

Investigation of the relationship between posture and hip joint reaction force during jogging

Research on the possibility of high-impact exercise after total hip arthroplasty

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INTRODUCTION: With regard to exercise for patients who have undergone total hip arthroplasty (THA), high-impact and high-load exercises have been reported to increase the risk of mechanical failure of the artificial hip joint. In particular, jogging is not recommended for patients who have undergone THA. Meanwhile, activities such as walking, swimming, and tennis, which place less stress on the hip joint, are recommended as they effectively restore physical ability. However, patients who have undergone THA often express a desire to continue exercising at the same level as before surgery. Therefore, exercises that are more satisfying than walking and place less stress on the hip joint need to be explored. Previous studies have reported a relationship between hip joint reaction force and walking posture. The present study aimed to investigate the relationship between jogging posture and the hip joint reaction force.

METHODS: This study involved 10 healthy adult males (average age: 21.8 years [standard deviation: 0.98]) with no history of lower limb surgery. Movement was measured using a 3D motion analysis device (Vicon). The hip joint reaction force was estimated for three motions: walking and two types of jogging with different stance widths. For walking, the participants were instructed to proceed in a forward direction only. There were two types of jogging: jogging 1 (participants were instructed to move forward only) and jogging 2 (participants were instructed to move forward while keeping their feet shoulder-width apart). Each movement was measured twice. The hip joint reaction forces during walking and jogging were estimated using a musculoskeletal simulation software. In this study, comparisons were made using the ratio of the maximum hip joint reaction force to body weight (peak BW) to compare the peak hip joint reaction force values of subjects with different body weights. The Wilcoxon signed-rank test was used to compare the peak BW and movement speed of jog1 and jog2.

RESULTS: The maximum hip joint reaction force and average speed for each movement are shown in Table 1. The mean ± standard deviation values of peak BW were 4.40 ± 0.48 for walking, 6.90 ± 0.84 for jogging 1, and 6.26 ± 0.98 for jogging 2. Statistically significant differences were observed between each movement (p < 0.05). The changes in the hip joint reaction force during the stance phase of each movement are shown in Figure 1.

DISCUSSION: The hip joint reaction force decreased with increasing stance width. Previous studies have reported that the hip joint reaction force increases with increasing speed. However, in the present study, there was no difference in speed between jogging 1 and jogging 2. This was thought to be because widening the stance width moved the center of gravity closer to the hip joint center on the stance side, thereby reducing the abductor muscle force that generates abduction moment and decreasing the hip joint reaction force. For patients who want to engage in the same level of exercise as before surgery, jogging with a modified running style may be suggested.

SIGNIFICANCE/CLINICAL RELEVANCE: A significant difference was observed between jogging 1 and jogging 2. Widening the stance width could reduce the hip joint reaction force.

Table 1. Maximum hip joint reaction force and average speed for each movement

	Gait		Jog1		Jog2		b / a	c / a
	Peak BW (a)	Speed [%]	Peak BW (b)	Speed [%]	Peak BW (c)	Speed [%]		
sub1	5.13	1.17	5.52	1.9	5.31	1.81	1.08	1.04
sub2	3.94	0.99	7.2	1.46	6.45	1.65	1.83	1.64
sub3	5.42	1.07	7.25	1.56	8.59	1.56	1.34	1.59
sub4	4	1.15	7.34	1.91	5.67	1.89	1.83	1.42
sub5	4.57	1.45	8.31	2.27	5.92	2.17	1.82	1.3
sub6	4.37	1.15	5.52	2.22	4.97	2.3	1.26	1.14
sub7	4.13	1.16	6.38	1.87	6.36	1.75	1.54	1.54
sub8	4.32	1.3	7.2	1.8	7.25	1.84	1.67	1.68
sub9	3.96	1.12	7.59	1.91	6.19	1.85	1.92	1.56
sub10	4.21	1.4	6.71	2.1	5.93	2.1	1.6	1.41
AVE	4.4	1.2	6.9	1.9	6.26	1.89	1.59	1.43
(SD)	-0.48	-0.14	-0.84	-0.25	-0.98	-0.22	-0.27	-0.21

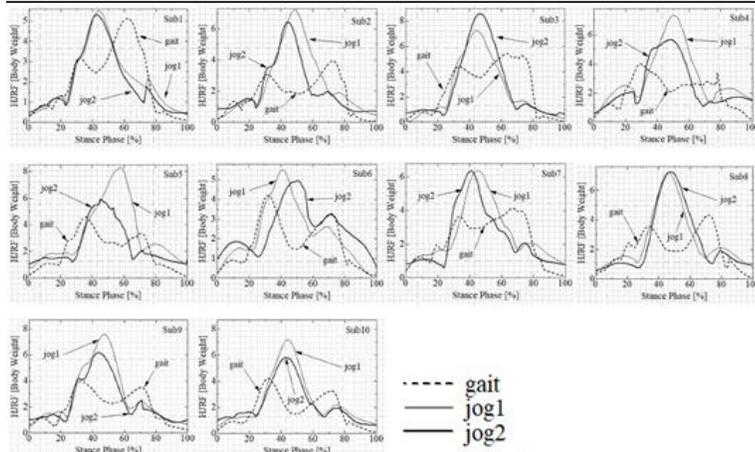


Figure 1. Hip joint reaction force during the stance phase of each movement