



Effect of Heterotopic Ossification on Hip Range of Motion and Clinical Outcome



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ABSTRACT

The utility of heterotopic ossification (HO) classification systems is debatable. The range of motion and Harris hip score (HHS) were calculated in 104 patients with known HO after total hip arthroplasty and 208 matched controls without HO. The patients with HO were radiographically divided into high and low grade HO groups. There was no statistically significant association of HHS with high or low grade HO. High grade HO had a statistically significant 6° loss of terminal hip flexion, 4° loss of abduction, and 6° loss of internal rotation at the hip. The small changes in terminal hip range of motion and lack of association with HHS may be the result of false radiographic continuity resulting in an overestimation of the disability in high grade HO.

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Heterotopic ossification (HO) is a complication of total hip arthroplasty (THA) [1,2]. The incidence of HO after THA in different reports varies, ranging from 15% to 90% [3]. This variation seems to indicate that some researchers tend to record only large amounts of HO, whereas smaller amounts of HO may have been disregarded or overlooked. Similarly, the incidence of high grade HO, i.e. Brooker grade III–IV, range from 7% in one study and up to 63% in another [4,5]. Recently, the reported rates of HO after THA have dropped to 5% with less than 1% of cases involving high grade HO [6].

The Brooker scale is the most common radiographic classification system for HO around the hip after THA [1,7–9]. A meta-analysis on the incidence of HO formation after major hip surgery, states that 47% of studies utilize the Brooker scale [10].

The clinical utility of well-established HO classification systems is subject to debate [11–13]. Brooker grade III–IV HO usually indicates a clinically significant loss of hip ROM [8,14]. However, Brooker et al [7] have noted that there is no effect of HO on clinical outcome scores unless there was bony ankylosis. The Brooker scale may be misleading when extrapolated to the clinical evaluation, stressing the need for a more clinically relevant system for HO classification around the hip [15]. We formally compared terminal hip ROM, arc of motion of the hip, and clinical outcome to HO grade.

Material and Methods

After receiving institutional review board approval, the charts of 104 patients with documented radiographic HO were reviewed. HO after THA occurs between 4 and 12 weeks after the operation with a peak occurrence at 2 months [3,16,17]. Predisposition to the inflammatory process involved in the initiation of HO and the mineralization process decrease with time [18]. Two months was chosen as the earliest time of radiographic evaluation. The Harris hip score (HHS) at final follow-up was calculated from survey sheets. The terminal ROM of the hip in forward flexion, abduction, and internal rotation were taken from the medical record. The arc of motion of the hip was calculated by adding the terminal abduction and adduction of the hip or the terminal internal and external rotation of the hip, available in the medical record. The arc of motion of the hip in flexion-extension was not able to be calculated because the amount of terminal extension was not routinely documented. The radiographs at final follow-up were reviewed by two clinicians (XXX, XXX) with more than six years of experience of independently reviewing radiographs according to the Brooker classification system. Fifty patients (48%) were categorized into the high HO (i.e., Brooker III–IV) group and 54 patients (52%) were categorized into the low HO (i.e., Brooker I–II) group. Each reviewer was blinded to terminal range and motion arc of the hip motion as well as HHS. Any disagreement among the independent radiographic rating of each reviewer was resolved by reaching a consensus for the HO grade. Fifty-one patients were classified as having high grade HO. Fifty-three patients were classified as having low grade HO.

A control group was created by matching the high and low HO groups 2:1 by age within 5 years, sex exactly, BMI within 5 points, date of THA within 5 years, and time of follow-up within 5

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years. A total of 208 hips without documented HO after THA were identified.

Statistical comparisons between terminal range, arc of motion, and HHS for each HO grade and the respective matched controls were made using a paired Student's t-test. Statistical significance was defined as $P < 0.05$. The sample size in this study was sufficiently powered (80%) to detect a clinically significant 6-point difference in HHS assuming α of 0.05 and standard deviation of 12° [19]. Additionally, the sample size in this study was sufficiently powered (80%) to detect a 4° difference in hip ROM assuming an α of 0.05 and standard deviation of 9° .

Results

Terminal hip flexion was reduced for patients with high grade HO. Terminal hip flexion was $102^\circ \pm 13^\circ$ with low grade HO and $97^\circ \pm 15^\circ$ in the matched controls without HO ($P = 0.102$). Terminal hip flexion was $98^\circ \pm 16^\circ$ with high grade HO and $104^\circ \pm 12^\circ$ in the matched controls without HO ($P = 0.025$). Patients with high grade HO had 6° less terminal hip flexion than control patients without HO. There was no statistically significant difference in terminal hip flexion ($P = 0.137$) between the high or low grade HO groups (Fig. 1).

Terminal hip abduction was reduced for patients with high grade HO. Terminal hip abduction was $27^\circ \pm 6^\circ$ with low grade HO and $28^\circ \pm 5^\circ$ in the matched controls without HO ($P = 0.446$). Terminal hip abduction was $25^\circ \pm 7^\circ$ with high grade HO and $29^\circ \pm 6^\circ$ in the matched controls without HO ($P = 0.008$). Patients with high grade HO had 4° less terminal hip abduction than control patients without HO. There was no statistically significant difference in terminal hip abduction ($P = 0.218$) between the high or low grade HO groups (Fig. 2).

Terminal hip internal rotation was reduced for patients with high grade HO. Terminal hip internal rotation was $19^\circ \pm 9^\circ$ with low grade HO and $21^\circ \pm 9^\circ$ in the matched controls without HO ($P = 0.139$). Terminal hip internal rotation was $15^\circ \pm 10^\circ$ with high grade HO and $21^\circ \pm 10^\circ$ in the matched controls without HO ($P = 0.006$). There was a statistically significant difference in terminal hip internal rotation ($P = 0.041$) between the high and low grade HO groups (Fig. 3). Patients with high grade HO had 6° less terminal hip internal rotation than control patients without HO and 4° less terminal hip internal rotation than patients with low grade HO.

The abduction-adduction arc was reduced for patients with high grade HO. The abduction-adduction arc was $48^\circ \pm 13^\circ$ with low grade HO and $52^\circ \pm 10^\circ$ in the matched controls without HO ($P = 0.061$). The abduction-adduction arc was $42^\circ \pm 13^\circ$ with high grade HO and $52^\circ \pm 13^\circ$ in the matched controls without HO ($P < 0.001$). There was a statistically significant difference in the abduction-adduction arc ($P = 0.022$) between the high and low grade HO groups (Fig. 4). Patients with high grade HO had 10° less abduction-adduction arc than control patients without HO and 6° less abduction-adduction arc than patients with low grade HO.

The internal-external rotation arc was reduced for patients with high grade HO. The internal-external rotation arc was $44^\circ \pm 14^\circ$ with

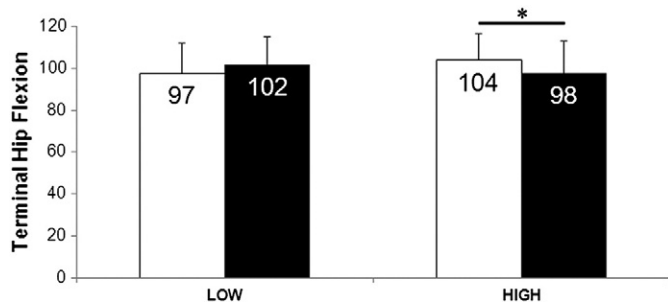


Fig. 1. Terminal hip flexion in the low and high HO groups. The white bars represent the matched control THAs without HO, and the black bars represent the motion of the THAs with low or high grade HO. * indicates statistical significance ($P < 0.05$).

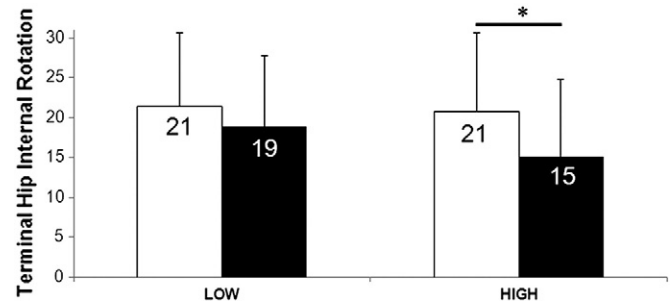


Fig. 2. Terminal hip abduction in the low and high HO groups. The white bars represent the matched control THAs without HO, and the black bars represent the motion of the THAs with low or high grade HO. * indicates statistical significance ($P < 0.05$).

low grade HO and $47^\circ \pm 15^\circ$ in the matched controls without HO ($P = 0.325$). The internal-external rotation arc was $38^\circ \pm 17^\circ$ with high grade HO and $49^\circ \pm 13^\circ$ in the matched controls without HO ($P < 0.001$). There was no statistically significant difference in the internal-external rotation arc ($P = 0.052$) between the high and low grade HO groups (Fig. 5). Patients with high grade HO had 11° less internal-external rotation arc than control patients without HO.

HHS was not reduced for patients with HO. The HHS was 79 ± 16 with low grade HO and 80 ± 18 in the matched controls without HO ($P = 0.799$). The HHS was 80 ± 17 with high grade HO and 79 ± 18 in the matched controls without HO ($P = 0.662$). There was no statistically significant difference in HHS ($P = 0.739$) between the high or low grade HO groups (Fig. 6).

Discussion

An important parameter for the usage of a classification system is its relevance to the staging of the clinical situation for which it has been designed. The purpose of this study was to assess the effect of radiographic HO in the Brooker classification system on the terminal range, motion arc, and clinical outcome score after THA. We demonstrated a statistically significant decrease in terminal hip internal rotation as well as a statistically significant decrease in the abduction-adduction arc of motion with high grade HO.

The clinical relevance of these differences is debatable given the lack of a statistically significant difference in HHS with HO grade. Additionally, HHS is not sensitive to changes in hip ROM. Only 5% of the HHS is assigned to hip ROM [20]. The risk of deterioration of a patient's overall health due to concomitant medical comorbidities would lead to greater decrease in HHS score than the one caused by the HO presence alone.

Loss of hip ROM may interfere with activities of daily living, such as tying shoes, using a chair, and picking things up from the floor [21]. The effect of limited hip ROM is more pronounced in the non-Western

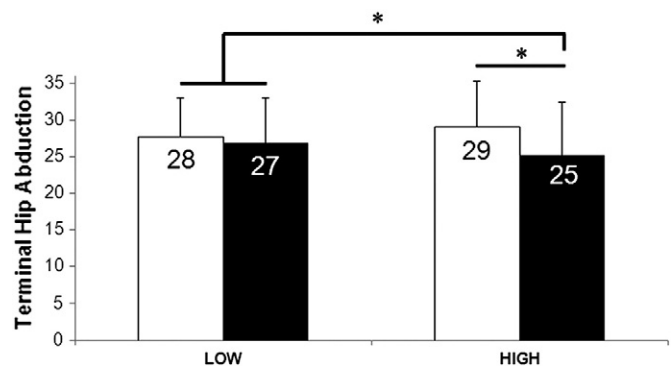


Fig. 3. Terminal hip internal rotation in the low and high HO groups. The white bars represent the matched control THAs without HO, and the black bars represent the motion of the THAs with low or high grade HO. * indicates statistical significance ($P < 0.05$).

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