

Heterotopic Ossification in Total Hip Arthroplasty

The Influence of the Approach

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Abstract: The effects of lateral approaches for total hip arthroplasty on heterotopic bone formation were studied in 264 patients with primary osteoarthritis. The Hardinge approach was used in 82 patients, the transtrochanteric approach in 94, and the Liverpool approach in 88. The incidence of heterotopic ossification was 42%. A severe form of bone formation occurred five times more in the Liverpool approach than in other two approaches. **Key words:** heterotopic ossification, total hip arthroplasty, Hardinge approach, transtrochanteric approach, Liverpool approach, osteoarthritis.

Heterotopic ossification (HO) is a well-known postoperative complication of total hip arthroplasty. The incidence of HO has ranged from 1 to 80% in different surveys. The risk factors predisposing to HO, such as age, sex, type of osteoarthritis, operative time, and prosthetic design, have been discussed in the literature.^{5,7,9,10,13,14,16,17} Testa and Mazur compared the influence of the transtrochanteric and direct lateral approaches.²⁰ Although they found an increased incidence of HO in the direct lateral approach, they noted that severe HO was more common in the transtrochanteric than in the direct lateral approach. Vicar and Coleman reported that HO was three times more common in the posterior and transtrochanteric approaches than in the anterolateral approach.²¹ However, Morrey et al. failed to find any difference between the three approaches.¹² There is thus conflicting evidence on the influence of surgical approaches on HO.

The purpose of this study was to analyze the factors associated with HO and the incidence of HO with three commonly used lateral approaches, namely, transtrochanteric, Liverpool, and Hardinge, in a series of 264 cases of low-friction arthroplasty.

Materials and Methods

Between January 1987 and October 1989, 354 low-friction arthroplasty procedures were performed by three consultants and their residents at the Clatterbridge Hospital (Wirral, U.K.). Of the 354 operations, 264 low-friction arthroplasties (performed for primary osteoarthritis) were selected for this study: 82 Hardinge, 88 Liverpool, and 94 transtrochanteric. To maintain the groups' compatibility, secondary osteoarthritis, previous hip operations, and infected hips have been excluded.

Approaches

The Liverpool and Hardinge approaches originated from the McFarland and Osborne approach¹¹ with some modifications. The basic anatomic principle is that the gluteus medius and vastus lateralis muscles act in functional continuity via their facial connection over the greater trochanter.

Transtrochanteric Approach. In this approach the trochanter is cut using a Gigli (Downs, Sheffield, U.K.) saw to create a biplane osteotomy. The trochanter is fixed using a single horizontal compression wire and double vertical wire.²³

Hardinge Approach. In this approach the gluteus medius is reflected anteriorly in continuity with a portion of the vastus lateralis in a bucket handle fash-

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ion. This is accomplished by a sharp dissection close to the trochanter. The conjoint tendon with the gluteus minimus and capsule is elevated as a single flap.⁸

Liverpool Approach. This approach is similar to the Hardinge approach. The only modification is that a sliver of trochanteric bone is taken with the gluteal flap so as to allow better fixation of the flap to the greater trochanter during closure.¹⁹

Classification

The influence of surgical techniques and duration of operation were radiographically assessed at 3 months and 2 years after surgery.

The degree of HO was established based on the classification described by Brooker et al.³: Grade 0, none; grade I, islands of bone in the soft tissue about the hip; grade II, bone spurs from the proximal end of the pelvis or femur; grade III, HO occupying more than half of the gap between the femur and pelvis; and grade IV, bony ankylosis of the hip.

Clinical evaluation of each patient, both before and after surgery, was recorded using the grading system described by d'Aubigne and Postel.⁴

Results

Incidence

One hundred eleven of the 264 cases (42%) in this study exhibited some degree of HO, while 5% showed severe HO (grades III and IV).

Age

The average age of the group with ectopic bone formation was 68.5 years (range, 54–82 years). The average age of the group without ectopic bone formation was 71 years (range, 52–86 years).

Sex

Fifty-seven of the 111 cases of HO were in men ($P \geq .05$). Of the 12 cases with severe HO, 8 were in men.

Morphology of Osteoarthritis

Based on the preoperative radiographs the osteoarthritis was classified as either hypertrophic or nonhypertrophic (including atrophic and normotrophic) as described by Bombelli.²

A comparison of the incidence and extent of HO between the hypertrophic and nonhypertrophic types of osteoarthritis revealed a significant differ-

Table 1. Morphology of Osteoarthritis and Heterotopic Ossification

Heterotopic Ossification	Hypertrophic (n = 113)	Nonhypertrophic (n = 151)
Grade 0	50	103
Grade I	34	31
Grade II	18	14
Grade III	10	3
Grade IV	1	0

Chi-square test = 18.47 (4 df), $P \leq .001$.

ence (Table 1). Patients with the hypertrophic type were at a higher risk of developing HO and at a higher grade ($P < .001$).

Surgical Approach and Ectopic Bone Formation

Analysis of the incidence and extent of HO in the three different lateral approaches revealed significant differences in both of these variables (Table 2). The incidence of HO varied between the three approaches: 36% in the transtrochanteric approach, 65% in the Liverpool approach, and 24% in the Hardinge approach. Severe HO (grades III and IV) was observed in 11% of the Liverpool approach patients in comparison to 2% observed in the other two approaches.

Duration of Surgery

Table 3 suggests that there is some relation between the duration of surgery and HO. Heterotopic ossification occurred more frequently when the surgical time was 2 hours or more ($P \leq .01$).

Effect of Trochanteric Healing and HO

The association of HO with trochanteric healing was analyzed in the transtrochanteric and Liverpool approaches. Severe HO was observed in 12 of 156 patients who experienced sound healing of the trochanter compared to 2 of 26 who experienced trochanteric nonunion. This was not statistically significant.

Functional Significance of HO

The effects of HO on hip function after arthroplasty were assessed using Charnley's modification of the methods of d'Aubigne and Postel. All but one patient had good range of movement in the hip and were fully satisfied with the results (Table 4). Unfortunately, one patient had a totally ankylosed hip (grade

Table 2. Surgical Approach and Heterotopic Ossification

Heterotopic Ossification	Transtrochanteric Approach (n = 94)	Liverpool Approach (n = 88)	Hardinge Approach (n = 82)
Grade 0	60		
Grade I	21	31	62
Grade II	11	28	16
Grade III	2	19	2
Grade IV	0	9	2
		1	0

Chi-square test = 38.18 (8 df). $P \leq .001$.

IV) and was referred to a specialized center for further management.

Discussion

The etiology and pathogenesis of HO are still obscure, but several factors have been investigated in the literature. The reported incidence of this complication varies from 10 to 80%.^{5,7,12,15,17} In this series HO was found in 42% of the patients; in 5.3% it was a severe grade (grades III and IV).

Heterotopic ossification, as such, is not of great clinical significance.^{5,12,15} It is, however, responsible for pain and limitation of postoperative motion in 2-4% of patients.²² Ahrengart and Lindgren¹ studied the effects of heterotopic bone formation on hip function after arthroplasty in 145 cases of total hip arthroplasty. They concluded that heterotopic bone had no serious impact upon hip muscles or gait, although the gain in range of movement after surgery was significantly less in class III or IV heterotopic bone formation. Even for the more severe cases of HO (grades III and IV), only 10% reported serious pain and 26% had reduced hip flexion.⁶ This study lends strong support to this observation.

There have only been a few studies about the development of HO on the basis of surgical approach.^{12,20,21} I am not aware of any study in which the three commonly used lateral approaches (Liverpool, Hardinge, and transtrochanteric) are compared. Although the Liverpool and Hardinge ap-

proaches were developed from the McFarland and Osborne approaches¹¹ with subtle differences as far as tissue plane is concerned, it is interesting to note that HO is more common in the Liverpool approach. In the Liverpool approach an anterior sliver of the trochanter with the conjoint gluteus-vastus flap is elevated; the aim is to achieve better healing than in the Hardinge approach where a sharp dissection of the conjoint tendon is performed.

Sodemann et al. suggested that the magnitude of the bone inductive stimulus released at surgery and the inflammatory reaction caused by surgical trauma may play important roles in the formation of HO.¹⁸ Theoretically, both of these factors operate in the Liverpool approach. First, the trochanter is violated and second, there is an increase in surgical trauma compared to the transtrochanteric approach due to retraction during the surgical procedure. This, however, needs further study to confirm.

Goel and Sharp defined the relationship between heterotopic bone formation and the morphologic type of osteoarthritis after 43 hip arthroplasties.⁷ They reported that the incidence of bone formation

Table 3. Duration of Surgery and Heterotopic Ossification

Duration	Grade		
	0 (n = 153)	I and II (n = 9)	III and IV (n = 14)
<1 hour	57	21	3
1½ hours	73	38	7
>2 hours	23	38	3

Chi-square test = 20.34 (4 df). $P \leq .001$.

Table 4. Clinical Results versus Heterotopic Ossification*

	Heterotopic Ossification		
	No Heterotopic Ossification	Grades I and II	Grades III, and IV
Pain			
Preoperative	2.6	2.7	2.6
Postoperative	5.8	5.8	5.8
Mean difference	3.2	3.1	3.2
Walk			
Preoperative	2.6	2.7	2.9
Postoperative	5.5	5.6	5.3
Mean difference	2.9	2.9	2.4
Range of Motion			
Preoperative	3.0	3.0	3.1
Postoperative	5.8	5.7	5.2
Mean difference	2.8	2.7	2.1

*Scores recorded using the grading system described by d'Aubigne and Postel.⁴

in the atrophic type was 11%, 32% in the normotrophic type, and 87% in the hypertrophic type. This study confirms that hypertrophic arthritis is a risk factor for HO formation.

Soballe et al. analyzed 119 consecutive patients with 129 primary total hip arthroplasties and felt that both local and systemic factors were important in the development of HO.¹⁷ They found that the development of HO was related to the duration of the operative procedure and handling of the tissue at the time of surgery. I agree with this view as Table 3 suggests that there is definite relationship between the duration of surgery and the incidence of HO.

Various prophylactic regimes have been proposed for discouraging heterotopic bone formation. Anti-inflammatory agents, such as indomethacin and ibuprofen have been effective. In agreement with Ahrengart and Lindgren,¹ I believe that HO is not sufficiently important clinically to justify the routine use of prophylactic drugs.

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References

- Ahrengart L, Lindgren U: Functional significance of heterotopic bone formation after total hip arthroplasty. *J Arthroplasty* 4:125, 1989
- Bombelli R: Osteoarthritis of the hip: classification and pathogenesis: the role of osteotomy as a consequent therapy. 2nd ed. Springer-Verlag, Berlin, 1983
- Brooker AF, Bowerman JW, Robinson RA, Riley LH: Ectopic ossification following total hip replacement. *J Bone Joint Surg* 55A:1629, 1973
- Charnley J: Low friction arthroplasty of the hip: theory and practice. Springer-Verlag, Berlin, 1979
- DeLee J, Ferrari A, Charnley J: Ectopic bone formation following low friction arthroplasty of the hip. *Clin Orthop* 121:53, 1976
- Fahrer H, Koch P, Ballmer P et al: Ectopic ossification following total hip arthroplasty: is diffuse idiopathic skeletal hyperostosis a risk factor. *Br J Rheumatol* 27:187, 1988
- Goel A, Sharp DJ: Heterotopic bone formation after hip replacement: the influence of the type of osteoarthritis. *J Bone Joint Surg* 73B:255, 1991
- Hardinge K: The direct lateral approach to the hip. *J Bone Joint Surg* 64B:17, 1982
- Kjaersgaard-Andersen P, Hougaard K, Linde F et al: Heterotopic bone formation after total hip arthroplasty in patients with coxarthrosis. *Orthopaedics* 13:1211, 1990
- Kaersgaard-Andersen P, Sletgard J, Gjerloff C, Lund F: Heterotopic bone formation after noncemented total hip arthroplasty. *Clin Orthop* 252:156, 1990
- McFarland B, Osborne G: Approach to the hip. *J Bone Joint Surg* 36B:364, 1954
- Morrey BF, Adams RA, Cabanela ME: Comparison of heterotopic bone after anterolateral, transtrochanteric and posterior approaches for total hip arthroplasty. *Clin Orthop* 188:160, 1984
- Muller JP, Koch P: Peri articular ossification in total hip prostheses. *Orthopade* 18:511, 1989
- Pedersen NW, Kristensen SS, Schmidt SA et al: Heterotopic bone formation after total hip arthroplasty. *Arch Orthop Trauma Surg* 108:92, 1989
- Ritter MA, Vaughan RB: Ectopic ossification after total hip arthroplasty. *J Bone Joint Surg* 59A:345, 1977
- Rockwood P, Horne JG: Heterotopic ossification following uncemented total hip arthroplasty. *J Arthroplasty* 5(suppl):543, 1990
- Soballe K, Christensen F, Kristensen SS: Ectopic bone formation after total hip arthroplasty. *Clin Orthop* 228:57, 1988
- Sodemann B, Persson PE, Nilsson OS: Periarticular heterotopic ossification after total hip arthroplasty for primary coxarthrosis. *Clin Orthop* 237:150, 1988
- Surendra K: brief review of approaches for total hip arthroplasty and comparing liverpool and charnley approaches. MCh(Ortho) thesis. University of Liverpool, Liverpool, 1979
- Testa NN, Mazur KU: Heterotopic ossification after direct lateral approach and transtrochanteric approach to the hip. *Orthop Rev* 17:965, 1988
- Vicar AJ, Coleman CR: A comparison of the anterolateral, transtrochanteric, and posterior surgical approaches in primary total hip replacement. *Clin Orthop* 188:152, 1984
- Warren SB: Heterotopic ossification after total hip replacement. *Orthop Rev* 19:603, 1990
- Wroblewski BM, Shelly P: Reattachment of the greater trochanter after hip replacement. *J Bone Joint Surg* 67B:73, 1985