THE EFFECT OF STANCE WIDTH AND ANGLE ON THE ROTATIONAL RANGE OF MOTION OF PELVIS AND TRUNK

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[Background] In golf, snowboarding, etc., the distance between both feet (stance width), the angle of the foot (stance angle) are considered as an important factor for its performance. Those position of the legs (stance) are the empirically coached in the sports field. The purpose of this study was to investigate the influence of stance width and angles on the trunk range of motion and the laterality of the load. [Methods] Eleven healthy males participated as subjects in this study. To measure the maximum trunk rotational range of motion in the posture in which the standing to straightened the leg. In the experimental setting, the stance width was set to 42cm, 52cm wide and the stance angle was varied 5 conditions; the central angle (0deg), the central angle±15deg and ±30deg. The central angle was defined as the average of the maximum internal- and external-rotation of hip joint in a static standing. Measurement was used an optical motion capture and the force plate, including 12 units infrared camera. The local coordinate systems were set in the spine (T1, T4, T7, and L1)[1)]. [Result] In the stance angle -30deg, the rotational range of motion of the pelvis and trunk decreased significantly in the stance width 42cm compared to the stance angle 0deg. Effect due to the difference in the stance was not observed. SI (Symmetry Index) of the load increased on the rotation side in accordance with the stance angle increased. The load on the leg of the rotational side in the stance angle +30deg was significantly greater than that in the stance angle -30deg. [Conclusion] It was suggested that the difference in the stance angle changed the trunk rotational range of motion in a static standing.

KEY WORDS: stance angle, stance width, rotational range of motion

INTRODUCTION: In golf, snowboarding, etc., the distance between both feet (stance width), the angle of the foot (stance angle) are considered as an important factor for its performance. The position of the legs (stance) have been empirically coached in the field of sports. There were few reports that examined the relationship between the joint angle in lower limbs and the range of motion of trunk. The purpose of this study was to investigate the influence of stance width and angles on the range of motion of trunk and the laterality of the load on the limbs.

METHODS: Eleven healthy males participated as subjects in this study (age: 21.5 ± 1.7 years old, height: 171.3 ± 6.5cm, weight: 65.4 ± 9.1kg; mean ± SD). To measure the maximum trunk rotational range of motion in the posture in which the standing to straightened the leg. In the experimental setting, the stance width was set to 42cm, 52cm wide and the stance angle was varied 5 conditions; the central angle (0deg), the central angle±15deg and ±30deg. The central angle was measured with the STANCER (gyro Technology Co., Ltd.), to determine the average value of the maximum internal- and external- rotation for each leg in the stance width 42cm and 52cm. The conditions of the stance angle (-30deg, -15deg, 0deg (the central angle), +15deg, +30deg) was set randomly in each stance width. Measurement was used an optical motion capture (MAC3D, Motion Analysis Corp., USA, 12 infrared cameras, sampling Freq. 100Hz) and the two force plate (BP6001200, AMTI Inc., sampling Freq. 1kHz, USA). The reflective markers were attached on the subject as follows. Spinous process of the spine (T1, T4 is, T7, and L1) was set up three markers in the triangle that has as a vertex[1)]. Then the trunk was divided into four segments those had the local coordinate system (Fig.1). Other markers were attached to the bony landmarks according to the Helen Hayes marker set (Fig.1). The subject's feet were fixed on the self-made rotation tables that was able to set the rotational angle arbitrarily. Measurement data was analyzed using the Visual3D (C-Motion, Inc., USA). The analysis parameters were the ground reaction force, range of motion of each segment in the trunk (T1, T4, T7, and L1), the range of motion of the pelvis rotational angle. Those angles were obtained relative to the global coordinate system. The symmetry index (SI) of the load between the left and right limb was calculated by the following equation;

$$SI = \frac{GRF_R - GRF_L}{0.5(GRF_R + GRF_L)} \times 100\ (\%)$$

where, GRF_R and GRF_L are vertical components of the ground reaction force acted on the right and left foot, respectively.

In the statistical processing, One-way analysis of variance (ANOVA) was used to compare means among conditions. Post hoc analyses were performed with the multiple comparisons test when the F ratio for the ANOVA was significant at $p<.05$.

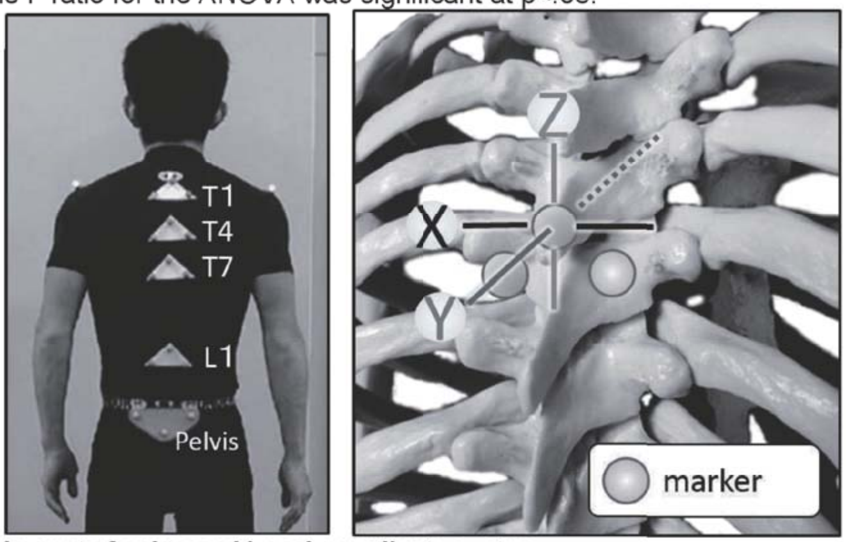

Figure 1 Marker set of spine and Local coordinate system

RESULTS: In the stance angle of -30deg, the rotational range of motion of the pelvis and trunk decreased significantly compared to the central angle (0deg) in the condition of the stance width 42cm (Fig.2, 3). The effect due to the difference in stance width was not observed. The SI increased on the leg of rotational side in accordance with the stance angle increases. The SI in the condition of +30deg was significantly greater than that in the condition of -30deg (Fig.4, 5).

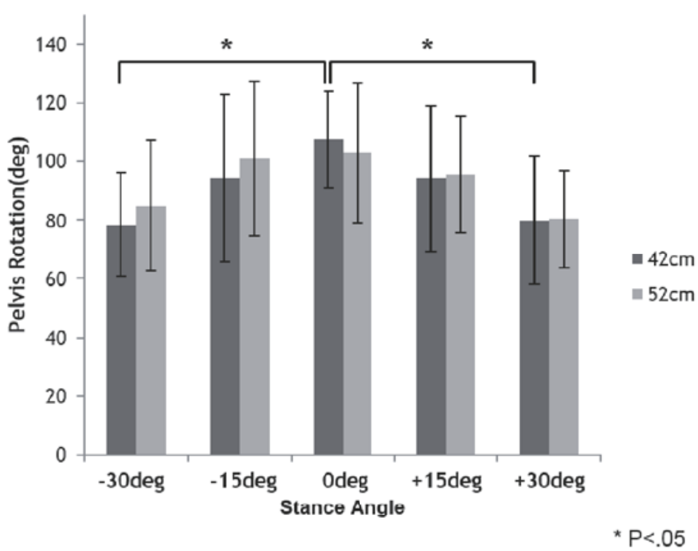

Figure 2: Rotation range of motion of the pelvis

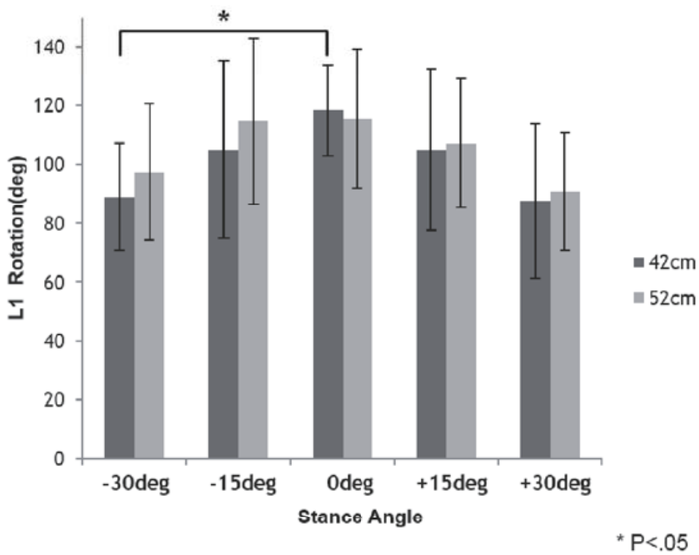

Figure 3: Rotation range of motion of the L1

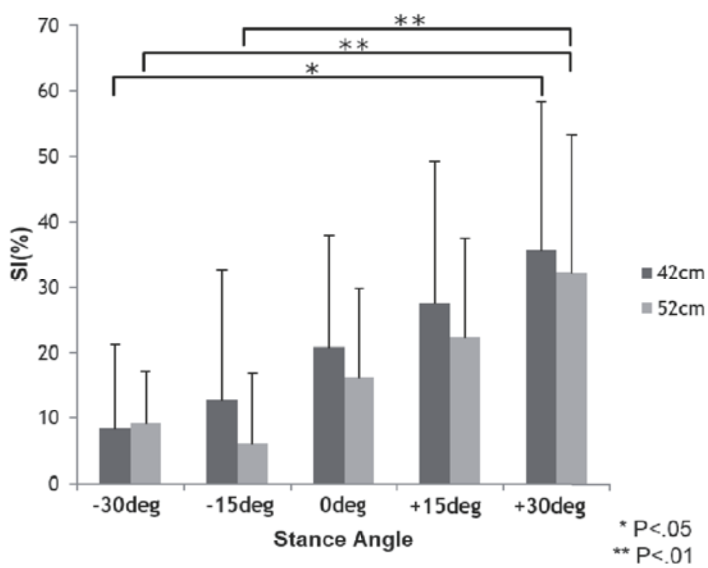

Figure 4: SI in trunk right rotation

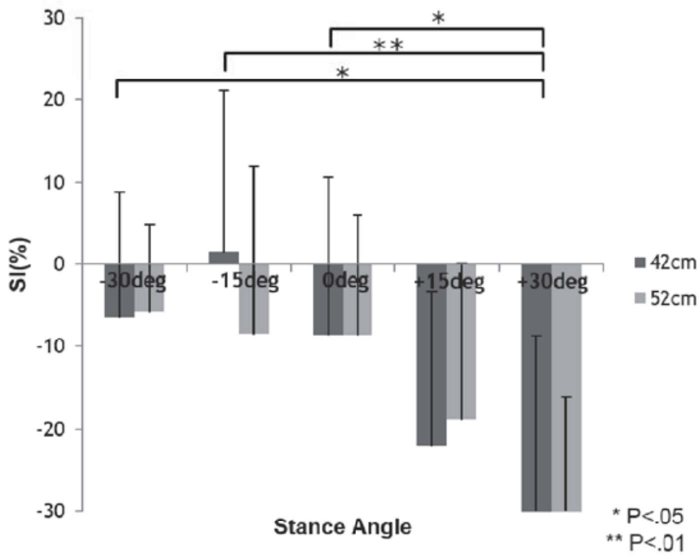

Figure 5: SI in trunk left rotation

DISCUSSION: It is suggested that the stance angle had an influence on the rotational range of motion of the pelvis and trunk (Fig.2, 3). On the other hand, the stance width had little effect on the rotation of the trunk. The rotational range of motion of the trunk and pelvis showed the largest value on the condition of the central angle. By the difference in the 15 degrees of the stance angle, the range of the motion of the trunk was changed about 13-20%. Sato et al. (2008) reported that the hip flexion angle decreased significantly in conjunction with increasing the hip internal-rotation angle[2)]. Neumann (2012) stated that the rotation of pelvis involved the pelvis's antero-posterior gradient[3)]. In the standing position, when the pelvis is tilted anterior and posterior, the hip joint is flexion and extension. Hip flexion and extension range of motion due to the difference in the hip rotation was considered that there has been an effect to the pelvis rotation. Change of hip flexion-extension range of motion by the hip rotation was considered to have an effect on the pelvis rotation. The changes in the range of motion of the trunk, was primarily due to changes in the rotation range of motion of the pelvis.

CONCLUSION: The stance angle involved the range of motion of the trunk. The rotational range of motion of the trunk was increased, when the stance angle was the central angle. On the other hand, rotational range of motion was reduced on the condition of standing with the larger stance angle. Addition to this, the weight bearing rate of the leg of the rotatory direction was increased significantly. Whether to focus on the balance of the load, or to focus on the trunk rotation mobility, the setting of the stance angle to match the characteristics of the movement, was considered to lead to both the injury prevention and the performance improvement.

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