EFFECTS OF MOVIE OBSERVATION AND MOTOR IMAGERY ON PERFORMANCE AND JOINT KINETICS DURING TAKE-OFF IN DROP JUMP

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The aim of this study was to investigate the effects of movie observation and motor imagery intervention during the pre-set phase (prior to jumping off the platform), on drop jump (DJ) performance and the variables of lower leg kinetics. Three male jumpers performed the DJ under three different conditions (Normal, Movie, and Imagery) from a drop height of 0.3 m. The performance variables and joint kinetics were measured. The DJ performance tended to improve with the intervention of movie and imagery condition. Moreover, the negative ankle joint and positive hip joint kinetics variables (power and work) tended to improve with the intervention of movie and imagery condition. Therefore, it was suggested that movie observation and motor imagery intervention could improve DJ performance and the force exerted by lower leg, which affects performance.

KEY WORDS: DJ-index, pre-set phase, plyometric training, joint kinetics

INTRODUCTION: Drop Jump (DJ) is used not only as a plyometric training method to improve explosive power in several types of sports, but also as a method to evaluate explosive power using the DJ-index (jump height/contact time; Zushi, Takamatsu, & Kotoh, 1993). From our previous studies we have clarified that the state of the brain during the pre-set phase prior to jumping off the platform influences the physiological and mechanical factors during the take-off, and thus, the performance of the DJ (Yoshida, Maruyama, Kariyama, Hayashi, & Zushi, 2016a; Yoshida, Naka, Kariyama, Hayashi, Takahashi, Zushi, & Zushi, 2016b). The results showed the importance of selective disinhibition of the brain areas associated with the agonist muscles during the pre-set phase for higher DJ performance. In addition, it implies that disinhibition of the brain areas during the pre-set phase affects the facilitation of the stretch reflex during the take-off phase, which results in increased force development of the ankle joint during the take-off phase. On the other hand, movie observation and motor imagery are used as a means for improving exercise performance, using the desired exercise. In a previous study, Bergmann, Kumpulainen, Avela, & Gruber (2013) reported that intervening motor imagery at a different time than the jump attempt improved DJ-index, maximum ground reaction force, and muscle activity of agonist muscles in DJ. Battaglia, D'Artibale, Fiorilli, Piazza, Tsopani, Giombini, Calcagno, & di Cagno (2014) also reported that incorporating movies and motor imagery into long-term plyometric training improved jump height and ground contact time in DJ. These reports indicate that movie observation and motor imagery interventions may improve DJ performance and the exertion of force at the three lower leg joints that comprise it. However, these findings were based on the intervention of movie observation and motor imagery at a different time from the daily training and measurement trials. In light of our findings presented above, it is possible that movie observation and motor imagery interventions during the phase just prior to jumping from the platform may immediately improve DJ performance and the exertion of the three lower extremity joints that comprise it. Therefore, we investigated the effects of video observation and motor imagery intervention during the pre-set phase on DJ performance and the variables of lower leg kinetics.

METHODS: We evaluated three male jumpers (Mean ± SD of age, 22.33 ± 2.30 years; height, 1.81 ± 0.53 m; mass, 69.67 ± 2.52 kg). This study was approved by the Ethics Committee of the Institute of Health and Sport Sciences, University of Tsukuba, Japan. The participants performed DJ in three conditions (Normal, Movie, and Imagery condition) from a drop height of 0.3 m. We have given instructions to jump as high as possible with the shortest possible ground contact time in all conditions.The normal condition (Normal) was to perform DJ without intervention during the pre-set phase. The movie condition (Movie) was that DJ was performed after watching the movie of the drop jump projected on a large screen installed in front of the subject during the 24-second pre-set phase. The imagery condition (Imagery) was that DJ was performed after imagining a high jump in a short time during the pre-set phase for 24 seconds. The 24 second pre-set phase was set with reference to previous studies (Yoshida et al., 2016ab). In both conditions, participants were verbally instructed to shorten ground contact time as much as possible and to jump as high as possible. Three-dimensional coordinates of the 12 retroreflective markers (left and right toes, heel, external capsule, fibular head, greater trochanter, and acromion protrusion) fixed on each subject's body were obtained using a Vicon T20 system (Vicon Motion Systems Ltd.) with 10 cameras operating at 250 Hz. Ground reaction force was measured by a force platform at a rate of 1000 Hz. Performance variables (DJ-index, contact time and jump height) and joint kinetics (joint torque, power, and work) of the lower leg (hip, knee, and ankle joints of take-off leg) were calculated by using inverse dynamics. The ankle joints were analyzed for plantar flexion/dorsiflexion, and the knee and hip joints were analyzed for extension/flexion. Joint kinetics were divided into the first half and second half of take-off based on the lowest point of the center of gravity. All analyses were done on the side of the take-off leg. In this study, since there were only 3 participants, we compared the mean, relative, and individual values between the conditions to compare the measured values.

RESULTS: The results of the DJ performance variables are shown in Table 1. The DJ performance showed an increase on the DJ-index and jump height in the movie and image condition compared to the normal condition. Additionally, the contact time was reduced in the movie and image compared to normal. The results of joint power during take-off phase on DJ are shown in Table 2. The results of joint work during the take-off phase on DJ are shown in Table 3. As a result, the negative ankle joint power and work, hip joint power and work showed an increased tendency in the movie and image compared to normal.

Table 1 Performance variables on the DJ in each condition.

	Sub.	DJ-index (ms)	Jump height (cm)	Contact time (s)
Normal	A	2.54	40.70	0.16
	B	2.30	39.50	0.17
	C	2.24	43.00	0.19
	Mean	**2.36**	**41.07**	**0.17**
	SD	0.16	1.78	0.02
Movie	A	2.41	39.50	0.16
	B	2.55	41.80	0.16
	C	2.73	44.70	0.16
	Mean	**2.56**	**42.00**	**0.16**
	SD	0.16	2.61	0.00
	Movie/Normal (%)	**108.60**	**102.27**	**93.89**
Imagery	A	2.38	39.00	0.16
	B	2.66	43.50	0.16
	C	2.58	42.40	0.16
	Mean	**2.54**	**41.63**	**0.16**
	SD	0.14	2.35	0.00
	Image/Normal (%)	**107.60**	**101.38**	**93.89**

DISCUSSION: The DJ-index, jump height, and contact time tended to improve with the intervention of movie observation and motor imagery (Table 1). Previous studies have reported that motor imagery interventions timed differently from jump trials improved the DJ-index, although the imagery interventions timed differently from jump trials improved the DJ-index, although the contact time and jump height on DJ were not significant (Bergmann et al., 2013).

Table 2 Joint power on the DJ in each condition.

		Negative joint power (W/kg)			Positive joint power (W/kg)		
	Sub.	Ankle	Knee	Hip	Ankle	Knee	Hip
Normal	A	-41.28	-25.63	-10.67	19.94	26.55	13.13
	B	-29.88	-35.39	-7.37	22.98	25.51	4.19
	C	-22.07	-19.12	-3.21	20.57	19.47	9.70
	Mean	**-31.08**	**-26.71**	**-7.08**	**21.16**	**23.84**	**9.01**
	SD	9.66	8.19	3.74	1.60	3.82	4.51
Movie	A	-31.66	-21.31	-5.92	17.48	22.63	8.17
	B	-39.24	-37.01	-12.93	23.53	27.98	12.71
	C	-26.74	-33.26	-3.82	29.33	19.05	8.37
	Mean	**-32.55**	**-30.53**	**-7.56**	**23.45**	**23.22**	**9.75**
	SD	6.30	8.20	4.77	5.93	4.49	2.56
	Movie/Normal (%)	**104.73**	**114.27**	**106.69**	**110.78**	**97.39**	**108.22**
Imagery	A	-36.47	-22.04	-6.95	20.30	25.60	10.15
	B	-35.67	-29.80	-2.58	25.62	27.18	11.66
	C	-31.38	-25.54	-2.58	23.95	17.65	5.52
	Mean	**-34.51**	**-25.79**	**-4.04**	**23.29**	**23.47**	**9.11**
	SD	2.74	3.89	2.52	2.72	5.10	3.20
	Image/Normal (%)	**111.04**	**96.55**	**56.98**	**110.05**	**98.45**	**101.15**

Table 3 Joint work on the DJ in each condition.

		Negative joint work (J/kg)			Positive joint work (J/kg)		
	Sub.	Ankle	Knee	Hip	Ankle	Knee	Hip
Normal	A	-1.23	-0.61	-0.02	1.33	1.03	0.27
	B	-1.03	-0.63	-0.04	1.44	1.21	0.11
	C	-0.75	-0.67	-0.08	1.25	0.88	0.33
	Mean	**-1.00**	**-0.64**	**-0.05**	**1.34**	**1.04**	**0.24**
	SD	0.24	0.03	0.03	0.10	0.17	0.11
Movie	A	-1.02	-0.59	-0.02	1.25	1.04	0.15
	B	-1.18	-0.65	-0.05	1.45	1.18	0.39
	C	-0.90	-0.65	-0.04	1.57	0.93	0.22
	Mean	**-1.03**	**-0.63**	**-0.03**	**1.42**	**1.05**	**0.25**
	SD	0.14	0.04	0.02	0.16	0.12	0.12
	Movie/Normal (%)	**103.04**	**99.17**	**75.10**	**106.07**	**101.14**	**106.85**
Imagery	A	-1.16	-0.44	-0.01	1.38	0.95	0.25
	B	-1.12	-0.78	-0.02	1.54	1.21	0.31
	C	-0.91	-0.57	-0.01	1.34	0.76	0.26
	Mean	**-1.06**	**-0.59**	**-0.02**	**1.42**	**0.97**	**0.28**
	SD	0.13	0.17	0.01	0.11	0.22	0.03
	Image/Normal (%)	**105.88**	**93.53**	**33.25**	**105.59**	**93.60**	**116.04**

No significant relationship was found between jump height and contact time in DJ, indicating that it is an independent variable (Zushi & Takamatsu, 1995). Therefore, it is possible that movie observation and motor imagery intervention during the pre-set phase had an immediate effect on factors affecting DJ contact time.

Next, we compared the kinetics of the three lower leg joints during the take-off phase in each condition, and found that the negative ankle joint power and negative hip joint power tended to improve with the intervention of movie observation and motor imagery (Table 2). Moreover, the joint work showed a similar tendency (Table 3). So far, it has been reported that the bounce-type drop jump, with higher jumps and a short contact time, exerts the greatest force on the ankle joint (Bobbert, Huijing, & Van Ingen Schenau, 1987), and affects the reduction of contact time. Additionally, it has also been suggested that increased hip work may lead to longer contact times, while affecting increased jump height (Zushi, Kariyama, Yoshida, Kigoshi, & Ogata, 2020). Furthermore, in a longitudinal investigation of rebound jump similar to DJ, it is suggested that the increase in hip joint work in combination with the increase in ankle power and work during take-off causes an increase in jump height and a reduction in contact time (Zushi et al., 2020). Therefore, movie observation and motor imagery intervention may immediately improve the ability of the ankle and hip joints to exert force, which affects jump height and contact time on the DJ. However, the limitation of our study is that the number of subjects in this study was small. Therefore, a detailed statistical analysis with a large number of subjects should be conducted in future studies.

CONCLUSION: The purpose of this study was to the investigate the effects of movie observation and motor imagery intervention during the pre-set phase on DJ performance and lower leg kinetics. As a result, DJ performance showed an increased tendency on the DJ-index in movie and imagery condition compared with normal condition. In addition, the contact time was reduced tendency in movie and imagery condition compared with normal condition. In joint kinetics, the negative ankle joint power and positive hip joint power showed an increased tendency in movie and image condition compared with normal condition. Moreover, the joint work showed a similar tendency. The results suggest that video observation and motor imagery interventions may improve DJ performance and improved lower leg joints to exert force, which affects shortening of contact time.

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