THE KINEMATIC ANALYSIS OF THE LUMBAR, LUMBOSACRAL, AND HIP JOINTS IN THE DOLPHIN KICK SWIMMING

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INTRODUCTION: The dolphin kick movement is commonly used in swimming. The low back pain (LBP) while using the dolphin kick motion is complained by many swimmers and that greatly influences their performance. Cailliet (1968) stated that LBP is caused by kinematic problems in the lumbar, the hip joint and the pelvis. Thus, the kinematic analysis that was included includes the pelvis, the hip joint as well as the lumber vertebrae was necessary for the prevention of the LBP. However, underwater analysis of the dolphin kick was not enough to explain the injury mechanism. Therefore the purpose of this study was the kinematic analysis of the lumbar, the lumbosacral, and the hip joints in the dolphin kick.

METHOD: Fifteen healthy male competitive swimmers were recruited for this study. The average age (± SD) was 20.0(±1.2) years old. The cone-shaped makers were affixed on the spinous process of C7, L1, L3, L5, S1, iliac crest (IC), and greater trochanter of femur (GT), lateral epicondyle of the femur (LE). The dolphin kick motion on the saggital plane was captured by a digital video camera. A 2D-motion analysis was performed to obtain the lumbar, lumbosacral, and hip joint angles during the motion. The trunk angle was calculated by the markers on C7, GT, and LE. The lumbar angle was calculated by the markers on L1, L3, and L5. The lumbosacral angle was calculated by the markers on L3, L5, S1, and IC. The hip angle was calculated by the markers on IC, GT, and LE. Each angle was measured at the trunk maximum extension and flexion. The degrees of each angle were compared. Fischer's multiple comparison was used for statistic analysis and significance level was less than 5%. This study was approved by the ethic screening committee of Hiroshima University graduate school of health sciences.

RESULTS: The results were showed on table 1. The motion of the hip joint was bigger than the lumbar motion at the trunk flexion. The motion of the hip joint and the lumbosacral joint were bigger than the lumbar motion at the trunk extension.

Table 1 the several angle when dolphin kick

	Trunk	Lumbar	Lumbosacral	Hip
Trunk flexion	23.0 ± 9.2	4.7 ± 7.1	6.5 ± 13.3	18.6 ± 9.6
Trunk extension	27.1 ± 7.5	4.3 ± 10.0	12.3 ± 15.5	14.1 ± 7.3

DISCUSSION: These results suggest the strong stress was applied at lumbosacral part. Kanaoka *et al.* (2007) reported the intervertebral disk degeneration at L5-S1 occurred twice as much as at L4-L5 in swimmers. This result agreed with the current study. But, the stress which cause LBP may be difficult to speak only by kinematic analysis. Consequently, further biomechanics studies are needed in swimmers.

CONCLUSION: The dolphin kick was analyzed from the kinematic viewpoint at the lumbar, the pelvic, and hip joint motion in this study. The motion of the hip joint was bigger than the lumbar motion at the trunk flexion. The motion of the hip joint and the lumbosacral joint were bigger than the lumbar motion at the trunk extension.

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