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EFFECT OF HAND PLACEMENT POSITION ON PRESS-TO-HANDSTAND TECHNIQUES AND STABILITY

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Considerable variations in hand placement positions are seen among gymnasts when executing a press-to-handstand. The purpose of this study was to investigate the effect of hand placement position on press-to-handstand techniques and stability. Three male gymnasts performed two press-to-handstands in different hand positions (fingers pointing forward and outward) on a force platform. Postural sway variables were measured to assess stability. Video recordings were taken to obtain temporal and kinematic measurements. Results showed pressing to handstand in fingers outward position was characterised by less postural sway, less extended body alignment and a more under-rotated handstand orientation. These can be seen strategies to adjust the centre of mass towards a more anterior position to avoid over-rotation.

KEY WORDS: gymnastics, centre of pressure, kinematic.

INTRODUCTION: The press-to-handstand (Figure 1) is an important skill in gymnastics. It is often used as a hold element in routines on floor execise, rings, parallel bars and balance beam. Gymnasts must hold the handstand in good body posture for at least 2 s; otherwise points will be deducted (Federation International de Gymnastique, 2009). While the hand placement position is not judged, considerable variations are seen from a typical pronated radio-ulnar joint position with the fingers pointing directly forward to a more supinated position with the fingers pointing outwards (Uzunov, 2008). Although it is easier to balance the handstand in the fingers forward position, many gymnasts use other hand placement positions. This may be related to the characteristics of the apparatus (e.g. parallel bars), preparation for more advanced skills (e.g. wide arm or Japanese handstand) and/or personal preference. Using the fingers outward position can reduce the amount of hyper-extension at the wrist and this may help to reduce wrist stress, discomfort and pain. Thus, most gymnasts will use the fingers outward position when pressing to handstand from a straddled support lever and a support lever which require more forward lean at the shoulder.

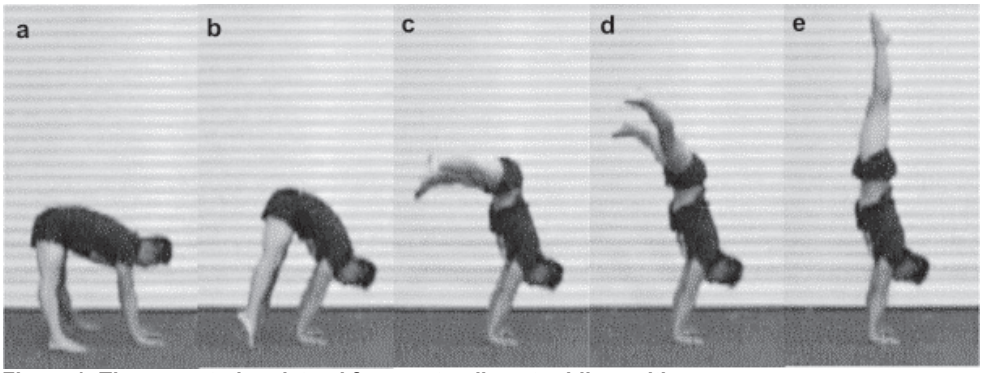

Figure 1: The press-to-handstand from a standing straddle position.

One study investigated the joint kinematics and kinetics of the press-to-handstand using a biomechanical model (Prassas, 1988). To our knowledge, there is no published information

on how different hand placement positions can influence the biomechanics of the press-to-handstand. The present study, therefore, aimed to examine the effect of hand placement position on press-to-handstand techniques and stability.

METHODS: Three male gymnasts from the Singapore national team (mean (SD) age = 20.5 (4.7) yrs, height = 1.68(0.05) m, mass = 62.4 (4.6) kg, years of training = 8.0 (0.8) yrs) participated in this study. Written informed consent was obtained from the subjects and/or their parents. Each subject performed one successful execution of a press-to-handstand from a standing straddle position (Figure 1) in two hand positions: 1) *fingers pointing forward* and 2) *fingers pointing outward* (90° supination from the fingers forward position). The order of execution was randomised. A trial was considered successful when the subject held the handstand position in a straight body position steadily for at least 3 seconds and this was determined by a national gymnastic coach. All press-to-handstands were performed on a force platform (Kistler 9287BA) located in the laboratory. Data were collected using the BioWare software sampling at 50 Hz. Data were analysed for 8 seconds once the vertical ground reaction force exceeded 60% of the subject's body weight. Centre of pressure (COP) range in the anteroposterior and mediolateral directions, together with the total distance travelled, were used to indicate stability.
Video recordings were taken of each gymnast executing the press-to-handstands from the frontal and sagittal views using two camcorders (Sony DSR-PD170P) operating at 50Hz. Four body landmarks (wrist, shoulder, hip and ankle joint centres) were manually digitised to form a three-segment model. The hip, shoulder and torso to horizontal angles were measured using the *Dartfish Video Analysis Software* (Figure 2). Angles at two key positions were used for analysis: 1) when the legs were in a horizontal position parallel to the ground (Figure 1c), and 2) when the handstand was held in a steady state (Figure 1e). Three temporal variables were also obtained from the video recordings: 1) *toes off ground to legs horizontal*, 2) *legs horizontal to legs first together*, and 3) *toes off ground to legs first together*. All angles and temporal variables were determined twice by the same investigator on separate days and the average value of the two measurements was used.

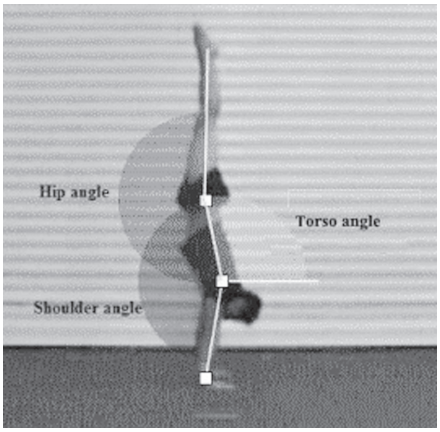

Figure 2: A 3-segment model was used to calculate the hip, shoulder and torso to horizontal angles during the press-to-handstand.

RESULTS: All three gymnasts consistently displayed more postural sway in the anteroposterior direction and increased total COP distance travelled when performing the press-to-handstand in the fingers forward position (Table 1). At the legs horizontal position (Figure 1c), the fingers forward position was characterised by a smaller hip angle, greater shoulder angle and smaller torso to horizontal angle (Table 2). In the steady handstand position, the hip was more extended in the fingers forward position (Table 3). The shoulder

and torso angles during the handstand were similar regardless of hand placement position for both subjects 2 and 3. Subject 1, however, demonstrated approximately 20° reduction in shoulder angle (less straight body alignment) and 10° increase in torso angle (more deviation from the vertical line) when using the fingers outward position. All subjects raised their legs from the toe-off to the horizontal position faster when using the fingers outward position (Table 4). No consistent trend was seen in the time from the legs horizontal to the legs together positions.

Table 1
Postural Sway of the Press-to-handstand in Fingers Forward and Outward Positions

Subject	Anteroposterior range (mm)		Mediolateral range (mm)		Total distance (mm)	
	Forward	Outward	Forward	Outward	Forward	Outward
1	56	45	90	59	1104	781
2	75	55	45	88	1540	1400
3	71	55	45	58	1063	992
Mean	67	52	60	68	1235	1058
SD	10	6	26	17	264	314
Difference*	-15		8		-177	

*Difference = outward position – forward position

Table 2
Kinematic Comparison of the Legs Horizontal Position Between Fingers Forward and Outward Positions

Subject	Hip angle (°)		Shoulder angle (°)		Torso angle (°)	
	Forward	Outward	Forward	Outward	Forward	Outward
1	103	108	158	145	100	106
2	101	110	158	149	96	103
3	107	112	144	144	104	106
Mean	103	108	158	145	100	106
SD	101	110	158	149	96	103
Difference*	7		-7		5	

*Difference = outward position – forward position

Table 3
Kinematic Comparison of the Steady Handstand Position Between Fingers Forward and Outward Positions

Subject	Hip angle (°)		Shoulder angle (°)		Torso angle (°)	
	Forward	Outward	Forward	Outward	Forward	Outward
1	211	196	167	148	98	109
2	204	200	166	164	100	101
3	195	185	154	156	104	104
Mean	204	194	162	156	101	105
SD	8	8	7	8	3	4
Difference*	-10		-6		4	

*Difference = outward position – forward position

Table 4
Temporal Variables of the Press-to-handstand in Fingers Forward and Outward Positions

Subject	Toe-off to legs horizontal (s)		Horizontal to legs together (s)		Toe-off to legs together (s)	
	Forward	Outward	Forward	Outward	Forward	Outward
1	2.02	1.93	0.91	0.96	2.93	2.89
2	1.24	0.81	2.39	2.12	3.63	2.93
3	3.04	2.22	3.13	4.92	6.17	7.14
Mean	2.10	1.65	2.14	2.67	4.24	4.32
SD	0.90	0.74	1.13	2.04	1.70	2.44
Difference*	-0.45		0.52		0.08	

*Difference = outward position – forward position

DISCUSSION: Increased postural sway was seen when performing the press-to-handstand with fingers pointing forward as compared to when it was performed with fingers pointing outward. This suggests that the fingers forward position provides a greater base of support, thereby allowing a wider window for the centre of mass (CM) of the gymnast to fluctuate while still maintaining balance. In the fingers forward position, gymnasts can apply wrist flexion torque to counter slight over-rotation (Kerwin & Trewartha, 2001) but this correction strategy is no longer effective when the fingers are turned outward. Thus, the gymnast needs to adjust their CM towards a more anterior position to avoid the risk of over-rotation. During the upward phase of the press-to-handstand, there was less forward lean of the torso in the fingers outward position. This can be seen as a strategy to avoid over-rotation which otherwise cannot be counteracted by wrist flexion torque. Similarly, at the steady handstand position, subjects were in a less straight body alignment and slightly short to the vertical (under-rotated) when the fingers were turned outward.

It has been shown that wrist torque played a dominant role, followed by shoulder torque, to maintain balance in the anteroposterior direction during a handstand (Kerwin & Trewartha, 2001). When the use of wrist torque is limited as in the fingers outward position, increased shoulder torque is needed to regulate the CM position. Since a large shoulder torque is required during the upward phase of the press-to-handstand (Prassas, 1988), muscular strength may be a limiting factor to whether a gymnast can execute the skill in a fingers outward position. One limitation of this study was that a single trial per condition was used for each subject. This may be a potential source of error arising from intra-subject variability.

CONCLUSION: Performing a press-to-handstand in a fingers forward position is easier as it allows more minor postural sway while still maintaining balance. Adopting a fingers outward position is more demanding as the gymnast needs to maintain the CM within a narrower window in a more under-rotated position.

REFERENCES:

Federation International de Gymnastique (2009). Men's Technical Committee Code of Points.

Kerwin, D.G. & Trewartha, G. (2001). Strategies for maintaining a handstand in the anterior-posterior direction. *Medicine and Science in Sports and Exercise*, 33, 1182–1188.

Prassa, S.G. (1988). Biomechanical model of the press handstand in gymnastics. *International Journal of Sport Biomechanics*, 4, 326-341.

Uzunov, V. (2008). The handstand: a four stage training model. *Gym Coach*, 2, 52-59.

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