Author(s): Paul R Worsfold ; Matthew Page

Title**:** The influences of rugby spin pass technique on movement time, ball velocity and passing accuracy

Date: April 2014

Originally published in: International Journal of Performance Analysis in Sport

Example citation: Worsfold, P. R., & Page, M. (2014). The influences of rugby spin pass technique on movement time, ball velocity and passing accuracy. *International Journal of Performance Analysis in Sport, 14*(1), 296-306

Version of item: Authors' post-print

Available at: http://hdl.handle.net/10034/344297

The influences of rugby spin pass technique on movement time, ball velocity and passing accuracy

Authors

1) Paul R, Worsfold.

Affiliations- University of Chester & English Institute of Sport. *Address*- University of Chester, Department of Sport & Exercise Sciences, Parkgate Road, Chester, CH1 4BJ. *Tel*: +44 (0)1244 513467. *Email*: p.worsfold@chester.ac.uk. / paul.worsfold@eis2win.co.uk

2) Matthew Page.

University of Chester. *Address*: University of Chester, Department of Sport & Exercise Sciences, Parkgate Road, Chester, CH1 4BJ.

Abstract

The success of a rugby spin pass is determined by the speed of the passing movement and the resultant velocity, distance and accuracy of the ball flight. The present study investigated 900 dominant and 900 non-dominant hand spin passes at three randomised target distances (4, 8 and 12 m), whilst players ran between 60 and 80% of their maximum speed. Two distinct types of spin pass technique were compared. One involved the player lowering their body height ('body drop') then raising it again prior to ball release, and the other, players maintained a more upright body position

and incorporated greater arm movement. The current study assessed performance measures (velocity, spin, timing, accuracy) of the two previously identified passing techniques made from the players' dominant and non-dominant hands. The percentage of passes that included a 'body drop' phase rose linearly with pass distance. The 'body drop' technique resulted in higher ball velocities and improved accuracy from both the dominant and non-dominant passing hands. In comparison, the more upright passing technique resulted in a faster passing movement, but was compromised by lower ball velocity and accuracy. The findings provide an understanding of how different spin pass techniques affect the mechanics of ball flight and performance.

Keywords: Kinematics, passing, technique, ball flight

The influences of rugby spin pass technique on movement time, ball velocity and passing accuracy

Abstract

The success of a rugby spin pass is determined by the speed of the passing movement and the resultant velocity, distance and accuracy of the ball flight. The present study investigated 900 dominant and 900 non-dominant hand spin passes at three randomised target distances (4, 8 and 12 m), whilst players ran between 60 and 80% of their maximum speed. Two distinct types of spin pass technique were compared. One involved the player lowering their body height ('body drop') then raising it again prior to ball release, and the other, players maintained a more upright body position and incorporated greater arm movement. The current study assessed performance measures (velocity, spin, timing, accuracy) of the two previously identified passing techniques made from the players' dominant and non-dominant hands. The percentage of passes that included a 'body drop' phase rose linearly with pass distance. The 'body drop' technique resulted in higher ball velocities and improved accuracy from both the dominant and non-dominant passing hands. In comparison, the more upright passing technique resulted in a faster passing movement, but was compromised by lower ball velocity and accuracy. The findings provide an understanding of how different spin pass techniques affect the mechanics of ball flight and performance.

Keywords: Kinematics, passing, technique, ball flight

1. Introduction.

Although the purist may argue Rugby Union and Rugby League are different sports, there are a number of skills with similarities, such as the passing technique. Passing has been identified to contribute more than any other skill, in terms of number of successful executions, to gains in attack (Sasaki, Murakami, Shimozono et al. 2002). Passing has also been recognised as a marker of talent (Pienaar & Spamer 1998). In comparison to most other sports, passing in rugby is unusual as passes must be orientated backwards, contrary to the overall intention of the game, which is to move forwards. The restriction to passing direction requires players to be competent at passing bilaterally (Craven, 1970). The variability of the pass is key to successful play, as ambidexterity increases passing options, which, in turn increases the likelihood of successful attack through gaining ground or scoring (Greenwood, 1997). The spin pass is one of the most commonly used passes in rugby, because of its wide acceptance as the fastest, longest and most accurate pass (Greenwood, 1997; Crothers, 1992). It is well noted that a spinning projectile will travel further than a non-spinning projectile (Calverley, 2009), and so, the amount of spin imparted to the ball may affect the desired outcome of an accurate, fast pass over varying distances. With limited understanding of how passing and bilateral technique differences influence ball velocity and accuracy, the aims of the study were threefold; Firstly, to assess the performance characteristics of different spin pass techniques; Secondly to investigate differences between the dominant and non-dominant passing hand when performing the spin pass, and finally to determine the characteristics that influence successful and unsuccessful spin passes.

2. Methodology.

2.1. Participants:

Following ethical approval, 30 male competitive rugby players (age 20.20 ± 2.00 y, stature 1.83 ± .06 m (in shoes)) agreed to take part in the study. Prior to testing a habituation session was conducted to familiarise each participant with the passing procedure and to identify each players preferred passing side. Three maximal 20 m sprint times were also conducted in order to establish maximum running velocity.

2.2. Protocol:

Three 8 m long running channels were set-up 4 m, 8 m and 12 m away from the passing target (Figure 1). Players were required to run between 60 % and 80 % of their maximum speed as previous research has determined 70 % of maximum running speed is representative of a player making a pass during a game (Pavely et al., 2009). Timing gates were positioned at 2.50 m and 5 m to record running speed when making a pass. The passing player began behind the start of the 8 m line, with the ball feeder positioned after the second timing gate.

A randomized audio-cue stating the appropriate passing channel (4 m, 8 m, 12 m) was given at the start of each trial. Each participant performed 10 passes from each channel from both their dominant (30 passes) and non-dominant hand (30 passes), resulting in a total 60 passes per participant.

At 5 m the passer received the ball from the feeder, standardized by being fed from 1 m away, ball point upwards and at chest height. The passing player then had 3 m to adjust the ball accordingly and make a pass at the target.

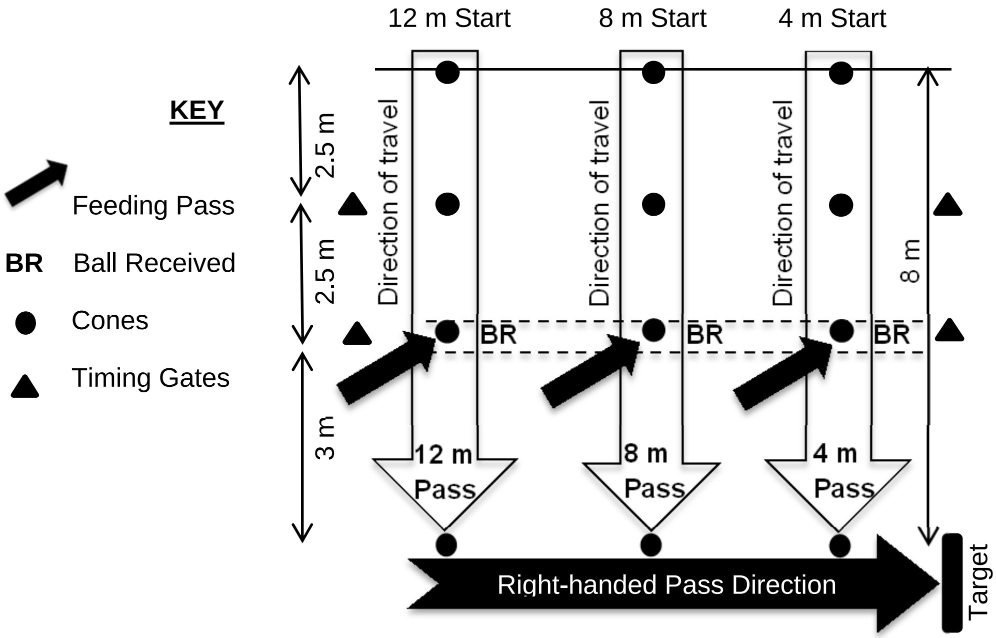

Figure 1: Test environment conditions for a right handed pass.

Mean values for each passing condition was identified for each participant for further analysis. To maintain ecologically, players were asked to employ their typical passing technique, adapting their movements to the constraints of each pass distance as they would within a competitive match situation.

The target was situated 0.92 m off the ground and measured 0.91 m wide, 0.85 m high. Using information on the ratio of upper body to lower body height (Herring, 2008). The height of the target was calculated as the upper body height (top of the head to the Iliac crest) of the average rugby player (1.77 m) (Quarrie, Handcock, Waller, Chalmers, Toomey & Wilson, 1995). The width of the target was based on the recommendation by Greenwood (1997) that passes should be made 3 ft (91.40 cm) in front of the recipient. The test setup was mirrored on the opposite side to test passing from the opposite hand. The ball was inflated to 0.70 kg per cm^2 in accordance with IRB ball regulations and had opposite panels colored black and red to enable quantification of the number of rotations during flight. Three video cameras (1/1000s) (Canon MV890, Canon Inc., Japan) were positioned and calibrated at the mid point of the pass distance (2 m, 4 m, 6 m) and were situated perpendicular to the direction of each pass. Passes were not assessed if the feed deviated from the standardised procedure, the running speed was outside the defined boundaries, or if the ball did not spin on its longitudinal axis. In total 1387 passes were analysed using video digitising software (Quintic Biomechanics 9.03v17, United Kingdom).

For each pass the accuracy, horizontal velocity, timing of the pass phase, ‘body drop’ height, body height at release and the number of ball rotations were recorded.

Ball horizontal velocity and rotations were calculated from the first video-frame where the ball had left one of the hands to the point of contact with the target. Rotations were calculated to the nearest quarter turn of the ball. The timing of the pass phase was calculated from the point the ball moved below chest height or across the body, to initiate the backswing phase, to the point of ball release. Passing accuracy was calculated as a percentage for each pass distance and for the dominant and non-dominant hand. Any part of the ball contacting the target was identified as successful. Testing was conducted in an indoor training facility to avoid fluctuations in temperature, ball moisture and wind.

‘Body height’ at release was calculated as a percentage of the participant’s full body height in shoes. The change in body height (Body drop) during the pass was defined as the lowest height of the passing player, if different to the body height at release. This was only calculated if the ‘body drop’ phase occurred within one step of ball release. The ‘body drop’ height was converted into a percentage of full body height in shoes, and the difference between 'body drop' height and body height at release was then recorded.

Participants adapted to each passing condition using their own movement strategies. No instruction was given to perform a specific passing technique other than to pass from a specific hand (dominant or non dominant) at a specified distance. Kinematic analysis identified that participants adopted two distinct passing techniques during the trials. Therefore, each pass was divided into one of four categories: 1) passes including a 'body drop' phase from the dominant hand; 2) passes including a 'body drop' phase from the non-dominant hand; 3) passes excluding a 'body drop' phase from the dominant hand; and 4) passes excluding a 'body drop' phase from the non-dominant hand.

Mean values were identified for each variable within each passing condition. The assumptions of normality (Shapiro-Wilk), homogeneity of variance (Levene's) and sphericity (Mauchley's) verified parametric data. The assessment of data comparisons and interactions were performed using a series of repeated measures ANOVA tests. Post-hoc Tukey HSD tests identify where significant differences occurred. Wilcoxen tests were conducted on non-parametric data (% body height at release and % body drop height, % accuracy). Statistical significance was set at $P<0.05$ throughout

3. Results.

Two discrete passing techniques were assessed during the testing, one involved the player dropping their body height then raising it again prior to ball release, and the other, players maintained a more upright body position and incorporated greater arm movement. The percentage of passes that included a ‘body drop’ phase rose linearly with pass distance (Table 1).

Table 1: Frequency of the ‘body drop’ passing technique adopted by participants within each passing varible.

Pass Distance	**Body Drop Dominant Hand**	**Body Drop Non Dominant Hand**
4 m	39%	44%
8 m	56%	63%
12 m	65%	69%

Accuracy: As one would expect, the accuracy of passing decreased as the target distance increased (Figure 2). Significant differences ($P<0.05$) were identified between the accuracy of the 4 m and 8 m pass, and the 8 m and 12 m pass from the dominant and non-dominant hands. Passes that included a ‘body drop’ phase from both the dominant and non-dominant hand identified greater passing success across all target distances.

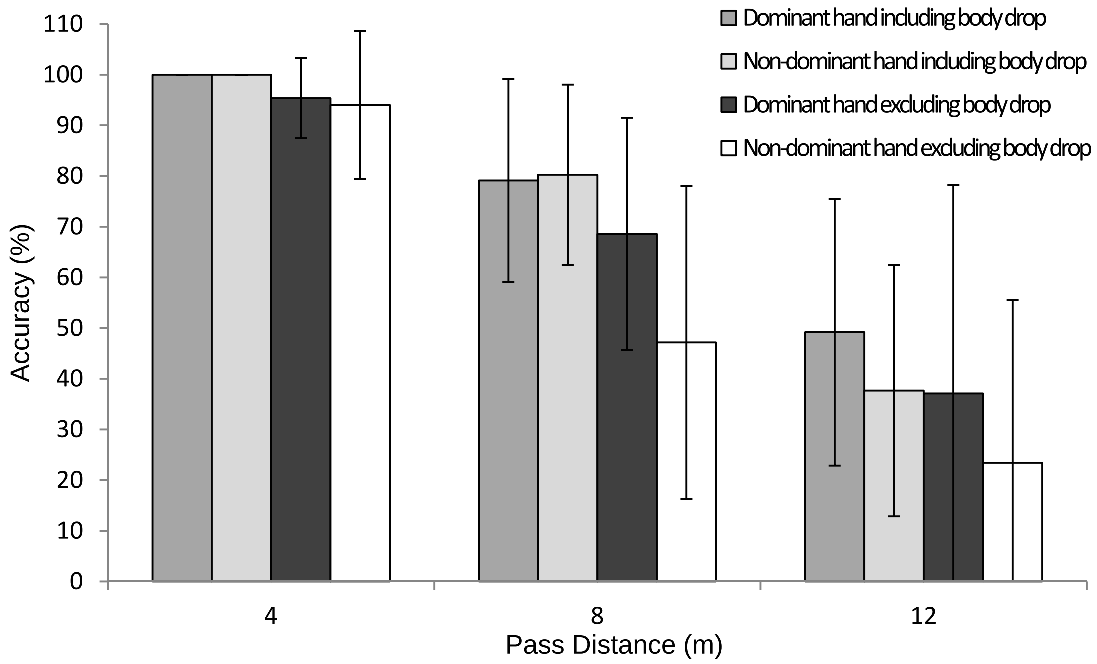

Figure 2: Comparison of the accuracy of passes over different distances, including and excluding a ‘body drop’ phase from the dominant and non-dominant hand.

Velocity: Ball velocity increased linearly as the target distance increased; with the 4 m passes being significantly slower ($P<0.05$) than all other passes. Passes incorporating a ‘body drop’ phase generated greater ball velocity from both the dominant and non-dominant hands when compared to passes without this movement phase (Figure 3).

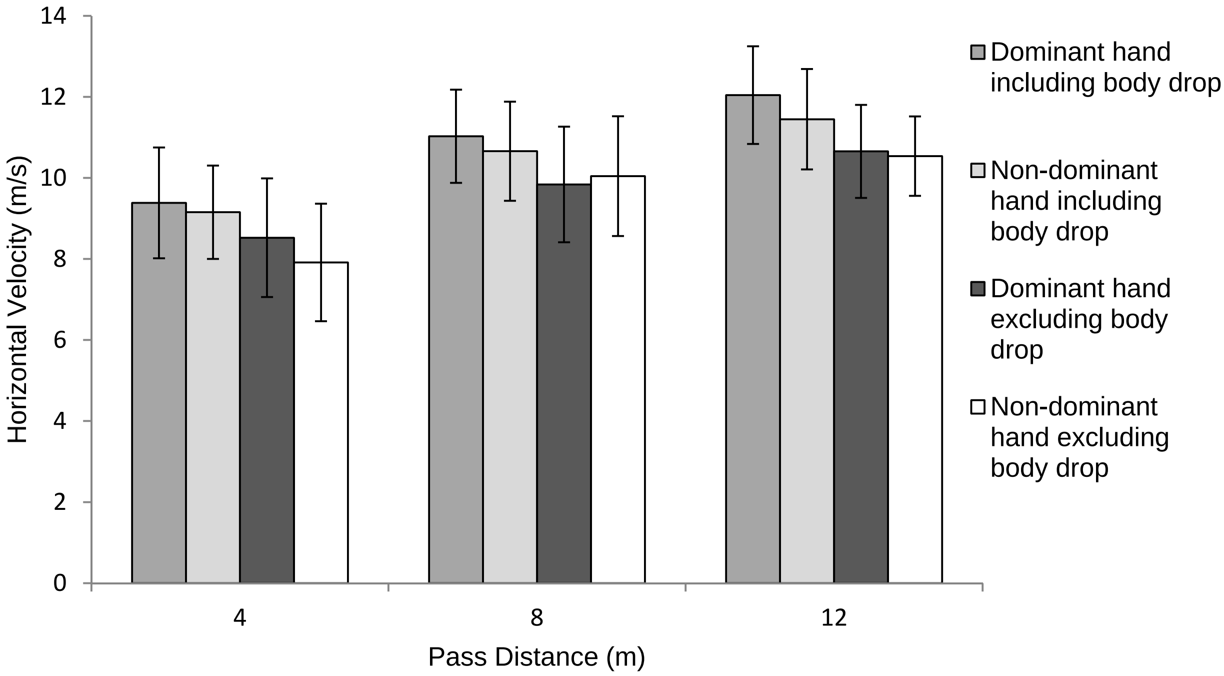

Figure 3: Differences in ball horizontal velocity of successful passes including and excluding a ‘body drop’ phase.

Timing: Temporal analysis of the pass sequence identified passes incorporating a ‘body drop’ phase took longer to complete than techniques without (Figure 4); these were significantly slower ($P<0.05$) during the 8 m and 12 m passes. Dominant hand passes were quicker than the non-dominant hand in all except 12 m passes without a ‘body drop' phase. The 8 m and 12 m passes identified significantly slower (P<0.05) pass times from passes including a 'body drop' phase from both hands when compared to 4 m passes.

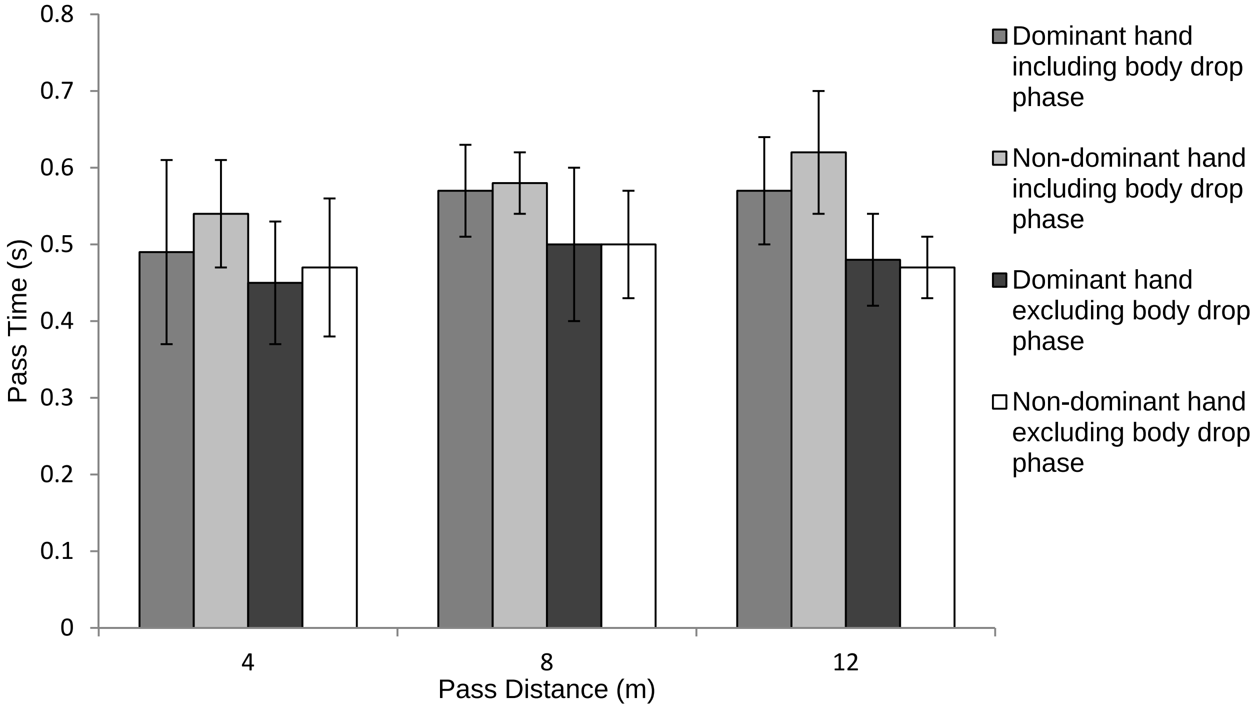

Figure 4: Timings of the pass phase during different amalgamations of the spin pass.

A comparison of spin pass variables between distances, successful and unsuccessful passes, and between hands is illustrated within tables 2 & 3.

Table 2: Comparison of body height variables between distances, successful and unsuccessful passes, and between hands.

Hand	Body Height at Release (% full body height)		Body Drop Height (% full body height)	
	For All Successful Passes			
Hand	**Dominant**	**Non Dominant**	**Dominant**	**Non Dominant**
4 m	92.55±5.07	93.99±4.93	83.72±3.50	85.18±2.49
8 m	87.75±5.74	88.98±4.94	80.08±5.29	81.69±4.82
12 m	86.59±7.43	86.65±5.82	78.41±7.52	79.52±6.96
	For All Unsuccessful Passes			
4 m	93.13±9.59	94.57±7.28	84.10±3.23	86.47±3.69
8 m	88.65±11.60	89.98±5.06	82.54±4.51	81.56±3.96
12 m	87.95±7.54	88.47±5.88	80.20±7.69	81.49±6.11

Key:] denotes a significant difference between values (*P*<0.05).

Table 3: Comparison of ball rotations between distances, successful and unsuccessful passes, and between hands.

	Ball Rotations	
	For All Successful Passes	
	Dominant Hand	**Non Dominant Hand**
4 m	1.94±.37	1.98±.44
8 m	4.00±.72	4.14±.79
12 m	6.10±.88	6.30±1.19
	For All Unsuccessful Passes	
4 m	2.17±.68	2.83±.34
8 m	4.31±.76	4.44±.87
12 m	6.34±1.04	6.67±1.34

Key:] denotes a significant difference between values (*P*<0.05).

4. Discussion.

The aims of the study were to assess the performance characteristics of two different spin pass techniques, to identify differences between the dominant and non-dominant passing hand and to determine the mechanisms that influence successful and unsuccessful spin passes.

From qualitative analysis it was evident that the spin pass technique involving a ‘body drop’ phase, was achieved by players abducting the front-leg towards the intended target and planting it on the ground, slowing the players forward motion. The action widened the base of support and lowered the player’s body height. Players then flexed their knees and trunk causing their centre of mass to lower toward the ground and consequently increased their stability. The pass was made as the knees and trunk extended and the body moved toward the target. Although not directly measured, one can assume muscle stretch shortening phases occurred within the upper and lower body, which resulted in faster ball velocities (8 m and 12 m). Similar movements have previously been identified in other sports, such as the tennis backhand and the ice-hockey wrist-shot (Elliot, 2001; Bahamonde, 2001; Michaud-Paquette, Magee, Pearsall & Turcotte, 2011). The amount of ‘body drop’ was influenced by pass distance, with greatest ‘body drop’ occurring at 12 followed by 8 m. It was at these longer distances when players required greater whole body movements to facilitate stretch shortening actions of the gross lower body muscles in order to generate the power to project the ball further. The results support Trewartha et al. (2008) who found that increased whole body movement increases the speed of the lineout throw.

The second passing technique involved flexing at the knees to lower the body height, but to a lesser extent than the technique previously described. The movement required a greater demand from the arms to generate power to displace the ball. Limited movement through flexion-extension was evident when compared to the ‘body drop’ technique; accordingly the stretch shortening sequence was less apparent. With a higher centre of mass and narrower base of support, less power and consequently ball velocity was generated from the arms. Stability was compromised during the longer passes, to try to compensate for this, the back leg (furthest from the target) was often swung outward by players and served to counter-balance the movement of the arms.

As one would expect, *passing accuracy* from both the dominant and non-dominant hand decreased as the target distance increased. Interestingly, passes that included a ‘body drop’ phase from both the dominant and non-dominant hand resulted in less variability within the measured varibles and improved passing success across all target distances. This is possibly due to improved stability and a greater contribution of whole body movements.

The *horizontal velocity* of the ball from a ‘body drop’ pass was higher across all distances when compared to passes without a ‘body drop’ technique. The findings illustrate the influence of the stretch shortening phases associated with the ‘body drop’ technique. Only a small increase in ball velocity was identified between 8 and 12 m for passes excluding a ‘body drop’ phase from both hands, inferring players were reaching a limit to the amount of power that can be generated primarily by the arms. This corresponds with past studies, which have shown side-differences in proficiency when performing tasks from both hands (Grious, 2004; Pavely et al., 2009, 2010). Such passing hand technique preferences suggest motor control asymmetry and muscle strength imbalance between dominant and non-dominant hands. However, this finding may be less prevalent within an elite rugby cohort.

As one would expect, there was a significant increase in *ball rotations* as pass distance increased. Interestingly the non-dominant hand produced a higher number of ball rotations across all distances. Moreover, a higher number of ball rotations were recorded for unsuccessful passes over all pass categories. The findings suggest that increased ball rotation can cause inaccuracy, through magnifying the deviation from the intended flight path through an off-centre centre of pressure (see Horn & Fearn, 2008).

When compared to ball velocity the findings suggest that passes from the non-dominant hand sacrifice horizontal velocity for rotational velocity. Moving the hand over the top of the ball to exaggerate spin, sacrifices power through the central plane of the ball.

In comparison to unsuccessful passes, successful passes incorporated lower *body height* at ball release within both pass techniques. This was evident within passes from both the dominant and non-dominant hands. Moreover, body height decreased as the target distances increased. It is plausible that players perceived the need for greater stability as the demand of the pass distance increased. Therefore, players lowered their centre of mass by widening their feet and or flexing their knees and hips. It is interesting to note that the success of the pass was also influenced by the player’s body height at release. Even in passes that did not incorporate a distinct ‘body drop’ phase, a lower body position produced greater passing accuracy.

It was evident that passes incorporating a distinctive ‘body drop’ phase resulted in a notable decrease in running speed prior to ball release in order to facilitate the foot-plant and subsequent knee and hip flexion. With body collisions a fundamental aspect of the game, it may be beneficial to use a passing technique with wider support base and lower centre of mass. However, temporal analysis of pass techniques showed that the passes excluding a ‘body drop’ phase were completed faster than those including a ‘body drop’ phase due to the limited kinematic adaption prior to, and during the pass movement. It was apparent that passing-hand differences were also evident in the timing of the pass movement with increased motor competency within the dominant hand resulting in faster passes.

5. Conclusion.

The present study identified two distinct spin pass techniques. Differences between body movement and ball flight characteristics were determined and assessed in relation to passing hand dominance. The study provides an insight into the factors that affect the mechanics of a rugby spin pass and the resultant flight of the ball. From the results important applied applications can be considered. Which spin pass technique a player chooses should depend on a number of factors; the distance of the pass, the passing hand required to make the pass, the speed of attack, the position of the opposition / tackler(s), the time to conduct the pass and the ability of the player. For players with poor motor competency, particularly from the non-dominant hand, the ‘body drop’ pass would increase the likelihood of a higher ball release velocity with more accuracy and better position their body in preparation for oncoming collisions. Conversely, often the speed of ball release and just making the pass might be the most important; therefore, a pass excluding a ‘body drop’ will increase the likelihood of success. It is important to recognise the strengths and compromises between techniques and therefore identify / coach when to use the correct pass technique.

In a fast-paced game such as rugby, the speed of the pass movement is often as important as the ball velocity at release. With accuracy improved with the ‘body drop’ technique, but the time to execute the pass increased, players and coaches are faced with a decision as to which is most important at that specific phase of play. The confounding factors of each technique identified within the present study should be appraised in the context of the game situation.

6. References.

Bahamonde, R. (2001). Biomechanics of the forehand stroke, **ITF Coaching and Sport Science Review**, 24, 1-2.

Calverley, M. (2009). Biomechanics and Skill Analysis of Scrum-Half Passing Skills – *Part 2*. Retrieved from: www.attackingrugby.com/articles/SH%20Biomechanics%202.pdf.

Craven, D. (1970). **Rugby Handbook**. New Zealand: EP Publishing.

Crothers, D. S. F. (1992). Mathematics in sport I. **International Journal of Mathematical Education in Science and Technology**, 23, 117-126

Elliot, B. (2001). Biomechanics and stroke production: implications for the tennis coach. **ITF Coaching and Sport Science Review**, 24, 2-3.

Greenwood, J. (1997). **Total Rugby**. London: A &C Black.

Grouios, G. (2004). Motoric dominance and sporting excellence: training versus heredity. **Perceptual and Motor Skills**, 98, 53-66.

Herring, J. A. (2007). **Tachdjian's Paediatric Orthopaedics**. Saunders; 4th edition.

Horn, C., & Fearn, H. (2008). On the Flight of the American Football. (Unpublished Thesis). California State University, America. http://physics.fullerton.edu/~heidi/PROJECTS/football.pdf

Michaud-Paquette, Y., Magee, P., Pearsall, D., & Turcotte, R. (2011). Whole body predictors of wrist-shot accuracy in ice hockey: a kinematic analysis. **Sports Biomechanics**, 10, 12-21.

Pavely, S, Adams, R. D., Francesco, T. I., Larkham, S., & Maher, C. G. (2009). Execution and outcome differences between passes to the left and right made by first-grade rugby union players. **Physical Therapy In Sport**, 10, 136-141.

Pavely, S., Adams, R. D., Francesco, T. D., Larkham, S., & Maher, C. G. (2010). Bilateral clearance punt kicking in rugby union: effects of hand used for ball delivery. **International Journal of Performance Analysis in Sport**, 10, 187-196.

Pienaar, A. E., & Spamer, M. J. (1998). A longitudinal study of talented young rugby players as regards their rugby skills, physical and motor abilities and anthropometric data. **Journal of Human Movement Studies**, 34, 13-32.

Quarrie, K. L., Handcock, P., Waller, A. E., Chalmers, D. J., Toomey, M. Y., & Wilson, B. D. (1995). The New Zealand rugby injury and performance project III: anthropometric and physical performance characteristics of players. **British Journal of Sports Medicine,** 29, 263-270.

Sasaki, K., Murakami, J., Shimozono, H., Furukawa, T., Katuta, T., & Kono, I. (2002). Contributing factors to successful attacks in rugby football games. In W. Spinks., T. Reilly., & A. Murphy. (Eds.). **Science and Football VI**. London: Routledge.

Trewartha, G., Casanova, R., and Wilson, C. (2008): A kinematic analysis of rugby lineout throwing. **Journal of Sports Sciences**, 26, 845-54.