A BIOMECHANICAL COMPARISON BETWEEN SHOOTING TECHNIQUE IN BASKETBALL AND NETBALL

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INTRODUCTION

Basketball and netball share several similarities. Both are invasive team sports and use a ball which may only be controlled by the hands. Central to both is the method of scoring, which is by projecting the ball through a horizontal hoop, elevated 3.05 metres from the ground. As scoring more baskets or goals than the the opposition is the only means by which a game can be won, it is arguable that the skill of shooting is central to both sports.

The accuracy requirements of shooting differ somewhat, however, in that the diameter of a basketball ring is at least 80% greater than that of the ball, whereas that of the netball ring is only 65% larger than the ball. For the same shooting distance, greater accuracy is, therefore, required to score in netball than basketball.

For any shooting distance, there are infinite combinations of release speed and release angle which will result in a successful outcome, and Hay (1985) has shown that, amongst others, the angle of entry of the ball into the basket is an important factor in determining success. This is, in itself, dependent upon both release speed and release angle. The most advantageous approach of the ball, in terms of margin for error, is from vertically above, where the ball "sees" the basket as a circle. Such steep approaches require similarly steep angles of projection (ignoring the effects of air resistance) and, therefore, require considerable release speed. At shallower approaches, however, which up to a point require a lower release speed, the basket appears to become increasingly elliptical until such a time as the ball cannot pass through it without making contact. There is thus a choice to be made between the advantages to be gained from an increased margin for error due to a high release angle, and those to be gained from utilising a lower release speed, where the muscles with a smaller innervation ratio - and therefore a finer control - may play a dominant role in the movement.

Brancazio (1984) demonstrated mathematically that the angle of release which requires the minimum release speed, and therefore minimum impulse, for any shooting distance, is given by "45° + half the angle of incline to the basket". From this, it can be seen that an inverse relationship exists between shooting distance and this angle. For example, for an increase in shooting distance from 1 to 2 metres, the angle requiring minimum release speed decreases from 61° to 54°. This effect is greatest for short range shots, as the angle of incline from point of release to the basket changes exponentially with respect to distance.

Whilst there are differences between the accuracy requirements in the respective sports, coaching manuals (e.g. Coleman, 1975 for basketball and Galsworthy, 1990 for netball) are uniform in recommending similar shooting techniques, and it may, therefore, be expected that a comparison may reveal common elements.

The rules of netball, however, specify that the body of a defender must be 0.9 metres away from that of the shooter for a period of 3 seconds, after which time the ball must be released. No such rule exists in basketball, and defenders may approach as close as desired without making contact. As the ability to shoot without interception or deflection is of paramount importance, it is possible that different strategies have been developed in response to the respective rules of each sport. A further factor worthy of consideration is reproducibility of movement. For skills requiring a high element of accuracy, which both evidently do, replicability is important, and given the more "closed-skill" nature of netball shooting, it may be expected that this would produce a greater consistency of movement. The objectives of the study were, therefore, to conduct a kinematic comparison between the shooting techniques of netball and basketball players.

METHODOLOGY

Three-dimensional video techniques, adhering to the recommendations of the British Association of Sports Sciences (Bartlett, 1992), were used to capture images of close range basketball and netball shots, as performed during competition by members of the men's quarter-finalist teams at the XVIth Universiade, and England Senior Women's netball team during a training match in April 1993. In both cases, two gen-locked Panasonic F-15 video cameras, the optical axes of which formed an angle of approximately 90°, running at 25 Hz, were used to capture three-dimensional performance images. In both cases, only five sequences were suitable for analysis, a suitable sequence being defined as one in where a goal or basket was scored and an unobstructed view of the subject was available from both cameras.

A 14 segment, 18 point model of the human performer, with one extra point representing the ball, and using the Direct Linear Transformation algorithm, was employed to reconstruct a three-dimensional image from the related object-space coordinates. Analysis began from the first perceived initiation of the shooting movement, and ended 10 frames after ball release. Data were digitised at 50 Hz, and sequences smoothed using a generalised cross-validatory quintic spline. As performances were not experimenter-controlled, the plane of ball release did not correspond to the orthogonal axes as defined by the calibration frame. To facilitate analysis, sequences were rotated sequences about the ball position in the final frame such that the projection of its direction during flight onto the X-Y plane was made parallel to the X axis.

Independent t-tests were applied to variables to test for differences between data sets.

RESULTS

	Basketball (± 1 S.D.)	Netball (± 1 S.D.)
Rel. Speed (m s^{-1})	3.04 ± 0.65	3.71 ± 0.43
Rel. Angle (°)	49 ± 10	80 ± 9

Table 1. Release Parameters

Ball release parameters are shown in table 1. Mean release speeds were 3.04 and 3.70 m s^{-1} respectively, which were not significantly different, this may suggest that shooting distances were similar. Examination of the release angles, however, suggests that this may not be the case as the mean angle for netball (80°) was significantly greater ($p < 0.01$) than that for basketball (49°).

	Basketball (± 1 S.D.)	Netball (± 1 S.D.)
Trunk[1] (°)	82 ± 5	74 ± 3
Shoulder (°)	137 ± 8	145 ± 9
Elbow (°)	143 ± 2	156 ± 7
Wrist (°)	13 ± 18	28 ± 22

[1] to forward horizontal

Table 2. Upper body angles at release

The ball release velocities described are determined by body segment positions and resultant velocities at release (table 2). Upper body angular displacements were similar, but slightly greater for netball, yet full extension was not in evidence. This is consistent with previous literature for both sports (e.g. Miller, 1993, Elliott and Smith, 1983). Extension of the shoulder and elbow joints increases release height which improves accuracy. Extension of these joints decreases the chances of the shot being blocked or deflected, however, this was compromised by the forward trunk lean exhibited by both groups.

	Basketball (± 1 S.D.)	Netball (± 1 S.D.)
Timing of release[1] (s)	-0.04 ± 0.05	-0.05 ± 0.03
CM speed (m s^{-1})	0.79 ± 0.52	0.61 ± 0.16
CM angle[2] (°)	57	87 ± 14

[1] with respect to vertical peak of CM trajectory

[2] to the forward horizontal

Table 3. Timing of release, Centre of mass velocity

Ball release tended to occur a similar time prior to the centre of mass reaching its vertical peak (table 3). The slightly greater standard deviation for basketball shows that at least one subject released the ball after the peak of the centre of mass, whilst all those for netball were prior to that time. Whilst ball release prior to the centre of mass reaching its peak has been cited as an aid to the provision of the required release speed, this is unlikely to be a necessary strategy due to the short range nature of the analysed shots.

Whilst shooting is essentially a two dimensional skill, both groups exhibited leftwards shoulder and hip axis rotation (table 4), which is thought to be used to aid alignment of the eye, elbow, wrist and ball in a vertical plane with the goal. Basketball shooters tended to remain closer to 90° to the direction of release.

Such rotations originate in the stance position, where again similarities between the groups existed. The foot on the side of the shooting hand was always forward which, in conjunction with medio-lateral separation, increased the potential stability of the body by increasing the base of support. Correlation coefficients of $r = 0.60$ for basketball and 0.52 for netball suggests that the amount of hip rotation is influenced by antero-posterior foot separation.

	Basketball (± 1 S.D.)	Netball (± 1 S.D.)
Shoulder Rotation[1] (°)	75 ± 9	68 ± 10
Hip Rotation[1] (°)	82 ± 15	63 ± 2
Right Foot[1a] (°)	4 ± 40	17 ± 19
Left Foot - X[1a] (°)	24 ± 36	35 ± 14
Foot separation A/P[2] (°)	0.17 ± 0.11	0.23 ± 0.27
Foot separation M/L (°)	0.38 ± 0.30	0.44 ± 0.10

[1] X = direction of shot
[a] (+ve = anti-clockwise from above)
[2] right foot forward

Table 4. Parameters relating to stance

CONCLUSION

On the basis of the foregoing discussion, the following conclusions were drawn:
Release angles tend to be lower in basketball due to the inclusion of a jump into the shot, thereby reducing the angle requiring minimum release speed.
Ball release occurred prior to the centre of mass reaching its vertical peak, and with an upward and forward centre of mass velocity. Any non-zero velocity at release, especially one which varies over trials makes the computation of release parameters more difficult and should, if possible, be avoided.
Netball shooters displayed a slightly larger base of support, as defined by antero-posterior and medio-lateral foot separations. It is likely that the former contributed to the greater rotations of the hip and shoulder axes.

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