Heterotopic Bone Formation Following Resurfacing Total Hip Arthroplasty

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Abstract Heterotopic bone (HO), a rare association with total hip arthroplasty (THA), has recently been shown to be more of a problem with resurfacing hip arthroplasty (RHA). It has been speculated to be the result of greater soft tissue dissection required for this procedure. HO most commonly develops in males and patients with bilateral disease. To better understand if this problem does occur in RHA, groups of patients with RHA on one side and conventional THA on the other were evaluated. We retrospectively identified 45 patients that had RHA on one side and conventional cemented THA on the other. Follow-up has been up to 25 years. HO was graded at every clinical visit using the Brooker Classification. In the RHA group, there were 32 hips without evidence of HO, ten with grade 1, and three with grades 2 or 3. In the THA group, there were 36 hips without any HO, eight with grade 1, and one with grade 2. There was no statistical difference between either types of hip arthroplasty in HO formation overall or in the development of more severe grades. Motion was not significantly affected with the more severe grades. Our data obtained from a bilateral patient model suggests that RHA does not predispose to a greater development of HO. In doing a RHA, one should be aware that there might be an increased likelihood of HO in males with bilateral disease.

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Each author certifies that his or her institution has approved the reporting of these cases, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participating in the study was obtained.

Level of Evidence: Level III: Therapeutic Study: Retrospective Review with Comparative Group.

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Introduction

Heterotopic ossification (HO), a common development following total hip arthroplasty (THA), has been reported in literature as ranging from 15% to 76% [1–7]. The main mechanism of HO development has been attributed to the soft tissue dissection along with other patient-related risk factors such as age, gender, and bilaterality [5, 7, 8]. Those patients that develop clinically severe HO have been shown to have a decreased range of motion (ROM) of the hip following recovery from the arthroplasty.

With the recent resurgence of resurfacing hip arthroplasty (RHA), due to advances in the understanding of metal-on-metal articulation, incidences of HO have been shown to be more of a problem [7–12]. This heightened risk of HO formation in RHA is possibly attributed to the need for greater exposure of the surgical area, involving more soft tissue dissection than THA [5].

To better understand if the problem of HO formation is more prevalent in RHA, groups of bilateral patients with RHA on one side and conventional cemented THA on the other were evaluated. The specific aims of our study were to compare the severity of HO using the Brooker Classification system between the RHA and THA in patients who have received both types of implants. We also wished to evaluate the effect of gender on the development of HO in these two types of implants. Finally, we wished to determine if HO formation was associated with greater pain, reduced ROM, and survival of the prostheses.

Materials and methods

Forty-five patients who had similar bilateral disease of the hip and who simultaneously had underwent a conventional THA on one side and a RHA on the other between May

1977 and March 1980 were evaluated for this retrospective review of a case series study. Hips were divided into two groups based on bilaterality. Group 1 consisted of those hips that had RHA. Group 2 consisted of hips which had conventional THA. All procedures were done by the senior author. The type of procedure for each hip was based on randomization to eliminate preferential use from the study [7].

A minimum 2-year follow-up was required for induction into the study, with a mean follow-up period of 13.2 years (range, 2.0 to 30.7 years). The average age of the 45 patients in this study was 64.2 ± 12.0 years (range, 22 to 88 years). Out of 45 patients, 23 were male (51.1%). An Indiana prosthesis ($n=45$ hips) with an all-polyethylene cemented cup (DePuy; Warsaw, IN, USA) was used in the RHA group. T28 ($n=18$ hips) and Tr28 ($n=27$ hips) femoral stems (Zimmer; Warsaw, IN, USA) were used in the THA group. All T28/Tr28 stems had cemented all-polyethylene cups implanted during THA. Of the 90 hips, 74 had a diagnosis of osteoarthritis, eight had rheumatoid arthritis, six had osteonecrosis, and two had ankylosing spondylitis. Twenty-seven (60.0%) RHAs were done on the left hip and 18 (40.0%) on the right. Eighteen (40.0%) THAs were done on the left hip and 27 (60.0%) on the right.

A lateral transtrochanteric approach was utilized in all patients on both sides, independent of which type of arthroplasty was performed. Aspirin was used in all patients following the procedure for thromboembolism prophylaxis. The patients had identical rehabilitation routine, which included walking 1 day postoperative and increasing walking distance each corresponding day. Patients were to return for follow-ups at 6 months, 1 year, and subsequently every 2 years. AP and frog lateral radiographs were taken at each follow-up visit. The senior surgeon evaluated the radiographs to determine heterotopic presence and classification, as defined by Brooker et al. [13]. Radiographs were analyzed at each follow-up visit. Patients were followed clinically at each corresponding follow-up for pain (range, 0 to 44 points) and at endpoint for failure (revision of original procedure) of the prosthesis. Pain score was determined by asking the patient at each follow-up to rate the pain on a set scale of 0 (severe) to 44 (no pain). Each patient's pain score was determined by the most recent clinical follow-up using the Harris hip evaluation. Range of motion (flexion, adduction, and abduction) was also analyzed at each follow-up with differences determined by type of procedure and severity of HO.

Statistical analysis was performed by frequency analysis with chi-square tests to determine a correlation between procedure and severity of HO.

Results

There was no difference in the incidence or severity of HO when the THA and RHA hips were compared. The incidence of heterotopic formation was 28.9% (13 of 45 hips) in the RHA group compared to 20.0% (nine of 45

hips) in the THA group ($p=0.3265$). In the RHA group, 32 patients had no HO, ten had class I, and three had class 2. In the THA group, 36 had no HO, eight had class 1, and one had class 2. No hips were noted to having class 3 and 4 HO. There was no difference between the two groups with respect to the distribution of the classes of HO ($p=0.4825$), nor was there a difference between the two groups and the more severe class 2 ($p=0.3265$).

Male sex was not associated with a higher incidence of HO in either the RHA hips ($p=0.3724$) nor in the THA hips ($p=0.2966$). In the RHA group, males had an incidence of HO of 34.8% (eight of 23 hips) compared to the female's incidence of 22.7% (five of 22 hips). In the THA group, males had an incidence of HO of 26.1% (six of 22 hips) compared to the female's incidence of 13.6% (three of 22 hips). Furthermore, there was no association between the male sex and more severe classes of HO in either of the two groups (RHA, $p=0.3611$; THA, $p=0.4517$).

At final follow-up, pain scores were worse for patient's hips with HO regardless of the type of implant (37.4 points vs. 41.8 points; $p=0.0034$). However, there was no difference in pain between the types of implants ($p=0.4963$) or between genders ($p=0.8107$). Mean pain score was 40.3 for the RHA group (range, 20 to 44) and 41.2 for the THA group (range, 20 to 44).

At final follow-up, flexion ($p=0.0995$), abduction ($p=0.0718$), and adduction ($p=0.8757$) scores were not significantly different in either procedure. They were not statistically different between grades of HO either (no myositis, $p=0.5684$; some myositis, $p=0.7931$).

In this series, resurfacing arthroplasties failed more commonly than total hip arthroplasties. In both groups, hips that developed HO were at significantly higher risk of failure than those without HO ($p=0.0235$). Of the 45 hips with RHA, 20 of them failed within 27.9 years post-operatively (44.4% failure rate). Of the 45 hips with THA, six of them failed within 14.3 years post-operatively (13.3% failure rate). Of the 26 failures in this study, nine of 22 hips (40.9% failure rate; mean years to failure, 10.3 years) with HO and 17 of 68 hips (25.0% failure rate; mean years to failure, 21.9 years) without HO failed.

Discussion

In this study, we used a series of patients with THA on one side and RHA on the other to compare the incidence of HO formation as a function of implant type. We also addressed whether or not gender affected the incidence of HO as well as how HO affected pain and survival. The incidence of HO was similar between the groups and gender has no effect on the observed incidence of HO. Hips with HO were more painful and were more likely to require revision regardless of the types of prosthesis.

There were only a few limitations to this study. Firstly, the low amount of cases included in this study reduced the power of the study considerably. We are one of the few studies though to include simultaneous, bilateral cases with a moderate case count. Lastly, Brooker Classification in this

study was done by a single surgeon through visual observation, but because Brooker himself had classified heterotopic ossification visually by analyzing radiographs, this limitation was considered acceptable for this study.

We did not find that resurfacing arthroplasty led to a higher incidence of HO however; historically, other studies have found a problematic correlation with heterotopic ossification formation [5–12, 14]. After an analysis of current literature, only a few studies have compared RHA's and conventional THA's role in HO formation [5, 8]. Amstutz et al. detailed a similar RHA vs. THA comparison study using a Tharies metal-on-polyethylene implant, reporting severe HO incidence of 16% vs. 9% [8]. Rama et al., in a randomized clinical trial comparing the two groups, reported incidences of HO of 12.6% (13 of 103 hips) in the RHA group and 2.1% (two of 97 hips) in the THA group [5]. Rama's study had only five patients included that had undergone bilateral procedures (THA and RHA on opposite sides) and males were not equally distributed between the groups [5]. Our study used a relatively large number of patients that had received the two prostheses in separate bilateral procedures, thereby permitting a more controlled matched-pair analysis.

The wider exposure needed in RHA and its connection with soft tissue damage has often been considered determining factors in the formation of HO. A previous study has suggested that, as a more complicated surgical procedure, RHA may lead to a higher risk for HO formation [5]. Our study, in contrast to Rama's study, found an insignificant difference in HO between the two groups, suggesting that risk of HO formation is not a deterrent to resurfacing hip arthroplasty.

Although previously published studies have reported conflicting results regarding the effect of sex on HO formation, we found no effect of gender in our series. Riegler et al. reported though that there is no sex predilection for HO formation; more severe grades of HO appear in females [15]. Rama et al. found that incidences of HO were significantly higher in males than in females in his entire study and subsequently his study's RHA group. Our study's results differ in that, of 45 patients, neither RHA nor THA group had any sex predilection regarding HO formation incidences or more severe HO classes.

Of interest to us is our finding that patients who developed HO had a greater likelihood of having greater pain in that hip. To date, this association has not been reported by other studies. We believe that the association between post-operative pain and HO formation merits additional study. Our study found that hips with HO, regardless of the type of implant, had a significantly higher precedence of pain but there was no difference between the two separate procedures with reference to pain scores. There was also no significance between those hips with THA and RHA nor those with myositis and those without with respect to range of motion.

Among the vast improvements in orthopedics, the recent resurgence of resurfacing hip arthroplasty for use in osteonecrosis patients and younger patients who might benefit from conservation of bone stock is still viewed with skepticism [5, 7, 8]. Further advantages of RHA might include optimization of stress transfer and inherent stability [10]. We believe our study demonstrates that RHA does not lead to a higher incidence of HO. However, as with total hip replacement, there is a likelihood of an increased incidence of HO in a male with bilateral disease.

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