

# Acute revision hip arthroplasty: a previously unrecognized risk factor for heterotopic ossification

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## Abstract

**Background** The aim of this retrospective review was to determine the incidence and severity of heterotrophic ossification (HO) following acute revision total hip arthroplasty (THA), and whether this represents a significant risk factor for HO that should be treated prophylactically.

**Materials and methods** A total of seven patients (three men and four women) with a mean age of 55 years (39–70 years) who underwent a reoperation of their THA for any reason that required a hip arthrotomy within 3 weeks of their primary or revision THA were included, with a mean follow-up of 8.8 years (2–12 years). All patients were evaluated radiographically for any evidence of HO and clinically using the Harris Hip Score.

**Results** All seven hips (100 %) developed HO, with 71 % being severe (Brooker III and IV HO). One hip (14 %) developed Brooker IV HO, four hips (57 %) developed Brooker III HO, and two hips (29 %) developed Brooker II HO. The patient's range of motion varied, but was very limited in three patients. Three patients (42.8 %) were not satisfied with their surgery; one patient had Brooker IV HO, and two patients had Brooker III HO.

**Conclusion** Acute reoperation after primary or revision THA is a significant risk factor for the development of extensive HO, which requires prophylactic treatment.

**Keywords** Hip arthroplasty · Heterotopic ossification · Acute · Revision · Complication

## Introduction

Heterotopic ossification (HO) is a well-recognized complication following total hip arthroplasty (THA). The incidence of HO has been reported as low as 1–2 % in the general population, and up to 90 % in patients with multiple risk factors [1–7]. Although the majority of cases are clinically insignificant and asymptomatic, severe HO can significantly compromise the patient's outcome following an otherwise successful THA. The formation of extensive HO can cause severe postoperative hip pain, significantly restrict hip motion and can cause impingement that results in instability [8, 9].

Radiotherapy and non-steroidal anti-inflammatories have been shown to be effective prophylactic measures to minimize the likelihood of ectopic bone formation, as well as increase the likelihood that any bone that does form, remains mild enough to not be of clinical concern following THA [10–15]. The prevention of postoperative HO can best be accomplished by the preoperative identification and subsequent treatment of those patients who are at high risk of its development. Known risk factors include a history of HO in either hip, ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis, hypertrophic arthrosis, male gender, advanced age and ipsilateral acute displaced acetabular fracture [1, 7, 16–23]. Revision THA is not recognized as a risk factor per se, unless there is a history of HO in either hip [5, 7, 17, 24–27].

Due to population aging, the rate of revision THA surgery is on the rise with aseptic loosening being the most common cause [28]. On the other hand, acute reoperation

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after primary or revision THA is very uncommon and is usually related to technical errors, dislocation, periprosthetic fracture or infection. However, we have noted that early revision THA is frequently complicated by severe HO. The aim of this study was to determine the incidence and severity of HO following acute revision THA and determine whether this represents a significant risk factor for HO.

## Materials and methods

Using prospectively collected data from our computerized database, we reviewed 963 consecutive primary THAs and 190 consecutive revision THAs performed by a single surgeon (MT) from August 1991 to August 2012. We identified all patients who underwent a reoperation of their hip arthroplasty for any reason that required a hip arthrotomy within 3 weeks of their primary or revision THA. None of the patients undergoing an acute revision surgery had any prophylactic treatment for HO, and all patients had at least a 2-year follow-up. Institutional review board approval for the study was obtained.

Seven patients (seven hips) were found to meet the inclusion criteria (Table 1). There were four women and three men, with an average age of 55 years (range 39–70 years). The average patient height was 1.68 m (range 1.58–1.8 m), and the average weight was 70 kg (range 50–95 kg). The right hip was involved in three patients and the left in four patients. The demographics of the patients undergoing an early revision are listed in Table 1. The initial surgery was a primary cementless THA in five cases and a revision THA in two cases (Table 1). The primary THA was done for osteoarthritis in three cases and avascular necrosis in two cases. A S-ROM femoral component (DePuy, Warsaw, IN) was used in two hips, a Versys Fiber Metal Taper stem (Zimmer, Warsaw, IN) was used in one hip, a Multilock femoral stem (Zimmer, Warsaw, IN) was used in one hip, and a Trilock stem

(DePuy, Warsaw, IN) was used in one hip. The acetabular component was a Pinnacle cup (DePuy, Warsaw, IN) in three hips, and a Trilogy cup (Zimmer, Warsaw, IN) in two hips. Both revision arthroplasties were cementless revisions done for aseptic loosening of a cemented THA. In both cases, a Trilogy cup with screws (Zimmer, Warsaw, IN) was used. A S-ROM femoral component (DePuy, Warsaw, IN) was used in one case, and a Solution femoral stem (DePuy, Warsaw, IN) was used in the other case. Both index revision surgeries required bone grafting of the acetabulum and femur using morcellized, non-structural allograft bone. A posterolateral approach to the hip was used in all cases for the initial surgery and for the acute reoperation. The abductors were not released or partially detached in any of the primary cases. An extended trochanteric osteotomy was required in both index revision cases, but only one hip required a repeat trochanteric osteotomy for the acute reoperation.

All patients were prospectively evaluated clinically and radiographically preoperatively and postoperatively at 6 weeks, 3, 12 months, 2 years and every 1–2 years thereafter. Established preoperative risk factors for HO were specifically assessed for each patient, including clinical and/or radiographic evidence of HO in either hip, ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis, hypertrophic arthritis or an acute acetabular fracture. All hips were evaluated radiographically with an anteroposterior (AP) pelvis, AP hip, and true and frog-leg lateral radiographs. Preoperatively, the radiographs were assessed in order to identify any risk factors for HO. Final radiographs were assessed for HO and, if present, quantified using the Brooker classification [29, 30]. Brooker Grade 0 indicated no ossification; Grade I indicated islands of bone within the soft tissues; Grade II indicated bone spurs arising from the pelvis or proximal end of femur, leaving at least 1 cm between opposing bone surfaces; Grade III indicated bone spurs arising from the pelvis or proximal end of femur, reducing the space between opposing bone surfaces to less than 1 cm; and Grade IV indicated apparent ankylosis of the hip. Clinical outcomes,

**Table 1** Patient demographics

Patient	Age (years)	Gender	Body mass index	Side	Primary or revision hip arthroplasty	Etiology
1	39	F	23	R	Primary	Osteoarthritis
2	64	M	31	L	Primary	Osteoarthritis
3	44	M	28	R	Primary	Avascular necrosis
4	70	F	24	L	Primary	Osteoarthritis
5	48	M	20	R	Primary	Avascular necrosis
6	51	F	19	L	Revision	Aseptic loosening
7	68	F	29	L	Revision	Aseptic loosening

including range of motion were evaluated using the Harris Hip Score (HHS) [4].

## Results

Of the five hips (five patients) identified that required an acute reoperation after the primary THA, the reason for reoperation was recurrent anterior hip dislocation in three patients, postoperative subsidence of the femoral stem with fracture of the lateral femoral cortex in one patient, and incomplete seating of the acetabular component secondary to an interposed fractured osteophyte in one patient (Table 2). Two of the three hips that underwent acute reoperation for recurrent instability had revision of the modular S-ROM stem with retention of the modular sleeve in order to decrease the femoral anteversion and increase the offset. The third hip required revision of the acetabulum, with a Trilogy cup implanted in less anteversion. The hip with incomplete seating of the acetabular cup required revision of the acetabulum with a Trilogy cup, after removal of the interposed fractured osteophyte. The femoral component that subsided was revised to an S-ROM stem with a bulk strut allograft to cover the lateral cortical defect. Of the two patients who underwent a revision THA as their initial surgery, one patient required reoperation for

recurrent anterior dislocation, and one had a fracture of the medial wall of the acetabulum with migration of the cup. The hip that dislocated had a revision arthrotomy and partial excision of the ischium to correct the impingement that was occurring and causing anterior levering of the hip. The hip with the medial wall fracture was revised to a Burch-Schneider cage (Zimmer, Warsaw, IN) with a cemented acetabular cup used with morcellized bone allograft to the anterior and medial walls of the acetabulum. The average time from the index THA and the acute reoperation was 10 days (range 1–19 days) (Table 2).

Only one out of these seven patients (14 %) had a predisposing risk factor for postoperative HO. This patient developed Brooker II HO following a primary THA on the contralateral side. After his acute reoperation, he developed Brooker III heterotopic ossification. The remaining six patients had no risk factors for developing postoperative HO after their hip arthroplasty.

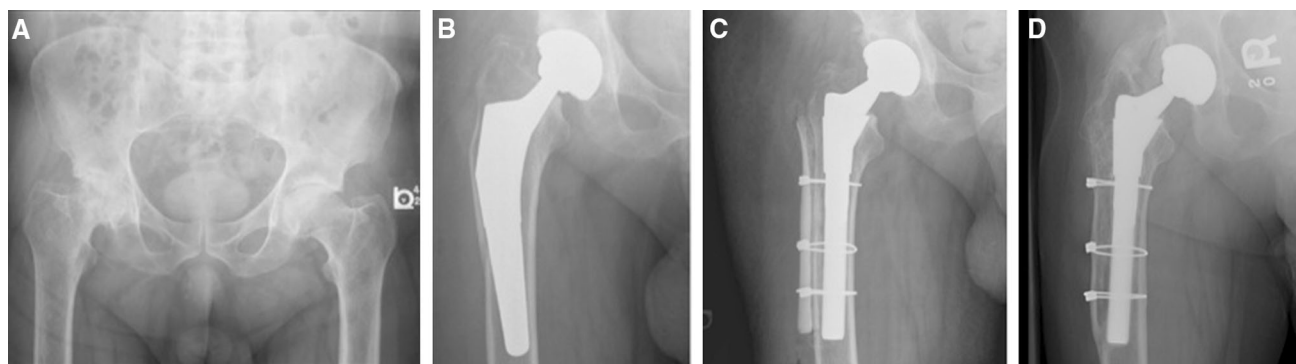
All seven hips (100 %) that underwent reoperation within 3 weeks of the initial hip arthroplasty developed HO (Table 2). The severity of HO varied, but the majority of the hips (71 %) developed severe HO (Brooker III and IV) (Table 3). One of the seven hips (14 %) developed Brooker IV HO, four hips (57 %) developed Brooker III HO (Fig. 1), and two hips (29 %) developed Brooker II HO.

**Table 2** Reoperation and outcome

Patient	Reason for acute revision	Time between surgeries (days)	Brooker Grade	Final Harris Hip Score	Follow-up (years)
1	Incomplete seating of the acetabular cup secondary to bone interposition	7	III	96	12
2	Recurrent anterior dislocation	19	II	70	2
3	Femoral stem subsidence creating a lateral cortical defect	16	III	97	2
4	Recurrent anterior dislocation	7	III	94	10
5	Recurrent anterior dislocation	10	II	100	2
6	Recurrent anterior dislocation	1	IV	72	10
7	Medial acetabular wall fracture with migration of the cup	11	III	91	6

**Table 3** Severity of heterotopic ossification and clinical outcome

Patient	Brooker Grade	Satisfied with surgery	Final Harris Hip Score	Hip range of motion (°)					
				Extension	Flexion	Abduction	Adduction	Internal rotation	External rotation
1	III	Yes	96	0	140	45	45	45	45
2	II	Yes	70	0	110	30	30	45	45
3	III	No	97	0	80	20	20	20	20
4	III	Yes	94	0	130	45	45	45	45
5	II	Yes	100	0	140	45	45	45	45
6	IV	No	72	0	0	0	0	0	0
7	III	No	91	0	80	35	35	45	45



**Fig. 1** **a** Preoperative anteroposterior (AP) radiograph of the pelvis, showing degenerative changes of the right hip in a 44-year-old male (patient 3, Table 2) with no evidence of known risk factors for heterotrophic ossification (HO). **b** An AP radiograph of the hip 2 days post-primary total hip arthroplasty (THA), demonstrating femoral stem subsidence and fracture of the lateral femoral cortex. This

required revision surgery 16 days following the primary THA. **c** An AP radiograph of the hip taken 2 days post-revision THA, showing a modular femoral stem with a strut allograft fixed with cables. **d** Seven years post-revision surgery; an AP radiograph of the hip demonstrates Grade III HO

One patient with Brooker II and another patient with Brooker III HO received late irradiation (7 gray) at 6 and 12 weeks, respectively [31].

The average clinical follow-up was 8.8 years (range 2–12 years). The final HHS was excellent (>89) in five patients (71 %), fair (70–79) in 1 patient (14 %) and poor (<70) in one patient (14 %) (Table 3). The patients with the fair and poor HHS had Grade IV and Grade II HO, respectively. The patient's range of motion varied, but was very limited in three patients (Table 3). Three patients (42.8 %) were not satisfied with their surgery; one patient had Grade IV HO, and two patients had Grade III HO. The remaining four patients (57.2 %) were satisfied with their surgery (Table 3).

## Discussion

The identification of risk factors in patients undergoing primary or revision THA is the mainstay in preventing the formation of postoperative heterotopic ossification. Once identified, patients at risk of HO can be effectively treated perioperatively. This study identifies an acute reoperation, following primary or revision THA, as a previously unrecognized risk factor for HO. In all our cases, revision hip arthroplasty done within 3 weeks of the initial hip arthroplasty resulted in the formation of HO.

Not only did all the patients in this study develop HO after their acute reoperation, in 71 % of the cases the patients formed significant HO, being Brooker Grade III or IV. Although one could postulate that the HO may have formed in these patients even in the absence of an acute reoperation, this is unlikely since the incidence of HO was 100 % in this series, with only one patient having a well-documented risk factor for HO. This patient developed

Brooker II HO after a contralateral primary THA and developed Brooker III HO after his acute reoperation. Previously, Ritter and Vaughan reported that the quantity of HO developed in a cohort of 23 patients with a history of HO was similar to that developed after their original arthroplasty [17]. Although the patient in this study has a confounding risk factor, the increased severity of HO formed after the acute revision surgery indicates that an acute reoperation adds to the risk of developing HO.

Although HO following hip arthroplasty may at times be no more than a benign radiographic appearance, in some cases, there can be significant clinical compromise in long-term function. The grading of HO with the Brooker classification has been shown to correlate with hip range of motion, but not with the HHS [32]. Our results showed a similar correlation. Five of the six patients who did not develop ankylosis from their HO had an excellent HHS, while three of the five patients who developed Brooker III or IV HO had a limited range of motion.

In this study, two hips were treated with late irradiation, at 6 and 12 weeks postoperatively, in an attempt to prevent progression of the HO that had already developed. This technique has previously been shown to be effective by Kantor et al. [31]. Using a standard dose of 7 gray, eight patients who underwent a cementless THA were irradiated after their 6-week postoperative follow-up visit and none of the hips went on to progress from clinically insignificant grades of HO (Brooker I, II) to more advanced grades (Brooker III, IV). When compared to the untreated control group of nine patients, over the 2-year study period, the treated group had only a 32 % progression in the quantity of bone formed compared with 86 % in the control group. On the contrary, other authors reported a higher rate of heterotopic ossification if radiotherapy was given after the 4th postoperative day [33, 34]. Therefore, although it is

possible that if the two patients in our study did not have late irradiation treatment they may have developed a higher grade of HO with clinical symptoms, but this remains unclear.

One can only speculate on why an acute reoperation following hip arthroplasty results in such a significant risk of developing HO. The cause may be similar to HO forming following blast injuries or burns. Although the molecular mechanisms of HO have not been fully elucidated in experimental models [35], inflammatory signaling pathways are speculated to play critical roles in HO formation. Forsberg et al. [36] have found an association between a patient's systemic and local inflammatory responses and HO. It is conceivable that reoperating on a patient so soon after their initial surgery results in significant trauma to tissues already going through the inflammatory phase of wound healing. This may result in a significant increase in the local inflammatory response, which then predisposes to developing HO.

It is not clear from this small series whether the timing of the reoperation is correlated with the degree of HO that forms. However, the only Brooker Grade IV HO case occurred when the patient underwent a revision surgery within 24 h of her index procedure. The longest duration between the index surgery and the acute reoperation in this series was 19 days, and in this case, the patient only developed a small amount of HO (Brooker II). A larger number of patients are necessary to definitively correlate the severity of the HO that occurs after an acute reoperation and the time between surgeries.

There are some limitations to this study, none of which significantly affect the findings. Although the study is retrospective, the clinical data were collected prospectively and reviewed with the radiographs retrospectively. One might consider that the small number of patients in this study may not reflect a larger cohort of patients. However, the incidence of significant HO in patients without risk factors is low. In this study, 100 % of the patients developed HO and the majority of the hips developed severe Brooker Grade III or IV HO. Given that acute reoperation after primary or revision THA is very uncommon, recruiting a large number of patients in such a study would require a multicenter collaboration.

This study clearly identifies acute reoperation after primary or revision THA as a significant risk for the development of HO. Furthermore, the HO that develops is usually more extensive and can adversely affect the outcome of the surgery. As a result, we strongly recommend prophylactically treating all patients undergoing a revision surgery within 3 weeks of the index arthroplasty with any of the effective methods described in the literature to prevent the formation of HO.

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#### Compliance with ethical standards

**Conflict of interest** Dr. Aljurayyan has nothing to disclose. D. Tanzer has nothing to disclose. Dr. M.Tanzer reports grants and personal fees from Zimmer, and grants from DePuy, outside the submitted work.

**Ethical standards** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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