THE ROLE OF LEAD-UP DRILLS IN TUMBLING

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An analysis of three commonly used lead-up drills in tumbling was undertaken to assess the validity in replicating key mechanical variables of a foundation tumble row. Six gymnasts (3 intermediate and 3 elite) were analyzed using a 12-camera Vicon analysis system operating at 250 Hz. Data were then modeled and filtered through Vicon Workstation and processed through Matlab (Version 7.0). Similarities were assumed if the difference in performance was less than one standard deviation away from the mean for variables from the tumble row. Results indicate that the corbette and set jump drills were more likely to produce mechanical variables in preparation for the "tumble row" than the round-off drill. Elite gymnasts in general displayed mechanical characteristics more related to superior performance than the intermediate gymnasts both in the drills and the "tumble row".

KEY WORDS: gymnastics, children, skill development, tumbling

INTRODUCTION: Following its introduction to the Olympic Games in 1928 women's artistic gymnastics (WAG) has rapidly evolved into one of the most popular, demanding and technically complex sports in the world. The high intensity of modern day training and the constant change to the International Gymnastics Federation (FIG) code of points has meant that progress must be related to the quality of coaching and the role biomechanics plays in allowing more advanced and original skills to be developed, whilst controlling circumstances that may lead to injury (Bruggemann, 1987). The floor exercise in artistic gymnastics is performed by both men and women with the acrobatic skills consisting of rolls, hand support elements, with and without a flight phase, and somersaults. Two or more of these acrobatic skills joined in succession are called a tumble row and this is viewed as the pinnacle of the floor exercise. A typical tumble row, onto which more difficult skills may be added, is *the round-off, back handspring, backward layout somersault.* This tumble row is compulsory for novice gymnasts, while advanced gymnasts use it to warm-up for their more complex skills. In order for gymnasts to confidently perform this high velocity tumble row, it is essential that lead-up drills focus on specific and complex components that complement skill acquisition. The round-off and corbette drills, which assist in the linking of the round-off and back handspring and the take-off for the somersault are the 3 areas commonly taught in isolation before a gymnast attempts the full tumble row. There is a paucity of research conducted into the role lead-up drills play in gymnastics. It is not known if the drills contain the necessary biomechanical properties to adequately prepare the gymnast for more complex manoeuvres. Elliott and Mitchell (1991) in studying the Yurchenko vault reported that many of the mechanical characteristics displayed in lead-up drills did not reflect the performance level required for the vault. This study investigated 3 lead-up drills; a hurdle round-off, corbette back handspring, and set jump for height, as well as the round-off, back handspring backward layout somersault tumble row. Performance by an elite sample of gymnasts was also compared with that from a group of competent state gymnasts (intermediate).

Definition of Terms:

Round-off- From a one foot take-off the hands are placed at 90° to the body and the gymnast then rotates 180° about the centre line of the body. The body then follows over the hands, landing facing the opposite direction from take-off.

Backhandspring- The gymnast jumps backwards, raising the arms above the head and at the same time "lifts" the hips to initiate rotation about the transverse axis, to land on their hands. She then pushes, with the hands both vertically and horizontally, to land on the feet.

Corbette- An essential backward movement from hand support to landing. As the gymnast lands on their hands in a round-off or back handspring, they immediately push from the ground and rotate to a standing position.

Set jump- A straight jump that is performed for height, prior to any body rotation.

METHODS: Three intermediate (mean 11.1 years) and 3 high-performance gymnasts (mean 13.5 years) participated in the study. All gymnasts were confident performing the tumble row (round-off, back handspring and backward layout somersault) and the lead-up drills (hurdle round-off, corbette back handspring, and set jump for height, - WAG Level 2 Manual). Twelve infra-red cameras operating at 250 Hz (tolerance 1.5 mm) recorded 3 successful trials of each drill and the tumble row in a laboratory environment on an Acromat sprung floor. A beat board and crashmat were used for the corbette and set jump drills. Forty-seven reflective markers were attached to each gymnast, following a warm-up and prior to data collection (Figure 1). Data were modeled to determine joint centres and filtered using a Woltring filter (MSE of 20). Trials were then prepared for post-processing in Matlab. Differences between the tumble row and drills were deemed significant if the selected variable was more than one standard deviation away from the mean recorded in the tumble row. All three tumble rows were assessed by an accredited FIG judge, who recorded the elite performers with fewer deductions (0.18) than the intermediate gymnasts (0.43).

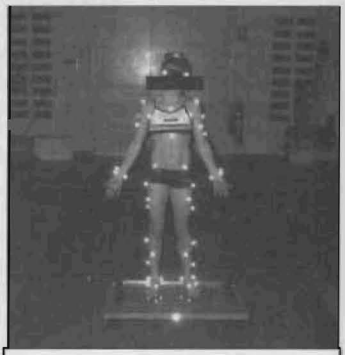

Figure 1 Gymnast with markers.

RESULTS AND DISCUSSION: The primary aim of this study was to investigate the validity of three frequently used lead-up drills in the acquisition of a foundation tumble row. In general terms vertical and horizontal take-off velocities prior to the back handspring in the tumble row were not replicated in the round-off or corbette drills (Table 1). In general terms the values for the two groups were similar.

Table 1 Vertical and horizontal take-off velocities.

	Vertical Take-off Velocity (m/s)			Horizontal Take-off Velocity (m/s)		
	Round-off	Corbette	Tumble	Round-off	Corbette	Tumble
Int (n=3)	2.7* (0.3)	2.9* (0.5)	3.7 (0.2)	1.4*	0.4*	2.2
Elite (n=3)	2.8* (0.3)	3.4 (0.1)	3.4 (0.4)	1.6 (0.2)	0.9* (0.3)	1.9 (0.5)

* Greater than 1 SD from the "tumble row" mean

Hand-support angles at the hip and shoulder joints in the corbette drill were generally similar to those recorded in the tumble. However, the corbette drill produced a more aligned trunk-thigh, for both groups (6.4°) compared with the tumble row (11.3°). As previously stated shoulder angles were similar for both the corbette drill and the tumble (136° to 135° respectively). While the hip angles were similar between groups the hand-support shoulder angle was closer to a straight line (180°) for the elite group (142.2°) compared with the intermediate performers (129.°).

Table 2 Take-off angles prior to back handspring.

	Roundoff	Corbette	Tumble
Intermediate (n=3)	50.8 (7.0)	127.0 (4.9)	124.4 (2.2)
Elite (n=3)	51.2 9 (5.3)	130.1 (2.8)	130.3 (4.8)

Vertical touchdown velocities were also similar for the set-jump and the tumble (Table 3). However, the horizontal values for the set jump were higher than those recorded for the tumble. Values were generally similar across groups.

Table 3 Vertical and horizontal touchdown velocities.

	Vertical touchdown velocity (m/s)		Horizontal touchdown velocity (m/s)	
	Set jump	Tumble	Set jump	Tumble
Int	-2.03	-2.22	2.50*	1.94
(n=3)	0.48	0.40	0.35	0.47
Elite	-2.30	-2.06	2.70*	1.83
(n=3)	0.29	0.39	0.37	0.46

* Greater than 1 SD from the "tumble row" mean

While the mean vertical velocity for the tumble (2.86 m/s) was replicated by the set jump drill (3.06 m/s), this was not the case for the horizontal velocity values that were considerably larger for the set jump (1.47 m/s) compared with the tumble (0.08 m/s) (Table 4). This may actually be advantageous as it indicates a position closer to vertical on takeoff for the layout. Again the elite performers were able to produce higher values with the greater height of the centre of mass achieved in both the set jump (0.60 v 0.54 m) and tumble (0.67 v 0.39 m).

Table 4 Vertical and horizontal take-off velocities.

	Vertical take-off velocity (m/s)		Horizontal take-off velocity (m/s)	
	Set jump	Tumble	Set jump	Tumble
Int	2.89	2.68	1.21*	-0.01
(n=3)	0.41	0.36	0.44	0.51
Elite	3.24	3.04	1.72*	0.16
(n=3)	0.19	0.31	0.41	0.17

Take-off angles of the centre of mass, in the set jump, were lower than recorded for the tumble, irrespective of performance level (Table 5). Similarly the angle at touchdown (centre of mass to feet) was less than for the intermediate but not for the high performance gymnasts (Table 6).

Table 5 Take-off angles prior to the layout in the tumble row (°).

	Set Jump	Tumble
Int	49.1*	70.5
(n=3)	(3.4)	(12.3)
Elite	52.0*	62.9
(n=3)	(3.6)	(5.7)

* Greater than 1 SD from the "tumble row" mean

Table 6 Touchdown angles prior to the layout in the tumble row (°).

	Set Jump	Tumble
Intermediate	34.9*	42.9
(n=3)	(4.6)	(5.5)
Elite	41.6	44.4
(n=3)	(7.5)	(7.9)

* Greater than 1 SD from the "tumble row" mean

CONCLUSION: In general, it can be concluded that if used in conjunction with other variations, the lead-up drills, with the exception of the round-off drill are valid in replicating some key variables measured in the tumble. There were also observed similarities between the female gymnasts analysed in this study when compared with an elite male performance analysed by Yeadon and King (2002).

The round-off drill was not successful in replicating take-off variables present in the tumble. The corbette drill was successful in replicating shoulder and hip angles recorded in the tumble row in all participants, and as ability increased takeoff angle and vertical velocity of the centre of mass were also similar. The set jump produced varied results, with takeoff duration, maximum height achieved and vertical touchdown velocity were similar to variables measured in the tumble. However, the horizontal touchdown velocity was higher in the set jump drill than the tumble.

The round-off drill produced similarities between all groups for takeoff angle, and horizontal takeoff velocity. The takeoff characteristics of the corbette drill were similar between intermediate and elite performers. Hand support angles demonstrated similar hip and greater shoulder angles than were recorded for the elite gymnasts. The set jump produced varied results when participants were compared.

When performance of the tumble row was compared to identify mechanical variables, elite gymnasts demonstrate a greater horizontal velocity and angle on takeoff prior to the back handspring, a greater shoulder angle in handsuport, and greater vertical takeoff velocity prior to the layout somersault, resulting in a greater height of centre of mass in the layout. Therefore, it may be concluded that these variables are linked to successful performance of the tumble row. Furthermore, it highlights the importance of all aspects of the tumble row in contributing to the flight phase, not just touchdown and takeoff characteristics.

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