectiveness. These consisted of three sections: (1) player profile (name, age, academic year, and years of RU experience—asked only before the program), (2) recognition of suspected concussion symptoms, and (3) knowledge of concussion. The pre-implementation questionnaire had an additional section on the experience of suspected concussion symptoms.

In the symptom recognition section, we included 33 symptoms; 22 were correct symptoms from Sports Concussion Assessment Tool 5 (SCAT 5),[18] and 11 were incorrect distracters.[19] The symptoms recognized scores (SRS) were calculated as the number of correct symptoms a player recognized out of 33. A higher SRS indicated a better knowledge of suspected concussion symptoms.

The section on concussion knowledge consisted of four sports-related concussion questions and three on rugby-specific concussion.[3,11,12,20] In addition, the players were asked whether they had received concussion education only before the intervention.

Experience of suspected concussion symptoms was defined as "had experienced at least one of the 22 suspected concussion symptoms from SCAT 5[18] after a blow to the head, face, neck, or other parts of the body with an impulsive force transmitted to the head." Players with such experience were asked for additional details: (1) "How many times have you experienced the suspected concussion symptoms?"; (2) "Have you

experienced any of the suspected concussion symptoms within the last three months?" and (3) "Have you had symptoms more than three months ago that are still present, or have you been treated in a hospital for those symptoms?"

Statistical analysis

Continuous variables were reported as means and 95% confidence intervals (95% CI); categorical variables were reported as frequencies. SRS, that is, numerical data, were checked for normality using the Shapiro-Wilk normality test. Due to the non-normality of SRS, the Friedman test was used to compare the SRS at three time points: before, immediately after the program implementation, and four weeks later. As multiple comparisons were performed, a Bonferroni adjustment was applied to reduce the risk of Type I errors ($p < 0.0167$).

The chi-square test was used to compare the differences in the recognition rates of suspected symptoms and knowledge of concussion at the same three-time points. Following this line of analysis, the adjusted standardized residuals (ASR) from the contingency tables were analyzed to determine the differences between the three groups. The categories with ASR > 1.96 indicated that there were more cases than expected, whereas those with ASR < –1.96 that there were fewer cases than expected.[21] All statistical analyses were performed using the SPSS version 28.0 package (IBM Japan Inc., Tokyo, Japan) with the significance level set at $p < 0.05$.

Results

One participant, absent when the questionnaire was administered four weeks after the program, was excluded from the analysis; therefore, 30 participants were included in

the study. Their mean age was 19.5 years (95% CI, 19.2–19.8), and the mean number of years players had been playing RU was 7.7 years (95% CI, 6.5–9.0). Of the 30 players, 29 (96.7%) had experienced suspected concussion symptoms at least once. The mean number of times this had happened was 2.5 (95% CI, 1.8–3.2). Moreover, of these 29 players, 4 (13.8%) had experienced suspected symptoms within the last three months. None of the players had symptoms that had been present for more than three months or had been treated in a hospital for those symptoms.

Effectiveness of concussion awareness program

When comparing SRS at the three-time points (Fig. 1), SRS immediately after (28.3; 95% CI, 27.1–29.6) was significantly higher than before (24.0; 95% CI, 22.8–22.5; $p < 0.001$) and four weeks later (26.1; 95% CI, 24.8–27.5; $p = 0.002$). On the other hand, the SRS after four weeks was higher than before; however, the difference was not statistically significant ($p = 0.019$; Fig. 1).

Insert Fig. 1 near here.

The program changed the recognition of suspected concussion symptoms (Table 1). Immediately after its implementation, the following nine symptoms were significantly more often recognized as correct: fatigue or low energy (100.0%), drowsiness (100.0%), neck pain (96.7%), being more emotional (96.7%), nervous or anxious (96.7%), sensitivity to light (93.3%), irritability (93.3%), sadness (93.3%), and trouble falling asleep (93.3%). In addition, four weeks later, the following five symptoms were significantly more often recognized: sensitivity to light (96.7%), sensitivity to noise (90.0%), trouble falling asleep (90.0%), irritability (86.7%), and being more emotional

(80.0%).

Insert Table 1 near here.

The program did not statistically significantly change the responses to the three sports-related concussion questions (Table 2). However, immediately after implementation, significantly more players correctly responded that the "doctor" would decide on their return to play after concussions (27, 90.0%; $p < 0.001$; Table 2).

Insert Table 2 near here.

Regarding the mechanism of concussions in rugby, "when a player is tackled" (14, 46.7%) was selected by significantly more respondents before the program, while "when a player tackles" (30, 100.0%) was so immediately after its implementation ($p < 0.001$; Table 2).

Regarding the tackle phase, which participants thought is important in concussion prevention, "the moment of tackle" (14, 46.7%) was selected by significantly more players before the program, while "the approach phase" (23, 76.7%) was so immediately after its completion ($p = 0.001$; Table 2).

Before the program, more players thought that a tackler's technique was not involved in concussions than expected frequency (9, 30.0%; $p = 0.001$; Table 2), while immediately after, 100% of them reckoned that it was ($p = 0.001$; Table 2).

Discussion

This study investigated whether implementing a rugby-specific concussion awareness program improved the recognition of suspected symptoms and knowledge of

concussion in male collegiate RU players. The results demonstrated that the SRS immediately after implementation was significantly higher than before and four weeks later; additionally, four weeks later, it was higher than before, but the difference was not statistically significant. These results suggest that the effect of a one-time concussion awareness program decreases over approximately four weeks. Therefore, continuous education would provide opportunities to improve the players' understanding of concussions and the team's concussion literacy.

Effectiveness of the concussion awareness program

The SRS results were in line with previous research.[7] In addition, the recognition rate for some symptoms shown in Table 1 was still significantly higher after four weeks, whereas the overall trend was similar to the change in the SRS. The findings suggest that continuous concussion education is needed. However, setting up learning opportunities every four weeks is not practical for many teams. Therefore, such opportunities should be scheduled regularly, such as at the start of each season, before the beginning of the competition season, and when new players join the team.

In this study, the program was in a lecture format, and absorbing concussion knowledge might be limited. Kneavel et al. evaluated the effectiveness of a peer concussion-education program for college student-athletes in the United States.[22] The results showed that the effects were maintained even four weeks after implementation. In the future, it is important to promote concussion awareness in Japan, including peer education programs.

Immediately after implementing the program, significantly more players agreed that the doctor make the final decision to return to play after suffering concussions. Before

the program, significantly more of them had reported that trainers would decide whether to return and significantly fewer that doctors would make the decision. A previous study by Salomon et al.[3] reported that players felt that the injured player, not a health professional/team medical staff, should decide when to return to play after concussions. Moreover, 25.4% of RU players returned to play after concussions without receiving medical advice.[23] These findings suggest that rugby players are likely to feel that they should decide to return to play by themselves after such an incident. The results of this study indicated that awareness education can change a player's recognition about the appropriateness of returning to play after a concussion. Such recognition shared also by the other players in the team can help to facilitate a correct return process. Therefore, it is important that a team is regularly provided with concussion awareness educational opportunities for the safety of its players.

Before the program, significantly more players answered that concussions were more likely to occur when they were tackled, that is, when being the ball-carrier (Table 2). However, previous studies have indicated that concussions occurring in RU are more frequent while tackling, regardless of the level of competition.[17,24-26] This suggests that rugby players recognize being the ball carrier as a situation that is likely to lead to concussions based on their own experiences. Additionally, the implementation of the awareness program significantly increased the number of players who answered that concussions occurring in rugby were more frequent during tackling and, after four weeks, an increase from before persisted but was not statistically significant (Table 2). Educational opportunities about the mechanisms of concussions are important for players' safety based on a correct understanding of the relevant risks.

Before the program, significantly more players thought that the tackler's technique

193 was not involved in concussions, whereas after its implementation, 100% of them
194 reckoned that it was (Table 2). Previous research by Hendricks et al.[27] has shown that
195 rugby players perceive the acquisition of good tackling skills as more important for
196 performance improvement than injury risk reduction. In addition, their attitude toward
197 safety decreases during matches.[27] Hence, the recognition of a player's technical factors
198 involved in concussions during tackling is important to promote behavioral changes. At
199 the same time, the technical improvement of the players depends strongly on the coaching
200 staff's instruction. Mandatory annual educational programs for coaching staff have
201 reduced concussion/brain injury-related personal injury claims and associated costs in
202 RU.[28] The coaching staff should also take part in the concussion awareness program
203 proposed by this study to promote prevention among RU players.
204 Before the program, more players thought that a concussion was only caused by a
205 direct hit to the head (56.7%), whereas after its implementation, fewer players thought
206 the same (26.7%); however, the difference was not statistically significant ($p = 0.061$;
207 Table 2). Because rugby is a collision sport, before the program, many players may have
208 thought that concussions are only caused by a direct impact on the head.
209
210 ***Study limitations***
211 In Japan, concussion awareness interventions have only been conducted with
212 teachers and coaches;[29] this study was the first one to be conducted with athletes.
213 However, a limitation should be addressed. Since just one team of college RU players
214 was used, a generalization of our results should be applied with caution, even at the same
215 level of competition. Further research should be required to accumulate data from rugby
216 teams, which have a variety of backgrounds.

Conclusions

This study aimed to determine the effects of a rugby-specific concussion awareness program on improving the recognition of suspected concussion symptoms and knowledge of concussion in male collegiate RU players. As a result, immediately after the program, SRS showed a statistically significant increase compared to before; however, this increase was not maintained after four weeks. In addition, regarding returning to play following concussion and the mechanisms of its occurrence in rugby, the program immediately increased the number of correct responses; however, this effect was not maintained after four weeks. Our results suggest that education is expected to improve concussion awareness immediately; however, it should be done regularly. As setting up educational opportunities every four weeks is not practical for many teams, these should be scheduled at key time points, such as at the start of each season, before the beginning of the competition season, and when new players join a team.

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Contributions

Study conception and design: KS, SN, and MT. Intervention and questionnaire implementation: KS. Analysis and interpretation of the data: KS. Paper composition: KS. Writing advice: NS and MT. All authors approved the final version of the manuscript.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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Figure legend

Fig. 1 Change in symptom recognition scores (SRS) by implementing the concussion awareness program. * $p < 0.0167$ (The significance level set at $p < 0.0167$, since a Bonferroni adjustment was applied to reduce the risk of Type I errors as multiple comparisons were performed.)

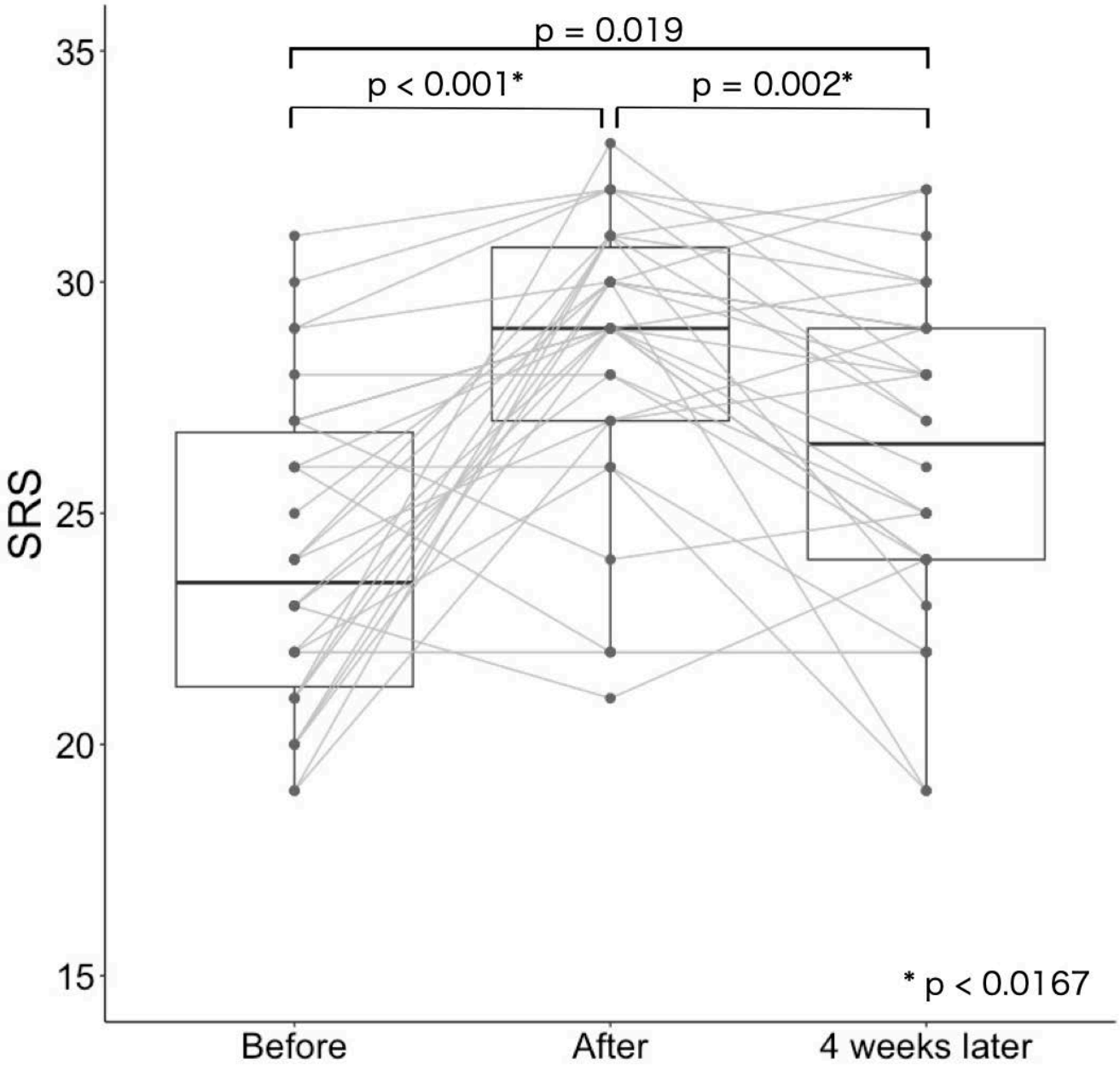
p = 0.019
p < 0.001*
p = 0.002*
35
30
25
20
15
SRS
* p < 0.0167
Before
After
4 weeks later

Table 1 Change in the Recognition of Suspected Concussion Symptoms

	Before		After		4 weeks later		
Suspected Concussion Symptoms[a]	n	(%)	n	(%)	n	(%)	p
Headache (true)	28	(93.3)	30	(100.0)	29	(96.7)	0.355
Pressure in head (true)	27	(90.0)	29	(96.7)	29	(96.7)	0.429
Neck pain (true)	21	(70.0)[b]	29	(96.7)[c]	24	(80.0)	0.024
Neck muscle weakness (true)	14	(46.7)	8	(26.7)	7	(23.3)	0.112
Joint stiffness (false)	22	(73.3)	19	(63.3)	15	(50.0)	0.174
Numbness in arms (false)	20	(66.7)	19	(63.3)	15	(50.0)	0.378
Nausea or vomiting (true)	29	(96.7)	30	(100.0)	30	(100.0)	0.364
Dizziness (true)	29	(96.7)	30	(100.0)	30	(100.0)	0.364
Blurred vision (true)	30	(100.0)	27	(90.0)	29	(96.7)	0.160
Black eye (false)	21	(70.0)	22	(73.3)	14	(46.7)	0.065
Bleeding from the ears (false)	24	(80.0)	26	(86.7)	20	(66.7)	0.165
Bleeding from the mouth (false)	27	(90.0)	27	(90.0)	24	(80.0)	0.237
Nosebleed (false)	20	(66.7)	23	(76.7)	17	(56.7)	0.259
Balance problems (true)	30	(100.0)	30	(100.0)	29	(96.7)	0.364
Sensitivity of light (true)	20	(66.7)[b]	28	(93.3)	29	(96.7)[c]	0.001
Sensitivity of noise (true)	15	(50.0)[b]	28	(93.3)[c]	27	(90.0)[c]	< 0.001
Abnormal sense of smell (false)	23	(76.7)	19	(63.3)	16	(53.3)	0.166
Abnormal sense of taste (false)	25	(83.3)	19	(63.3)	18	(60.0)	0.108
Feeling slowed down (true)	26	(86.7)	30	(100.0)	29	(96.7)	0.064
Feeling like “in a fog” (true)	22	(73.3)	24	(80.0)	25	(83.3)	0.627
“Don’t feel right” (true)	29	(96.7)	29	(96.7)	28	(93.3)	0.770
Difficulty concentrating (true)	27	(90.0)	28	(93.3)	30	(100.0)	0.227
Difficulty remembering (true)	25	(83.3)	29	(96.7)	26	(86.7)	0.232
Fatigue or low energy (true)	24	(80.0)[b]	30	(100.0)[c]	28	(93.3)	0.021
Fever (false)	15	(50.0)	15	(50.0)	12	(40.0)	0.669
Skin rash (false)	29	(96.7)	24	(80.0)	24	(80.0)	0.106
Confusion (true)	24	(80.0)	26	(86.7)	27	(90.0)	0.533
Drowsiness (true)	21	(70.0)[b]	30	(100.0)[c]	29	(96.7)	< 0.001
More emotional (true)	6	(20.0)[b]	29	(96.7)[c]	24	(80.0)[c]	< 0.001
Irritability (true)	9	(30.0)[b]	28	(93.3)[c]	26	(86.7)[c]	< 0.001
Sadness (true)	9	(30.0)[b]	28	(93.3)[c]	22	(73.3)	< 0.001
Nervous or anxious (true)	19	(63.3)[b]	29	(96.7)[c]	26	(86.7)	0.002
Trouble falling asleep (true)	12	(40.0)[b]	28	(93.3)[c]	27	(90.0)[c]	< 0.001

a The correct response for each item is indicated in parentheses.

b The adjusted standardized residuals < -1.96.

c The adjusted standardized residuals > 1.96.

Table 2 Change in Knowledge of Concussion

Question[a]	Before n	Before (%)	After n	After (%)	4 weeks later n	4 weeks later (%)	p
A concussion can only occur if there is a direct hit to the head.							0.061
Yes	17	(56.7)[c]	12	(40.0)	8	(26.7)[b]	
No	13	(43.3)[b]	18	(60.0)	22	(73.3)[c]	
After a concussion occurs, brain imaging (e.g., CT scan, MRI, X-Ray) typically shows visible physical damage to the brain.							0.955
Yes	12	(40.0)	12	(40.0)	13	(43.3)	
No	18	(60.0)	18	(60.0)	17	(56.7)	
Players must not be left alone for about 24 hours after a concussion.							0.600
Yes	29	(96.7)	30	(100.0)	29	(96.7)	
No	1	(3.3)	0	(0.0)	1	(3.3)	
Who makes the final decision to return to play from a concussion?							0.003
Players	6	(20.0)	1	(3.3)	3	(10.0)	
Club advisor/coach	4	(13.3)	2	(6.7)	1	(3.3)	
Trainer	7	(23.3)[c]	0	(0.0)[b]	2	(6.7)	
Doctor	13	(43.3)[b]	27	(90.0)[c]	24	(80.0)	
Most frequent plays leading to concussion in rugby union.							< 0.001
Tackling	14	(46.7)[b]	30	(100.0)[c]	27	(90.0)	
Be tackled	14	(46.7)[c]	0	(0.0)[b]	2	(6.7)	
Aerial collision	2	(6.7)	0	(0.0)	1	(3.3)	
Tackler's technique is involved in concussions during tackling.							< 0.001
Yes	21	(70.0)[b]	30	(100.0)[c]	29	(96.7)	
No	9	(30.0)[c]	0	(0.0)[b]	1	(3.3)	
The most important phase in preventing concussions in tacklers.							0.001
Approach phase	7	(23.3)[b]	23	(76.7)[c]	17	(56.7)	
The moment of contact	14	(46.7)[c]	4	(13.3)[b]	10	(33.3)	
Post contact phase	9	(30.0)[c]	3	(10.0)	3	(10.0)	

a Bold and underline set as a correct answer.

b The adjusted standardized residuals < -1.96.

c The adjusted standardized residuals > 1.96.