The association between femoroacetabular impingement and sitting positions: A three-dimensional simulation study

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論文題目

The association between femoroacetabular impingement and sitting positions: A three-dimensional simulation study

（股関節インピンジメントと座位姿勢の関係: 3D シミュレーション研究）

論文の内容の要旨

[Introduction]

Femoroacetabular impingement (FAI) is a motion-related clinical disorder of the hip characterized by an abnormal contact between the bones of the hip joint that may lead to articular damage and hip pain in non-dysplastic hips. Previous reports on FAI studies are mainly focused on abnormal morphologies, but few reports on the relationship between different sitting positions and FAI have been published. The purposes of this study were to investigate the relationship between FAI and different sitting positions.

[Patients and Methods]

The Hamamatsu University School of Medicine Hospital Institutional Review Board approved this study (the approval number: No. 19-335). A total of 24 consecutive patients met the inclusion criteria. Sacral slope (SS), pelvic incidence, and pelvic tilt (PT) were obtained from the lateral pelvis-hip radiographs in the standing positions. Sacral slope in the sitting position (sitting-SS) and femoral flexion angle (FFA) were obtained from the lateral pelvis-hip radiographs in the sitting position, and the difference between the standing and sitting-SS (ΔSS) was used as a measure of pelvic motion. CT examination of the pelvis and the proximal and distal femur was performed. The alpha angle, lateral center-edge angle, acetabular version femoral anteversion, femoral neck shaft angle (FNSA), and SS in the supine position were measured on the CT images.

The 3D model of each hip was loaded in software (3-Matic 12.0; Materialise) to construct the femur and pelvis. The 3D models were placed in the supine and simulated normal and cross-legged sitting positions, and the impingement between the proximal femur and acetabulum was assessed. According to the result of the analysis, all data were divided into the following two groups: impingement and non-impingement groups. The bone-to-bone overlapping volume of the impingement was also calculated.

[Results]

Femoral anteversion and the difference in SS between standing and sitting positions (ΔSS) were significantly lower in the impingement group than in the non-impingement group (both $p < 0.05$). Alpha angle, sitting-SS, and FFA were significantly higher in the impingement group than in the non-impingement group ($p < 0.05$, $p < 0.01$, and $p <$

0.05, respectively). FNSA correlated with impingement volume in the normal sitting position ($r = 0.602$, $p < 0.01$). FNSA, SS, and FFA correlated with the impingement volume in the cross-legged sitting position ($r = 0.409$, $p < 0.05$; $r = -0.438$, $p < 0.05$; $r = 0.420$, $p < 0.05$, respectively).

[Discussion]

In this study, one of the most important findings was that the abnormalities of femoral anteversion significantly affect the FAI during different sitting positions. Although femoral anteversion affecting FAI is not a new concept, both increased and decreased femoral anteversion are shown to be closely related to osteoarthritis of the hip. In this study, ΔSS, sitting-SS, and FFA were the other main determinants for predicting the differences in sitting position during the impingement simulation. Previous studies have examined the combined effects of different hip morphological features on impingement. However, little attention has been paid to the relationship between SS and FAI in different sitting positions. PT and SS have all been used to quantify sagittal balance. The FFA is reflective of the hip joint flexion degree in the sitting position. During the transition from standing to the sitting position, SS decreased to as low as 0° or even to negative values, depending on the individuals morphology. In this study, the impingement group had a significantly higher sitting-SS and FFA and a lower ΔSS in the normal and cross-legged sitting positions. The result contributes to furthering our understanding of the mechanisms of FAI during different sitting positions, in particular, the knowledge that increased sitting-SS protects the hip joint from impingement and decreased sitting-SS accelerates the development of impingement, which could be applied to the management of FAI patients. In the impingement simulation, the impingement volume was correlated with FNSA. The result also shows that FNSA was correlated with the impingement volume during normal and cross-legged sitting positions. These results show that the FNSA deformity might be a mechanical factor that could contribute to the impingement volume. The result also shows that the ΔSS and FFA are reflective of the impingement volume. The results suggest that FAI patients with increased sitting-SS may have decreased ΔSS, which could result in femoral head overcoverage. The increased FFA exacerbated the situation in the normal and cross-legged sitting positions, which might cause FAI. Conversely, FAI patients with decreased sitting-SS have an increased ΔSS and a large pelvic motion, which could be considered as a compensatory mechanism against FAI, especially in the cross-legged sitting position.

[Conclusion]

This simulation study demonstrated that, during normal and cross-legged sitting positions, FAI patients with increased sitting-SS, alpha angle, and FFA as well as

decreased ΔSS and femoral anteversion were more likely to have impingement. These findings suggest that FAI patients with increased alpha angle and sitting-SS as well as decreased ΔSS and femoral anteversion should avoid excessive femoral flexion during sitting and cross-legged sitting positions.