BALL RELEASE PARAMETERS IN MISSES AND SWISHES IN THE BASKETBALL FREE THROW

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INTRODUCTION

There have been several studies investigating the optimal ball release parameters in basketball [1-3]. These studies primarily provide theoretical data. Empirical data on differences between successful and unsuccessful shots is needed. The aim of this study was to compare the ball release parameters between misses and swishes in free throw shots in experienced basketball players.

METHODS

Collegiate level basketball players volunteered and provided written informed consent to participate (female n=5; 19.3±1.4yrs, 1.66±0.12m, 64.6±6.8kg; male: n=10; 19.1±0.8yrs, 1.91±0.07m, 85.8±12.6kg). Subjects performed 20 free throw shots, during which 5 markers on the ball (left and right medial-lateral axis, plus three more on right side) were recorded at 60 Hz using 12 Eagle cameras and Cortex v1.0 software (Motion Analysis Corp, Santa Rosa, CA).

For each subject, 3 misses and 3 swishes were randomly selected and analyzed using custom written code in Matlab (v2008b, MathWorks Inc, Natick, MA). Data were smoothed using an 8Hz second-order low pass filter. Using ball release parameters, optimal-minimum-speed parameters were calculated for $s_{opt}=(gx_b/2\cos^2\theta_{opt}(\tan\theta_{opt}-y_b/x_b)^{0.5}$ [eq. 1] [1], which in removing θ_{opt} becomes $s_{opt}=g(y_b+(y_b^2+x_b^2)^{0.5})^{0.5}$ [eq. 2], and for $\theta_{opt}=45+\mathrm{atan}(y_b/x_b)$ [eq. 3][1]. Margins of error were calculated for s_{opt} with equation 2 by changing x_b to clear the near and to clear the far side of the hoop, and for θ_{opt} with equation 1 using solver (Excel 2003, Microsoft Corp, Redmond, WA) by keeping the optimal speed the same and changing x_b to clear the near side of the hoop. See Table 1 for definitions.

Statistical analysis was performed using SPSS (v16.0 Chicago, IL). After removing one outlier for ω_{spin} data were normally distributed (Shapiro-Wilks>0.05). Release parameters were analyzed using 2-way repeated measure ANOVAs (outcome v trial). These data were presented as mean and standard deviation without the outlier, and minimum and maximum with the outlier. Percentages of shots within the margins of error were analyzed using Chi-squared. The alpha level was set at 0.05.

RESULTS AND DISCUSSION

For the ball release parameters (see Table 1), these were the same for misses and swishes for all variables except the deviation from the optimal release speed that was statistically significantly slower for misses (-0.12±0.11m/s) than swishes (-0.02±0.07m/s; $p<0.05$), where a negative number indicates the speed was below the optimal.

Margins of error for s_{opt} were between ±0.03m/s (approx 0.5% of s_{opt}) and for θ_{opt} ranged from -4.4 to -3.3º less (approx -9 to -6% of θ_{opt}). These small deviations from optimal emphasize the precision required to produce a successful shot. Indeed, of the misses only 13.3% of these shots fell within the margin of error for the optimal release speed derived from the actual release positions, which was less than the 55.6% achieved for the swishes ($p<0.05$). There was no difference for shots within the margin of error for θ_{opt} (misses 26.7%; swishes 35.6%; $p>0.05$). The lower release speed and fewer shots within the margins of error for misses suggest that these shots fell short, although the shot outcome was not recorded. The likelihood of the shot being short is accentuated in that the optimal-minimum-speed estimates were determined without consideration of aerodynamics forces that overall would further shorten the shot.

With regard to the other release parameters, there were no statistical differences between misses and swishes ($p>0.05$). Backspin ranged between 0.35-1.08 Hz which is much less than the optimal 3 Hz suggested through simulations [3]. These authors acknowledged that anecdotally it is hard to generate backspin of >3 Hz without affecting the consistency of release [3]. Empirical results for the amount of backspin generated by players are lacking, even though values of up to 5 Hz are considered in simulations [1,2].

CONCLUSIONS

In this group of experienced basketball players, as misses were distinguished from swishes by a release speed below the optimal-minimum-speed value suggests these subjects should attempt to increase the release speed by about 0.1-0.2m/s. This would place the ball towards the back of the hoop, where backspin could partly compensate for too long a shot and result in a greater chance of success. This recommendation is in agreement with the findings of simulations [3].

REFERENCES

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3. Tran CM et al. *J Sports Sci*. 26(11):1147-55, 2008.

Table 1: Ball release parameters for swishes in experienced basketball players (n=15).

	Speed (m/s)		Angle (º)			Height (m)		Distance (m)		Spin (Hz)
	s_{opt}	s_b-s_{opt}*	θ_{opt}	θ_b	θ_b-θ_{opt}	h_b	y_b	d_b	x_b	ω_{spin}
Mean±SD	6.67±0.18	-0.02±0.07	49.8±1.7	50.5±4.1	0.8±3.2	2.41±0.23	0.64±0.23	0.35±0.09	3.84±0.09	0.57±0.10
Min; Max	6.31; 7.01	-0.22; 0.15	46.9; 52.6	43.2; 57.8	-5.6; 7.1	2.01; 2.80	0.25; 1.04	0.17; 0.59	3.61; 4.03	0.35; 1.08

Notes: optimal speed (s_{opt}); difference between actual and s_{opt} (s_b-s_{opt}); optimal angle (θ_{opt}); actual angle (θ_b); difference between θ_{opt} and θ_b (θ_b-θ_{opt}); height of ball (h_b); height of ball below hoop (y_b); distance in front of free throw line (d_b); distance from center of the hoop (x_b); backspin (ω_{spin}); * only statistically significant difference between swishes and misses.