



Original research

Pectoralis major ruptures during rugby league tackling – Case series with implications for tackling technique instruction

Steve Sartori^{a,*}, Rod Whiteley^b^a North Queensland Toyota Cowboys, Australia^b Aspetar Orthopaedic and Sports Medicine Hospital, Qatar

ARTICLE INFO

Article history:

Received 11 February 2019

Received in revised form 11 July 2019

Accepted 8 August 2019

Available online 14 August 2019

Keywords:

Tackle

Shoulder

Pectoralis

Injury

Prevention

ABSTRACT

Objectives: Document the mechanism and incidence of pectoralis major ruptures in a professional rugby league cohort, and compare to any existing data.

Design: Retrospective case series.

Methods: Case series which documents 3 such injuries incurred while effecting a tackle in 3 rugby league players from the same squad (of 36) in the same season.

Results: At the initial point of contact, all three players were in a similar shoulder position of outer-range abduction and horizontal abduction and subsequently it appeared their pectoralis major was torn while attempting to effect the tackle.

Conclusions: Complete tears of the pectoralis major muscle are rare but significant injuries often requiring surgical intervention to restore full function in collision sport athletes. In this same season, the organisation changed their defensive approach which may have contributed to these injuries. Each player was managed with acute surgical repair and returned to play at the same level. Suggestions are made to consider the possible training injury implications of changing tackle technique.

© 2019 Sports Medicine Australia. Published by Elsevier Ltd. All rights reserved.

Practical implications

- “Tackling high” to lock the ball up is likely associated with a higher incidence of pectoralis major rupture.
- Pectoralis major rupture is a rare but serious injury nearly always requiring surgery for full restoration of function in professional rugby players.
- Organisations need to weigh the potential performance improvements against the higher risk of serious injury before implementing organisation-wide policy changes.
- Note that the online supplementary material includes the complete video footage of the injury mechanism: <https://1drv.ms/f/s!AgytcDft4DRFhNIAjwHseBlyxuGTkg>

1. Introduction

Rugby league is a collision ball sport played professionally between 2 teams of 13 players with 4 “interchange” reserves available for a total of 8 replacements during the regular 80 min of the

game.¹ Players run with the ball and attempt to score primarily by placing the ball over the opposition’s “try-line”. Players are free to pass the ball backwards to their team-mates, and will attempt to break the tackles of the opposition, or pass the ball in an effort to improve their position on the field. The sport is similar, but distinct to the 15-player per side game of rugby union notably due to the rule difference relating to the tackled player. In rugby league, once a player is tackled, they must be allowed to stand, and “play the ball” to a team-mate where the play then continues. Six such tackles are allowed in a given “set” before the ball must be given to the opposition, who then have possession, and will, in turn, attempt to score against the now defending team. During rugby, once the tackle is effected, after releasing the attacker, the defending players are then free to attempt to retrieve the ball from the attacking player – that is to say, the tackle continues until either the ball is recycled or turned over to the defending team. The high-speed and physical nature of the rugby league mean that it has a relatively high rate of time-loss injury: during match play an injury incidence of 56.8/1,000 h is reported, with the shoulder being the highest source of injury in terms of body part at 15.6/1,000 h.^{2,3}

In recent years, with increasing attention being paid to the relatively high rate of injury, including catastrophic injury⁴ rule changes have been made in an attempt to reduce contact with opposing players’ heads, and the practice of “shoulder charging”

* Corresponding author.

E-mail addresses: ssartori@cowboys.com.au (S. Sartori), Rodney.whiteley@aspetar.com (R. Whiteley).

(attempting to stop the progress of an opponent by colliding using the point of the shoulder) has been made illegal.^{1,5} The act of tackling therefore always requires use of the arms in attempting to stop the opponent's progress and prevent their distribution of the ball.

More frequently reported shoulder injuries include direct contusions, acromioclavicular joint subluxations, rotator cuff tears, shoulder dislocations, and injury to the brachial plexus, among others.^{6–8} A rare but serious injury is a rupture of the pectoralis major muscle. Given the demands placed on the shoulders of these players, when such an injury occurs, it will usually require surgical repair, and an extended period of rehabilitation before return to professional play is possible. To our knowledge there is no published data on the incidence of these injuries in professional rugby league players, likely due to the rarity of the injury.

The present case series documents 3 instances of acute pectoralis major ruptures incurred by players from a single squad (of 36) during a single season while attempting a tackle. The technique used in these attempted tackles is similar in each case and involves a relative increase in the amount of shoulder abduction, a higher point of contact on the attacking player, and an initial point of contact from the defending (injured) player more distal on the arm than is usual. This case series describes the injury mechanism of these three injuries and makes recommendations for technical instruction with risk of injury in mind.

2. Methods

A sample of convenience comprising 3 injuries occurring in the 2017 season, each requiring surgical intervention were retrospectively examined as part of an annual injury and performance review process at a professional rugby league organisation. Annual injury surveillance report information is collated directly from each club within the National Rugby League and published annually. Individual club data is collated by respective clubs' medical staff and reviewed by the individual organisation.

Each case was reviewed considering the clinical presentation at the time of injury, analysis of the presumed injury mechanism using available commercial broadcast video, and the clinical notes, along with the player's standard routine shoulder performance testing data. This performance data was the mean power (in Watts) recorded for the best set of a bench throw exercise as documented by a Gymaware (Kinetic Performance Technology, Canberra, Australia) linear encoder (individual player data provided as online supplementary material). Each player was shown all available video of the injury, as many times as they deemed necessary, and at any speed they requested. Each player identified a single frame where they felt the injury occurred. The video was subsequently reviewed by 2 specialist sports physiotherapists using this frame as the index injury frame. The position of injury in this index frame, as well as the movements prior and subsequent to injury were independently described by these physiotherapists. Any disagreements were resolved through discussion.

Additionally, the players were asked about their perceptions regarding any influencing factors. In each case initial examination was conducted at the playing ground, off the field where the player recounted the injury history, along with the presenting symptoms. Key features of a report of a "tear" in the pectoral region during forceful arm movement associated with very high pain levels alert to the possibility of a pectoralis major muscle tear. Players were also questioned regarding key differential diagnoses including shoulder dislocation, fracture, and neurovascular injury. Examination then continues to inspection of the area looking for obvious muscular defects, followed by palpation of the same region examining for any discontinuity in the pectoralis major. Positive findings in these

individuals then progresses to imaging while providing for acute immobilisation in a sling. The imaging findings along with subsequent clinical examination are reviewed by a sports physician to arrive at a diagnosis of a pectoralis major tear in these 3 cases which was then confirmed through a subsequent examination conducted by an orthopaedic surgeon specialising in shoulder injury.

3. Results

Case 1. Player 1 (28 year-old, 190 cm, 104 kg) makes initial contact high on his opponent from a disadvantaged position away from the attacking player, having to make up ground laterally from a wide fixed base of support resulting in forced horizontal shoulder abduction in an elevated position. Ideally, the defender would be positioned closer to the attacking player with a narrower base of support prior to initiating the tackle. This positioning would allow initial contact to be made higher on the defender's arm close to the shoulder with relatively greater contribution of the legs and trunk to disturbing the progress of the attacker. Once the attacking player advances past player 1, the shoulder is forced into more relative horizontal abduction due to the defender's hand slipping high onto the attacking players head. Clinically, at this point in the tackle (Fig. 1d) the defending player reported feeling a mechanical "tear" and loss of power in his arm (that was making the tackle). Player 1 was removed from the field with subjective reports of distal pectoralis major pain, loss of power, and palpable defect present.

Initial physical examination confirmed localised distal tendon pain, loss of horizontal adduction/internal shoulder rotation power, and visible distal pec major tendon defect. Subsequent MRI illustrated sternal head tendon retraction from the delto-pectoral groove and an associated myotendinous strain of the clavicular head. Considering the high level of shoulder function required for this sport, surgical reattachment of the avulsed distal tendon with bioabsorbable anchors was performed within a few days of injury. Initial management involved a 4 week period of relative immobilisation allowing passive range of motion with a graduated rehabilitation following, and return to play at 12 weeks post-operative once restoration of 95% of pre-season baseline strength was achieved (mean power of the best set of bench throw as documented by a Gymaware (Kinetic Performance Technology, Canberra, Australia) linear encoder). Player 1 resumed playing the same season without further symptoms playing 13 matches in the remaining season.

Case 2. Player 2 (22 year-old, 183 cm, 90 kg) makes initial contact from a posterior position in an elevated position of shoulder horizontal abduction and contralateral trunk rotation. Clinically, on initial contact at this point in the tackle (Fig. 2c) the defending player describes feeling a mechanical sensation in his distal pectoral region and subsequent loss of power. He was removed from the field of play reporting similar symptoms as player 1. Initial physical examination was identical to Player 1, and subsequent MRI investigation documented a complete sternal head tendon avulsion and retraction with myotendinous clavicular component strain. Again, due to the upper limb requirements of the sport, similar surgical intervention was performed soon after the injury using bioabsorbable anchors. The post operative management was identical to the player above with a 12 week rehabilitation period, and subsequent uneventful return to play for 8 matches in the same season.

Case 3. Player 3 (24 year-old, 178 cm, 105 kg) relates a different history compared to the first two cases. Clinically he reported no symptoms until he was laying supine with his shoulder fixed in an elevated position and 3 other players landed on top of him (Fig. 3d). Note that the initial impact of his tackle is in a similar



Fig. 1. Time coded frames prior and subsequent to Player 1's reported point of injury taken from the commercial broadcast footage. Note the abducted and horizontally abducted shoulder position and impact point lower on the arm, with the player forced into further eccentric horizontal abduction and abduction at the shoulder during the tackle. This movement is associated with the "over the top" tackling method where the player, being first into the tackle, is attempting to "lock the ball up" to prevent further distribution. Player 1's hand slipping higher during the course of the tackle has further increased the horizontal abduction force moment. Also note that the inside defender has initially slipped over which caused Player 1 to react laterally and high. The reported symptoms did not occur on initial contact but later in the tackle sequence. Online supplementary material shows complete video sequence of this and the other two injuries documented here.

shoulder position to the other two cases, and as the tackle proceeds, he is rapidly turned, ending up underneath the attacking player who by then has two additional defenders overlaid. It would appear that his shoulder continues to be forced into relative horizontal abduction due to contralateral trunk rotation whilst prone. It is at this point of trunk rotation whilst his shoulder remains in a fixed, elevated and relatively abducted position that mechanical symptoms are first noticed. He again is immediately removed from the field with similar subjective symptoms to the players 1 and 2. Subsequent MRI illustrated complete distal tendon avulsion from the humeral insertion of both sternal and clavicular components. Early surgical reattachment was again performed, with an identical rehabilitation program and return to play timeframe. Player 3 resumed playing 7 matches within the same season without further incident.

4. Discussion

Pectoralis major injuries are uncommon generally¹² with some subgroups of higher incidence in some professional sports: weight lifting, rugby, extreme sports.¹³ There are no published data for the incidence of this injury in rugby league, perhaps reflecting its rarity. The 5 New Zealand-based Super Rugby (union) teams in the 16 years to 2016 had a total of 6 such injuries from a total of 2498 (0.24 injuries per 1000 player-hours, 95% CI 0.11 to 0.52).¹⁴ Match injury incidence in UK Rugby (union) for the 16 years to 2017/18 season is reported as even lower - 0.08 per 1000 h (0.04–0.15) – 9 cases in total.¹⁵ To our knowledge, three such injuries in the same professional team (from a squad of 36 players) within one match play season (6.66/1000 h, 1.37–19.45) has not been previously documented and warrants discussion. It is suggested that the adoption



Fig. 2. Time coded images prior and subsequent to the player-reported point of injury. Player 2 has attempted to tackle high from a posterior aspect, again in an elevated and horizontally abducted position. Symptoms were reported on initial contact, not later in the tackle sequence. Further horizontal abduction load is accentuated by contra-lateral trunk rotation and lack of elbow flexion around the ball carrier's body. Player 2 is a much smaller defender attempting to enforce control of the ball on his try line with an "over the top" tackle. Note the relatively poor quality of the still images due to a combination of rapid player movement and relatively lower light levels at this ground. This injury is better perceived examining the video from which these stills are taken (online supplementary material).

of a club policy of a changed tackling technique with the first player into a tackle contest attempting to tackle "high" to lock up the ball may have contributed to this.

The tackle is the most dangerous facet of Rugby Union and Rugby League.^{16,17} Tackle technique can affect injury rate in the upper limb.^{16–18} The introduction of different tackling techniques involve components of skill acquisition, and likely require new musculo-tendinous connective tissue adaptation to different loads. Tendon, muscle, and bones adapt according to the imposed loads²⁰ provided the exposure is correctly dosed. Changes to team defensive patterns and defensive "rules" represent a mechanism through which loads may be inadvertently abruptly increased. Changing tackle technique, either through rule changes, or variation in instruction are an opportunity to influence injury rates.¹⁹

The injured players in this case series were within a playing squad that had trained together for a minimum period of 3 years, with a consistent strength training program delivered by the same staff members. No change in strength training or load spike in strength training of the chest wall was demonstrated preceding injury,²¹ with predicted 1RM and mean power data remaining relatively consistent (see supplementary data). Hence we propose that these tackle events were likely aberrant individual loads rather than usual loading placed on relatively deconditioned athletes. As such, it is suggested that the specific loading pattern in these events, i.e. the tackle technique, warrants scrutiny.

Changes to defensive tackle techniques in professional Rugby League clubs have evolved in recent years with teams attempting to slow down the tackle to allow increased time for the defending



Fig. 3. Time-coded images prior and subsequent to the player-reported point of injury. Player 3 has an initial high tackle attempt but does not execute with adequate leg drive and subsequently ends up being rotated, eventually losing complete foot control then falling onto the ground supine. His arm remains fixed in an elevated position by the ball carrier and 2 other defenders. External player driven momentum induces contralateral trunk rotation causing horizontal abduction in an already fixed, abducted shoulder whilst on the ground. Player 2 sustained a complete isolated pectoralis major distal tendon rupture requiring surgical fixation as described above.

team to reorganise themselves, and potentially strengthen their defensive line.²² This has involved defenders trying to tackle high to prevent second phase attacking ball distribution, and multiple defenders coming to assist the initial defender. The organisation examined here introduced such a strategy of having the first player in a tackle make their point of contact high to “lock up” the ball and then subsequent defenders can join to assist in restricting further progression of the attacker.

Tackling high involves the shoulder being placed in a position of elevation (approximately 90°), abduction, and some relative external rotation. The case series injuries illustrated above are similar to the “arm tackle”,¹⁷ and the “over the top” tackle.²³ The “shoulder tackle” on the same side as the leading leg with arms wrapped around the ball carrier has been shown to have a lower injury rate¹⁷ compared to other tackle techniques described in youth Rugby Union. From the injury mechanisms described above, defenders who execute tackles in shoulder elevation with coupled horizontal abduction and contralateral trunk rotation, with an extended elbow and making contact with their arm (not shoulder) are potentially placing themselves in a higher risk position with regard pectoralis major rupture.

Proficient tackling ability can play a role in injury prevention.²³ Over-the-ball or smother tackles have been shown to be as effective as a traditional shoulder tackle.²⁴ It is unlikely that competitive teams will not use the high tackle if it gives them improved outcomes, despite a higher injury risk. We therefore suggest that risk mitigation of improving technique is a more likely successful approach. Specifically it’s suggested that feedback tools (post-hoc video analysis and real time verbal coaching feedback) during tackle practice be implemented to ensure correct body positioning. We believe it’s important to avoid arm contact in relative shoulder elevation and horizontal abduction. At the group level, a comprehensive understanding of any new defensive patterning is important to reduce the risk of players having to defend large gaps which risks defensive isolation and therefore being forced to make late, sudden defensive re-positioning where players may be forced to “reach” for a tackle and place their arm in the at-risk position described.

Adequate leg power and relative upper body strength parameters have been associated with improved tackling technique and effectiveness.²⁵ Upper limb peak power and rate of power production measured by force plates are also associated with

improved tackle technique.²⁶ Trunk positioning throughout the tackle sequence influences upper limb load, and trunk stabilisation under perturbation with progressively higher loads appear to be sensible preparation strategies.

Secondly, attempting to safely induce connective tissue adaptation in at-risk positions including shoulder elevation with horizontal abduction may also influence injury risk. Speculatively, neuromuscular training in positions of shoulder abduction, similar in principle to efficacious lower limb prevention programs could be implemented, however their effectiveness in preventing upper limb injury is unknown. A staged, graded exposure to eccentric shoulder loading in the at-risk position would theoretically induce the required changes, however it is not yet known what ultimate strength is required to tolerate a “worst case scenario”, nor the specific exercise parameters (i.e. frequency, intensity, duration, modes of exercise) which would optimally achieve these goals.

5. Limitations

The available broadcast video does not allow for completely accurate reconstruction of the positions of injury. Ideally, multiple camera angles, and higher frame rates and resolution would provide for a better opportunity to describe the injury mechanism.

6. Conclusion

This case series documents 3 instances of pectoralis major rupture associated with a change in tackle technique in professional rugby league. The high incidence and similar mechanism suggest that those considering tackle technique changes need to consider the potential injury consequences in addition to any performance advantages before implementing policy changes.

Acknowledgement

The authors acknowledge the assistance of the North Queensland Cowboys Rugby League in preparation of this manuscript, and in particular the players who volunteered their support for this project, and without whom, it couldn't have been done.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.jsams.2019.08.011>.

References

1. Commission ARL. *Rugby League Laws of the Game International Level with Notes on the Laws and NRL Telstra Premiership Interpretations*, 2019. Accessed 16 January 2019 <https://www.nrl.com/siteassets/documents/Australian-Rugby-League-Laws-and-Rules-of-the-Game-2017.pdf>.
2. King DA, Gabbett TJ, Dreyer C et al. Incidence of injuries in the New Zealand national rugby league sevens tournament. *J Sci Med Sport* 2006; 9(1-2):110–118.
3. Gabbett TJ. Incidence of injury in semi-professional rugby league players. *Br J Sports Med* 2003; 37(1):36–43, discussion 43–34.
4. Horn A. *Rugby League Urged to Ban Shoulder Charge in Wake of Player James Ackerman's Death*, 2018. Accessed 24 September 2018 <http://www.abc.net.au/news/2017-04-22/james-ackerman-mother-pleads-to-stop-deaths-in-rugby-league/8455332>.
5. Carter S. League: Shoulder Charge Banned from Internationals. https://www.nzherald.co.nz/sport/news/article.cfm?c_id=4&objectid=10866512.
6. Gabbett TJ. Incidence, site, and nature of injuries in amateur rugby league over three consecutive seasons. *Br J Sports Med* 2000; 34(2):98–103.
7. Gabbett TJ. Incidence of injury in junior rugby league players over four competitive seasons. *J Sci Med Sport* 2008; 11(3):323–328.
8. Gabbett TJ, Jenkins DG, Abernethy B. Physical collisions and injury in professional rugby league match-play. *J Sci Med Sport* 2011; 14(3):210–215.
12. Provencher MT, Handfield K, Boniquit NT et al. Injuries to the pectoralis major muscle: diagnosis and management. *Am J Sports Med* 2010; 38(8):1693–1705.
13. Kakwani RG, Matthews JJ, Kumar KM et al. Rupture of the pectoralis major muscle: surgical treatment in athletes. *Int Orthop* 2007; 31(2):159–163.
14. Quarrie K. *Pectoralis Major Rupture Epidemiology in New Zealand Super Rugby Union, 2002-2018*, in: Whiteley R, editor, Private message ed, 2019, p. 1.
15. Kemp S. Pectoralis Major Ruptures in the Rugby Union. In: Whiteley R, ed. Email discussion of rates of pectoralis major rupture in the RFU ed. email2019:1.
16. Quarrie KL, Hopkins WG. Tackle injuries in professional rugby union. *Am J Sports Med* 2008; 36(9):1705–1716.
17. Burger N, Lambert MI, Viljoen W et al. Mechanisms and factors associated with tackle-related injuries in South African youth rugby union players. *Am J Sports Med* 2017; 45(2):278–285.
18. Hayashi D, Roemer FW, Kohler R et al. Thoracic injuries in professional rugby players: mechanisms of injury and imaging characteristics. *Br J Sports Med* 2014; 48(14):1097–1101.
19. Hume P, Quarrie K, Carlson I et al. Can we reduce injury risk in rugby codes? *J Sci Med Sport* 2017; 20:1.
20. Khan KM, Scott A. Mechanotherapy: how physical therapists' prescription of exercise promotes tissue repair. *Br J Sports Med* 2009; 43(4):247–252.
21. Gabbett TJ, Hulin BT, Blanch P et al. High training workloads alone do not cause sports injuries: how you get there is the real issue. *Br J Sports Med* 2016; 50(8):444–445.
22. Speranza MJA, Gabbett TJ, Greene DA et al. Changes in rugby league tackling ability during a competitive season: the relationship with strength and power qualities. *J Strength Cond Res* 2017; 31(12):3311–3318.
23. Speranza MJA, Gabbett TJ, Greene DA et al. An alternative test of tackling ability in rugby league players. *Int J Sports Physiol Perform* 2018; 13(3):347–352.
24. Speranza MJA, Gabbett TJ, Greene DA et al. Relationship between 2 standardized tackling proficiency tests and rugby league match-play tackle performance. *Int J Sports Physiol Perform* 2018; 13(6):770–776.
25. Speranza MJ, Gabbett TJ, Johnston RD et al. Muscular strength and power correlates of tackling ability in semiprofessional rugby league players. *J Strength Cond Res* 2015; 29(8):2071–2078.
26. Speranza MJ, Gabbett TJ, Johnston RD et al. Effect of strength and power training on tackling ability in semiprofessional rugby league players. *J Strength Cond Res* 2016; 30(2):336–343.