Introduction. Socket malposition has been reported to be one of the causes of dislocation, increase of impingement, and re-duction of the safe range of motion after total hip arthroplasty (THA). Socket flexion angle should be set to minimize a chance of both anterior and posterior dislocation while walking and sitting. However, socket flexion angle is affected by inclination of the pelvis and the optimal angle may be different in each patient because of variability of pelvic inclination in various postures(1,2). There have been numerous reports concerning the optimal orientation of the socket, but of those reports few took the pelvic inclination, especially in the sitting position, into account. To obtain guidance for the optimal socket flexion angle in relation with postures in preoperative THA planning in each patient, the pelvic inclination in supine, standing, and sitting positions was measured using 3D-CT reconstruction of the pelvis.

Material and Methods. The subjects were 56 patients (46 hips with osteoarthritis, 5 hips with osteonecrosis, one with rapidly destructive coxarthrosis and 7 hips with loosening after THA. The mean age was 56 years (17-81 years) and there were 45 women and 11 men. CT scan of the pelvis in supine and standardized antero-posterior(AP) radiographs of the pelvis in supine, standing, and sitting positions were taken. CT images were transferred to a desktop computer, and 3D pelvic models were reconstructed using a volume rendering software (Vox Blast, VayTek, IA) (Fig.1). The pelvic flexion angle in supine was measured between the horizontal plane and the anatomical plane (defined by the two anterior superior iliac spines and by the pubic symphysis(3)) using the medial-lateral view of the model (Fig.2). The 3D pelvic model was rotated around transverse axis by 1degree increment, and the library of AP pelvic images in various pelvic inclination was obtained for each patient by projection of the rotated model in AP direction. The pelvic flexion angle in sitting and standing positions was determined by comparing the ratio of horizontal axis versus vertical axis of the intrapelvic cavity or the obturator foramen of standardized AP radiographs in sitting and standing positions and the library of the image set. Increase of flexion in pelvic inclination was regarded as a positive value.

Results. There was a great tendency of slight increase of flexion in supine (average 3.0 degrees) and in standing (1.7 degrees), and marked extension in sitting position(−29.1 degrees) (Fig.3). Large variation of flexion angle was noted in standing (Standard Deviation, 13.0 degrees) and sitting position (14.8 degrees). A close correlation was found between the pelvic flexion angles in supine and standing positions (r=0.832, p<0.0001, Pearsons correlation ). On the basis of this correlation and distribution of flexion angle in the standing and sitting positions, pelvic inclination in relation with the postures was classified into three categories (Fig. 4): Group A (extreme pelvic flexion in both the postures, the angle in the sitting position := −10 degrees and the angle in the standing position := −15 degrees), Group B (the angle in the sitting position := −10 and the angle in the standing position := −15), Group C (the angle in the sitting position < −10 and the angle in the standing position := −15). There were 3 patients (5.4% of all patients) in Group A, 51 patients (91%) in Group B, and 2 patients (4.6%) in Group C. Although most of the patients were classified in Group B, a few patients showed extreme flexion or extension of the pelvis (Group A and C).

Discussion and Conclusion. In sitting, component impingement in flexion and internal rotation of the hip joint in conjunction with the decrease of socket flexion angle by the increase of pelvic flexion angle may cause the posterior dislocation. In standing, component impingement in extension and external rotation of the hip joint in conjunction with the increase of socket flexion angle by the decrease of pelvic flexion angle may cause the anterior dislocation. Because most patients, classified in Group B, showed adequate change of pelvic inclination in sitting and standing position, anterior and posterior dislocation can be avoided. But in Group A, the small socket flexion angle may cause the posterior dislocation in the sitting position, and therefore the optimal socket flexion angle should be set small as compared with Group B. In Group C, the large socket flexion angle may cause the anterior dislocation in the standing position, and therefore the optimal socket flexion angle should be set large as compared with Group B. This study demonstrated the variability of the pelvic inclination in each posture, and the need of change of optimal socket flexion angle. Preoperative planning of the socket flexion angle to the anatomical plane of the pelvis should refer the pelvic inclination in both standing and sitting positions.

References.

Fig.1 3D reconstructed pelvic image in the supine position.

Fig.2 the pelvic flexion angle between the anatomical and horizontal planes.

Fig.3 The pelvic flexion angle in postures (95% confidence interval).

Fig.4 The pelvic angle in the sitting and standing position.