

Normative Spinopelvic Kinematics and Hip Motion Among Healthy Volunteers: Implications for Total Hip Arthroplasty

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INTRODUCTION:

Abnormal spinopelvic motion is associated with adverse outcomes following total hip arthroplasty. Spinopelvic motion and hip motion using standing and relaxed seated radiographs have been described extensively in the literature to plan total hip arthroplasty among patients with degenerative disease of the hip. However, to date, normal motion has not been defined in healthy patients without degenerative disease of the hip and spine. The aim of this study was to determine normal spinopelvic and hip motion in a young cohort without any history of hip or spine pathology to define normative spinopelvic and sagittal hip motion.

METHODS:

A cohort of fifty healthy subjects between 18- and 35-years-old were recruited to participate, including 25 males and 25 females. Exclusion criteria included presence of back or hip pain, inability to stand upright or sit with hips flexed to 90°, history of ankylosing spondylitis, femoroacetabular impingement, or prior hip or spine surgery. Four lateral radiographs were obtained for each patient, including standing, relaxed seated, single-leg step-up position, and the flexed-forward seated views. Radiographic variables measured included sacral slope (SS), pelvic-femoral angle (PFA), and lumbar lordosis (LL). Calculations included the change in SS (ΔSS), the change in PFA (ΔPFA), the change in LL (ΔLL), as well as the hip-user index ($\Delta PFA/(\Delta LL + \Delta PFA) * 100$), relative pelvic movement ($\Delta SS/(\Delta SS + \Delta PFA) * 100$), and the maximum femoral excursion (PFA_{single-leg step up}, femur-extension-PFA_{flexed-forward seated}, femur flexion). Descriptive analyses and univariate analyses were performed to establish reference values and differences between male and female participants with significance set to $p < 0.05$.

RESULTS:

The average age of participants was 25.70 ± 2.34 years with a body mass index (BMI) of 24.10 ± 3.02 kg/m². Between standing to relaxed seated, patients had an average ΔSS of $16.76 \pm 8.55^\circ$, ΔPFA of $71.32 \pm 10.15^\circ$, and a ΔLL of $28.58 \pm 11.60^\circ$ without significant differences between male and female participants ($p > 0.05$). The hip user index was 71.70 ± 10.88 and the relative pelvic movement was 19.10 ± 9.84 . The maximum femoral excursion between flexed seated and single leg step up was $105.30 \pm 10.85^\circ$. Pelvic motion (ΔSS) was strongly correlated with ΔLL . For every degree increase in ΔLL , ΔSS increased 0.63° ($R = 0.85$, $p < 0.001$). Similarly, ΔSS was strongly correlated with ΔPFA . For every degree increase of hip flexion (ΔPFA), the pelvis tilted posteriorly 0.71° ($R = 0.85$, $p < 0.001$). Hip flexion (ΔPFA) was strongly negatively correlated with lumbar flexion (ΔLL). For every degree increase of hip flexion, the lumbar flexion decreased 0.86° ($R = -0.75$, $p < 0.001$).

DISCUSSION AND CONCLUSION:

Here we provide previously undescribed normative values of spinopelvic and hip motion. Furthermore, we describe the relationships between motion through the spine, pelvis, and hip. These data provide additional context to the growing body of literature describing spinopelvic motion as it relates to total hip arthroplasty.