10. BIOMECHANICS (2)

O-056 Use of weighted balls in improving kicking for distance

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OBJECTIVE Kicking for distance is an important part of Australian Rules Football (ARF). However there has been no research examining how distance can be improved. Weighted implements have been successful in improving performance in sports such as baseball (Escamilla et al., 2000). The use of weighted balls might be useful in training for maximal kick distance. The aim of this study was to examine the effect of maximal distance kicking training using regulation and weighted balls on maximum kick distance.

METHODS Twenty-eight elite Australian rules footballers were divided into three groups. Group 1 used regulation balls, Group 2 used regulation and weighted balls (soaked in water to increase from 450 to 500 g), and Group 3 was the control. All were tested for maximum kick distance before and after the 4 week (10 sessions) intervention. Groups and changes were compared by ANOVA.

RESULTS There was no difference in kick distance in pre-testing between groups. In post-testing, both Group 1 and Group 2 produced significantly longer kick distances than the control group. As well, both group 1 and group 2 significantly increased distances from the pre-test to the post-test.

Table 1. Kicking distances for Group 1 (regular balls), Group 2 (weighted balls) and Group 3 (control before and after a five week distance kicking intervention

		Group 1 (N = 10)	**Group 2** (N = 10)	**Group 3** (N = 7)	**F**	**p**	**Effect**
Pretest	**Mean**	58.7	56.2	55.5	1.50	0.24	0.111
	SD	5.0	4.2	2.5			
Posttest	**Mean**	63.4	61.8	56.4	5.86	0.01	0.328
	SD	5.8	3.6	3.6			
Change	**Mean**	4.8	5.6	0.9	7.66	0.00	0.390
	SD	2.5	2.7	2.6			

DISCUSSION Specific kicking for distance improved maximal kick distance in an elite group. The use of regulation balls only or regulation and weighted balls both increased distance. There was no statistical difference between methods, although the weighted ball group improved 0.8m more. A longer intervention might show a significant result. Specific kick distance training is recommended to increase distance.

REFERENCES
Escamilla et al. (2000) *Sports Medicine* **29,** 259-272.

KEY WORDS Australian Rules Football, kick distance, weighted balls.

O-057 Development of a mechanical kicking simulator

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OBJECTIVE Ball sports equipment has utilised impacting machines or ‘robots’ for experimental verification of prototypes and computer models. In the case of soccer kicking machines are used during ball development as they provide repeatable impact conditions unobtainable during human testing procedures. This paper describes the development of a kicking machine and details some preliminary results. The study aimed to develop a kicking machine to allow accurate and repeatable simulation of impact between foot and ball that exists within various kicks in a game of soccer and rugby.

METHODS Previous player studies stated maximum ball launch velocities of 38.1m/s. The design was based on a rigid A-frame, using a servo motor, capable of accelerating the kicking leg to a maximum velocity of 2300deg/sec. The leg’s

rotation was adjustable within the machines software, and various launch conditions were replicated using an adjustable teeing mechanism and interchangeable end effectors.

RESULTS High speed video of soccer and rugby ball impacts at 10,000 fps, enable detailed analysis of launch conditions and ball deformation. A maximum ball speed of 50m/s was achieved, with the repeatability of the leg speed calculated to 0.06kph (1SD).

CONCLUSION The kicking machine developed was capable of producing the launch conditions experienced during game related impacts in an accurate and repeatable manner, using an adjustable teeing mechanism and interchangeable end effector. This development would allow manufactures to create and evaluate new products quickly and consistently.

KEY WORDS Kicking robot, ball impact simulation, launch conditions, soccer impact, rugby impact.

O-058 Movement patterns of body segments for curved running in soccer players

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OBJECTIVE Research into locomotion has tended to focus on linear motion, with only limited studies on non-linear motion that would be used in soccer play (Hamill et al., 1987; Smith et al., 1997). Body lean is a consistent feature of non-linear motion. For maintenance of body lean, the body centre of gravity must be moved toward the centre of the curve to counter the toppling moment. This study aimed to quantify the segmental contributions towards body lean and how this would affect the maintenance of non-linear motion in soccer on a natural turf surface. Body lean is achieved by reorientation of larger body segments.

METHODS In this study 8 male soccer players (21.7±2.3yrs, 72.3±6.4Kg) volunteered to participate. All wore standard six-studded soccer footwear. Trials were performed whilst running at 5.4ms-1 in both straight, and curved (radius 3.5m) conditions. Kinematic data was collected at 50Hz using Peak Performance pan and tilt software. Angles of lean with respect to vertical in the frontal plane were calculated.

RESULTS Differences were shown between straight and curved conditions at the torso, the neck, and the thigh of the inside and the outside limbs of the curve. Values were lower in the curved condition at Heel-Strike and Toe-Off in both limbs ($P<0.05$). Mean torso lean reduced from 181° (straight) to 158° (curved). Outside thigh from 180° to 155°, and inside thigh from 170° to 147°.

CONCLUSION Differences in function of inside and outside limbs were noted. The inside limb provided greater lean angles that the outside limb in the frontal plane. Lean of the lower extremities enabled repositioning of the larger torso segment. Subsequently body centre of gravity repositioning enabled maintenance of the curved running pattern of the type required to make offensive runs whilst remaining onside.

REFERENCES
Hamill et al. (1987*) International Journal of Sports Biomechanics* **3**, 276-286.
Smith et al. (1997) *Journal of Human Movement Studies* **33**, 139–153.

KEY WORDS Soccer, curve, lean, running.

O-059 Kinematic analysis of high performance rugby props during scrum training

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OBJECTIVE International rugby games have approximately 19 scrums and teams use scrums to establish dominance over the opposition, and to initiate offence. Despite its importance and the issues surrounding scrummaging and injury, there is limited research on the biomechanics of scrimmaging. No scientific research has reported the kinematics of scrummaging in elite rugby players. The purpose of this study was to examine the sagittal plane kinematics of several international rugby props during a combination of both training and game based scrummaging drills in order to develop a greater understanding of the techniques involved.

METHODS This study was based on 2-dimensional analyses of (n=5) from an international rugby team during machine (5 and 8-man), and live scrum training. High-speed (500 Hz) and 50 Hz digital video were recorded over 6 trials and analysed using APAS motion analysis software. Paired t-tests were used to test for differences in scrum technique between the scrum drills, and machine and live scrummaging.

RESULTS Differences in lower limb kinematics were evident amongst all scrum types. For example, peak hip and knee angular extension velocities were greater for 5-man scrums, while peak horizontal velocities of the CoM were greater for the 8-man scrums. Conversely, peak hip and knee extension velocities for live scrums were slower than during scrum machine training.

CONCLUSION It was concluded that clear differences exist in the sagittal plane kinematics of props during different types of scrummaging training. The implications of these findings are considerable, as these data suggest that the excessive use of scrummaging machines, plus some scrum training drills (e.g. 5-man) may have a negative training effect.

KEY WORDS Biomechanics, rugby, scrum, kinematics.

O-060 Foot to ball interaction in kicking in Australian Rules football

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OBJECTIVE Kicking is the most important skill in Australian Rules Football (ARF). A major coaching cue in kicking is the nature of contact with the ball (Ball, 2006). However, no ARF data exists for ball to foot contact times or for the distance the ball moves while in contact with the foot. As well, if work can be done on the ball during impact, this will have implications for conditioning and coaching. The first aim of this study was to provide basic information on contact times, the distance the ball moves and change in shank angle during ball contact. The second aim was to see if differences existed for these parameters for short and long kicks. The third aim was to determine if work was done on the ARF ball during kicking.

METHODS Eight elite level ARF players kicked an ARF ball over 30m and 50m. High speed video focused on the foot and lower leg and was used to calculate contact time between foot and ball. Digitised data was used to calculate the distance the ball moved, shank angle and ball velocity. T-tests compared 30m and 50m kicks.

RESULTS For 30m and 50m kicks mean contact times were 9.8 to 10ms, mean ball distances were 0.19 and 0.24m, and mean change in shank angles were 14 and 18 degrees respectively. 50m kicks were significantly larger change in shank angle, larger ball distances (small effect, p=0.06 only) and significantly larger change in ball velocity. No difference existed for contact times.

Table 1. Foot to ball interaction for a long and a short kick.

	Distance ball moved (m)	Change in shank angle (degrees)	Time in Contact (ms)	Change in Ball Velocity (m/s)
Long Kick (50 m)	0.24 (0.06)	18 (3)	10 (1.1)	25.0 (1.1)
Short Kick (30 m)	0.19 (0.02)	14 (2)	9.8 (1.2)	22.1 (1.8)
t-test (p-value)	0.068	0.048	0.79	0.027
Effect size (d)	0.046	0.049	0.005	0.063
	Small Effect	Small Effect	No Effect	Medium Effect

CONCLUSION Mean contact time and distance the ball moved lay between soccer values. Work can be done on the ball during the ARF kick (approx 270J) so using momentum equations is inappropriate. Change in shank angle and distance the ball moves during contact means muscular force can be applied and has implications for conditioning. In conclusion, recommendations for female soccer players are to encourage consumption of carbohydrate-electrolyte beverages to enhance carbohydrate intake and increase fluid intake, and ensure sufficient iron rich foods are included in the diet to meet the DRI.

KEY WORDS Kick, Australian rules, impact