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Can tackle height influence tackle gainline success outcomes in elite level rugby union?

Gregory J. Tierney[1]

gtierne@tcd.ie

Ciaran K. Simms[1]

csimms@tcd.ie

[1]Trinity Centre for Bioengineering, Trinity College Dublin, Ireland

Short Title: Rugby union tackle heights and gainline success

Corresponding Author:

Gregory Tierney

Trinity Centre for Bioengineering

Trinity College Dublin

Dublin 2

Ireland

gtierne@tcd.ie

+353 89 2381688

Abstract

In rugby union, effective defensive play is highly technical and essential for game outcomes. Therefore, the aim of this study was to identify tackle heights, for given tackle types, that had a greater propensity to result in tackle gainline success for the tackler using match video evidence. The results indicated that tackling the upper legs of the ball carrier had a greater propensity to result in tackler success for both front-on (OR=3.27; 95% CI=1.34-7.95; p<0.01) and side-on (OR=5.31; 95% CI=2.08-13.6; p<0.01) arm tackles. For shoulder tackles, tackling at the lower trunk for front-on tackles (OR=1.70; 95% CI=1.04-2.79; p=0.03) and the mid trunk for side-on tackles (OR=3.11; 95% CI=1.31-7.37; p<0.01) had a greater propensity to result in tackler success. For smother tackles, tackling at the mid trunk had a greater propensity to result in tackler success during front-on (OR=3.49; 95% CI=1.81-6.74; p<0.01) and side-on (OR=5.11; 95% CI=2.42-10.8; p<0.01) tackles. The results highlight the importance of tackle height when coaching the tackle. The findings also suggest that technically proficient players can advance to more challenging contact techniques than aiming for the ball carrier's centre of gravity.

Introduction

Rugby union is a territorial, dynamic and high-impact collision sport.[1] During an attacking phase of play, the attacking team has the option to advance the ball closer to the opposition try line by carrying the ball. Conversely, the defending team can prevent this forward movement by tackling the ball carrier. Tackling is thus a major component of rugby union with an average of over 220 tackles per game,[2] and the potential for individual players to be involved in over 30 tackles per game.[3] Therefore, effective attacking and defensive play are essential for game outcomes.[1 4 5] A recent study has shown that tackle performance can be assessed by tackle gainline outcomes.[6] A tackle gainline has been defined as "an imaginary line width-wise across the field at the point of contact for each tackle."[6] In a tackle, ball carrier success is based on the ball carrier advancing beyond the tackle gainline. Conversely, tackler success is based on the tackler preventing the ball carrier from advancing beyond the tackle gainline.

Analysis of match video evidence has been used successfully to identify certain performance based tackler and ball carrier strategies in Rugby Union,[1 5-11] as well as injury risk factors.[12-16] Tierney et al.[6] reported a number of proficiency characteristics associated with successful tackle gainline outcomes for the ball carrier and tackler. For example, for both the ball carrier and tackler, proficiency characteristics such as "leg drive on contact" and "explosiveness on contact" were effective for achieving the desired tackle gainline outcome. The technical proficiency characteristics examined in this study were previously utilised by Burger et al.[12] and Hendricks et al.[17] to examine injury risk in the tackle. In these studies, a number of ball carrier and tackler proficiency characteristics in front- and side-on tackles were developed based on studies of tackling proficiency in collision sports,[1 18-20] and guidelines from the South African governing body for Rugby Union.[21] One of the technical proficiency variables listed for the tackler was "Contact (the ball carrier) in the centre of gravity" however Tierney et al.[6] did not find this characteristic to influence tackle gainline success for the tackler. Furthermore, Hendricks et al.[1] found that shoulder tackles targeted at the ball carrier's mid-torso were associated with positive tackle outcomes for the tackler. It is possible that, for a given type of tackle, certain tackle heights are more associated with positive tackle outcomes than others for the tackler.

Accordingly, the aim of this study was to identify tackle heights, for arm, shoulder and smother tackles,[22] that have a greater propensity to result in tackle gainline success for the tackler. This was conducted by utilising match video evidence of tackles in elite level rugby union.

Methods

Tackle and gainline definitions

Similarly to Tierney et al.,[6] a tackle was defined as "when the ball-carrier was contacted (hit and/or held) by an opponent without reference to whether the ball-carrier went to ground".[23] Missed tackles in which the tackler made no contact with the ball carrier were excluded from the analysis. Nonetheless, tackles that involved the ball carrier losing the ball (dropped or ripped), breaking the tackle or offloading post-contact were included. Again, similarly to Tierney et al.[6] the tackle gainline existed width wise across the field at the point of contact for each tackle. Ball carrier success was defined by "the ball carrier advancing beyond the tackle gainline."[6] Conversely, tackler success was defined by "the tackler preventing the ball carrier from advancing beyond the tackle gainline."[6] If a ball carrier advanced beyond the tackle gainline, but lost the ball (dropped or ripped), this was defined as tackler success. A similar definition has been used previously to describe tackle dominance.[24]

Data collection

All games from elite level competitions including the Pro 12, European Rugby Champions Cup, 6 Nations and International Autumn Test Series from the 2014/15 season were assigned a number. A random number generator (http://www.random.org/) was utilised to select five games for analysis. This approach resulted in one Pro 12 game, three RBS 6 nations games and one autumn test series game.

Tackle analysis

All legal tackles that involved player-to-player contact (arm, shoulder and smother tackles)[22] from the five games were included in this analysis. Fuller et al.[22] defined the following for arm, shoulder and smother tackles; Arm Tackle - "Tackler impedes/stops BC with upper limb(s)"; Shoulder tackle - "Tackler impedes/stops BC with shoulder as the first point of contact followed by use of arm(s)"; Smother tackle - "Tackler impedes/stops BC with upper limb(s)". This resulted in 216 arm tackles, 390 shoulder tackles and 359 smother tackles being included in the dataset. Each tackle analysed was categorised based on tackle direction (front- or side-on), tackle

type (arm, shoulder or smother)[22] and tackle height (upper trunk, mid-trunk, lower trunk, upper leg or lower leg, see Figure 1). One reviewer analysed each video. The videos were analysed using Sports Code (Version 8) enabling frame-by-frame viewing of all tackles. The video had a minimum frame rate of 25 fps and could be replayed as often as necessary.

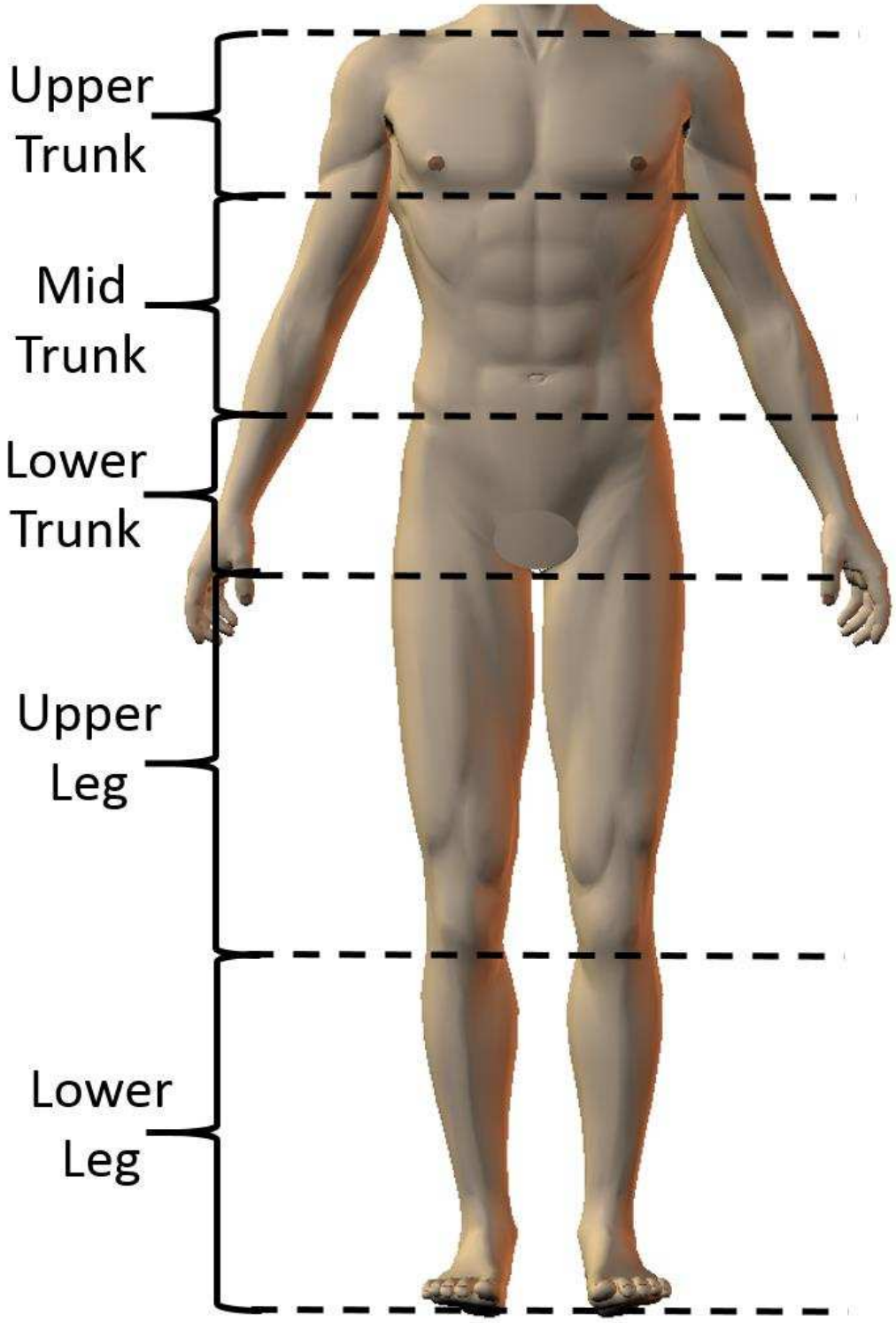

Figure 1: The ball carrier's body split into tackle height regions.

Statistical Analysis

For each tackle height, the Odds Ratio (OR), 95% Confidence Interval (CI) and probability (*p*) values were calculated.[25] The OR for each tackle height region was calculated by comparing the frequency of occurrence of

tackler success cases with the frequency of occurrence of ball carrier success cases. An OR=1 indicates that the tackle height has no greater propensity towards tackle gainline success than that anticipated by chance; an OR>1 and OR<1 indicates that the tackle height has a greater and lesser propensity towards tackle gainline success than expected by chance, respectively.[25] In scenarios where frequency of occurrence was zero, OR was calculated according to Pagano et al.[26] i.e. 0.5 is added to all cells. A tackle height was considered to have statistical significance if the 95% CI for the OR value did not include 1 and the *p*-value was <0.05.

Reliability

Fifty tackles were randomly selected using a random number generator (http://www.random.org/). The reviewer then conducted the analysis on these fifty cases, for each tackle variable (tackle height, direction, type and gainline), at least one week after analysing the original set of cases. An external coder (ex-player) analysed the same fifty cases using the same protocol as the main reviewer. Intra-rater and inter-rater reliability were then assessed using Cohen's Kappa (K). A Cohen's Kappa value greater than 0.8 indicates almost perfect agreement [27]. For intra-rater reliability, Cohen's kappa values of 0.93, 0.97, 0.93 and 0.96 were achieved for tackle height, direction, type and gainline, respectively. For inter-rater reliability, Cohen's kappa values of 0.87, 0.87, 0.84 and 0.83 were achieved for tackle height, direction, type and gainline, respectively.

Results

Arm tackles

Table 1 shows that tackling the upper legs of the ball carrier has a greater propensity to result in tackler success than failure for both front-on (OR=3.27; 95% CI=1.34-7.95; p<0.01) and side-on (OR=5.31; 95% CI=2.08-13.6; p<0.01) arm tackles. However, for side-on arm tackles, tackling the lower trunk has a lower propensity to result in tackler success (OR=0.26; 95% CI=0.10-0.67; p<0.01).

Shoulder tackles

For shoulder tackles, Table 2 shows that tackling the lower trunk of the ball carrier has a greater propensity to result in tackler success during front-on tackles (OR=1.70; 95% CI=1.04-2.79; p=0.03) whereas tackling the upper legs has a lower propensity (OR=0.32; 95% CI=0.15-0.64; p<0.01). For side-on shoulder tackles tackling the mid-trunk of the ball carrier has a greater propensity to result in tackler success (OR=3.11; 95% CI=1.31-7.37; p<0.01).

Smother Tackles

Table 3 shows that, for smother tackles, tackling the mid trunk of the ball carrier has a greater propensity to result in tackler success during front-on (OR=3.49; 95% CI=1.81-6.74; p<0.01) and side-on (OR=5.11; 95% CI=2.42-10.8; p<0.01) tackles whereas tackling the upper trunk has a lower propensity for both front-on (OR=0.29; 95% CI=0.15-0.55; p<0.01) and side-on (OR=0.20; 95% CI=0.09-0.41; p<0.01) tackles.

Table 1: The effect of tackle height on tackler and ball carrier success for arm tackles (includes % occurrence, Odd Ratios (OR) with 95% Confidence Intervals (95% CI) and p values).

Arm Tackle	Tackler Success	Ball Carrier Success	Odds Ratio (95% CI)	p Value
Front-On	(n=37)	(n=63)		
Upper Trunk	3 (8%)	11 (18%)	0.42 (0.11-1.61)	0.20
Mid Trunk	0 (0%)	4 (6%)	0.18 (0.01-3.37)	0.25
Lower Trunk	8 (22%)	24 (38%)	0.45 (0.18-1.14)	0.09
Upper Leg	17 (46%)	13 (21%)	3.27 (1.34-7.95)	**<0.01**
Lower Leg	9 (24%)	11 (17%)	1.52 (0.56-4.10)	0.41
Side-On	(n=29)	(n=87)		
Upper Trunk	0 (0%)	6 (7%)	0.21 (0.01-3.89)	0.30
Mid Trunk	2 (7%)	10 (11%)	0.57 (0.12-2.77)	0.70
Lower Trunk	7 (24%)	48 (55%)	0.26 (0.10-0.67)	**<0.01**
Upper Leg	14 (48%)	13 (15%)	5.31 (2.08-13.6)	**<0.01**
Lower Leg	6 (21%)	10 (11%)	2.01 (0.66-6.12)	0.22

Table 2: The effect of tackle height on tackler and ball carrier success for shoulder tackles (includes % occurrence, Odd Ratios (OR) with 95% Confidence Intervals (95% CI) and p values).

Shoulder Tackle	Tackler Success	Ball Carrier Success	Odds Ratio (95% CI)	p Value
Front-On	(n=162)	(n=120)		
Upper Trunk	38 (23%)	38 (32%)	0.66 (0.39-1.12)	0.13
Mid Trunk	37 (23%)	17 (14%)	1.79 (0.95-3.37)	0.07
Lower Trunk	73 (45%)	39 (32%)	1.70 (1.04-2.79)	**0.03**
Upper Leg	13 (8%)	26 (22%)	0.32 (0.15-0.64)	**<0.01**
Lower Leg	1 (1%)	0 (0%)	2.24 (0.09-55.4)	0.62
Side-On	(n=71)	(n=37)		
Upper Trunk	8 (11%)	9 (24%)	0.40 (0.14-1.13)	0.08
Mid Trunk	38 (53%)	10 (27%)	3.11 (1.31-7.37)	**<0.01**
Lower Trunk	21 (30%)	12 (32%)	0.88 (0.37-2.06)	0.76
Upper Leg	4 (6%)	5 (14%)	0.38 (0.10-1.52)	0.17
Lower Leg	0 (0%)	1 (3%)	0.17 (0.01-4.28)	0.28

Table 3: The effect of tackle height on tackler and ball carrier success for smother tackles (includes % occurrence, Odd Ratios (OR) with 95% Confidence Intervals (95% CI) and p values).

Smother Tackle	Tackler Success	Ball Carrier Success	Odds Ratio (95% CI)	p Value
Front-On	(n=56)	(n=156)		
Upper Trunk	30 (54%)	125 (80%)	0.29 (0.15-0.55)	**<0.01**
Mid Trunk	26 (46%)	31 (20%)	3.49 (1.81-6.74)	**<0.01**
Side-On	(n=65)	(n=82)		
Upper Trunk	13 (20%)	46 (56%)	0.20 (0.09-0.41)	**<0.01**
Mid Trunk	52 (80%)	36 (44%)	5.11 (2.42-10.8)	**<0.01**

Discussion

This study utilised video evidence of actual match-play to examine tackle heights that have a higher propensity to result in tackler success for given tackle types (arm, shoulder and smother tackles).[22] The findings suggest that tackle height influences tackler success outcomes and that this is dependent on the type of tackle executed by the tackler. The results from this study complement the findings of previous match-play video analysis technique studies,[1 5-10] and highlights the importance of tackle height when coaching the tackle. Players are initially coached to aim for the ball carrier's centre of gravity as this is the best target area to assess tackling technique.[1 18-20] However, the current findings suggest that technically proficient players can advance to more challenging contact techniques, for example, contacting the mid trunk during smother tackles.

Arm tackles to the upper legs were found to be an effective tackle strategy (Table 1). By tackling the upper legs, the tackler can clasp the two legs of the ball carrier together, impede the run and bring the ball carrier to ground. However, arm tackles at the lower trunk were found to be ineffective. In these cases, the arm contact was made at the ball carriers centre of gravity which resulted in the ball carrier having a large effective mass. Therefore, the momentum of the ball carrier was sufficient to overcome the impact of the arm, thus successfully advancing beyond the tackle gainline. Side-on shoulder tackles to the mid trunk were found to be an effective tackle

strategy and this appears to support the findings of Hendricks et al.[1] who reported that shoulder tackles targeted at the ball carrier's mid-torso (roughly mid trunk) were associated with positive tackle outcomes for the tackler.

Upper trunk smother tackles for both front- and side-on tackles were found to be an ineffective technique for the tackler. Upper trunk smother tackles generally allowed both the ball carrier and tackler to remain on their feet which afforded the ball carrier to continue to drive the legs.[6] Upper trunk smother tackles also enabled the ball carrier to exhibit "arm and shoulder usage [6]" post contact allowing the ball carrier to manoeuvre out of the smother or compromise the tackler's hold.

The tackle height law in rugby union is established at the line of the ball carrier's shoulder and any contact above this line is regarded as foul play.[22] The tackle height law is an area of concern with respect to injury,[28] and lowering the tackle height has been put forth as a recommendation.[28-30] A recent study,[31] found that tackles to the upper trunk accounted for nearly half (46%) of all tackle related direct head impacts to the tackler. The results of the current study support the recommendation of lowering the tackle height to below the upper trunk of the ball carrier, from a performance point of view, as tackles to this body region do not have a greater propensity to result in tackle gainline success for the tackler.

Limitations

The tackle is a dynamic and open phase of play and this must be appreciated when analysing video data.[12] Although the number of games analysed in this study was larger than that in certain previous tackle technique-based studies,[6 11] the study would have benefited from an analysis of more games. Only five games were selected for the study which involved eight elite level teams. This could make the data susceptible to outliers and further monitoring of other teams should be pursued. Nonetheless, the approach undertaken in this study can be utilised by coaches to identify any differences applicable to their own team. This in turn can allow customised tackling training regimes to be created based on their own team's needs. Only tackle height was analysed in this study. Modelling the combination and interaction of other technical characteristics and match situation characteristics,[1 32 33] as well as biomechanics,[15 24 34-36] could allow for an even greater understanding of tackle performance as well as injury risk. This study analysed elite level rugby games and the results are applicable to the elite game. Potentially these results are also applicable to amateur and youth level rugby union, however further research in these areas is needed.

Conclusion

This study utilised video evidence of actual match-play to examine tackle heights that have a higher propensity to result in tackler success for given tackle types (arm, shoulder and smother tackles). The results indicated that tackling the upper legs of the ball carrier had a greater propensity to result in tackler success for both front-on (OR=3.27; 95% CI=1.34-7.95; p<0.01) and side-on (OR=5.31; 95% CI=2.08-13.6; p<0.01) arm tackles. For shoulder tackles, tackling the lower trunk of the ball carrier had a greater propensity to result in tackler success during front-on tackles (OR=1.70; 95% CI=1.04-2.79; p=0.03). For side-on shoulder tackles tackling the mid-trunk of the ball carrier had a greater propensity to result in tackler success (OR=3.11; 95% CI=1.31-7.37; p<0.01). For smother tackles, tackling the mid trunk of the ball carrier had a greater propensity to result in tackler success during front-on (OR=3.49; 95% CI=1.81-6.74; p<0.01) and side-on (OR=5.11; 95% CI=2.42-10.8; p<0.01) tackles. The results from this study complement the findings of previous match-play video analysis technique studies and highlights the importance of tackle height when coaching the tackle. The findings suggest that technically proficient players can advance to more challenging contact techniques than aiming for the ball carrier's centre of gravity, for example, contacting the mid trunk during smother tackles. Tackles to the upper trunk have previously been found to account for nearly half of all tackle related direct head impacts to the tackler. The results of this study found that tackles to this body region also do not have a greater propensity to result in tackle gainline success for the tackler.

Declaration of Conflicting Interests

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