HETEROTOPIC BONE FORMATION AFTER HIP REPLACEMENT

THE INFLUENCE OF THE TYPE OF OSTEOARTHRITIS

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The relationship between heterotopic bone formation and the morphological type of osteoarthritis was examined after 43 hip replacements. Of the 43 hips studied, nine were atrophic, 19 were normotrophic, and 15 were hypertrophic. The incidence of heterotopic bone formation in the atrophic type was 11%, in the normotrophic type 32%, and in the hypertrophic type 87%. The difference between each type was statistically significant ($p < 0.001$).

Heterotopic bone formation (HBF) following hip replacement is a common complication occurring in 60% to 80% of cases (DeLee, Ferrari and Charnley 1976; Ritter and Vaughan 1977; Ling 1984; Sodemann, Persson and Nilsson 1988). The low incidence reported in early studies is attributable to the use of imprecise diagnostic criteria, overlooking minor degrees of ossification (Ling 1984; Sodemann et al 1988). Functional impairment is said to occur in 3% to 10% of the patients with HBF (Rosendahl, Krogh Christoffersen and Norgaard 1977; Morrey, Adams and Cabanela 1984; Ling 1984).

Studies of hip replacement indicate that HBF is more common in patients with osteoarthritis, and it has been assumed that an ill-defined 'individual reactivity or predisposition' is the major determinant (Ritter and Vaughan 1977; Ling 1984; Thomas and Amstutz 1985; Sodemann et al 1988).

This study has investigated the problem by correlating HBF with the biological expression of the osteoarthritis, more specifically with the osteoblastic response.

PATIENTS AND METHODS

We have studied a total of 43 hip replacements in 40 patients performed between 1985 and 1988.

To reduce the variation within material factors that

might affect the development of HBF the following criteria were used:

- 1) only patients with a pre-operative diagnosis of idiopathic osteoarthritis were included;
- 2) all cases with previous surgery on the same hip were excluded;
- 3) all patients were operated on by one consultant surgeon, as elective procedures, and using a posterior approach;
- 4) in all cases the same prosthesis was used (cementless Bateman II: 3M Health Care Ltd, Loughborough, England);
- 5) all cases with postoperative complications such as infection or dislocation were excluded from the study;
- 6) no postoperative treatment by non-steroidal anti-inflammatory drugs, diphosphonates or radiotherapy was used.

From the pre-operative radiographs, the osteoarthritis was classified into atrophic, normotrophic and hypertrophic types as described by Bombelli (1983) (Table I and Fig. 1). Sequential postoperative radiographs

Table I. Criteria for the three morphological types of osteoarthritis of the hip

Site	Atrophic	Normotrophic	Hypertrophic
Femoral head	Decreased in size due to partial collapse	No change in size but head usually deformed	Head increased in size and severely deformed
Femoral osteophytes	Absent	Moderate, medially and laterally; double contour of medial neck	Large lesions on several sides; double contour of medial neck
Acetabular osteophytes	Absent, or small, on acetabular roof	Multiple, on roof and floor, of moderate size	Multiple, giant lesions

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were studied to assess the development of HBF. This was classified using a five-grade scale (Brooker et al 1973, Fig. 2):

Grade 0. No HBF;

Grade I. One or two areas of ossification, each less than 1 cm in diameter;

Grade II. More widespread isolated areas of ossification from the proximal femur or acetabular rim covering less than one-half of the distance between the femur and the pelvis;

Grade III. Ossification covering more than one-half of the distance between the femur and the pelvis but not bridging the entire distance;

Grade IV. Ossification bridging the entire distance between the femur and the pelvis.

Each case was followed for a minimum of six months, and statistical analysis of the results was made using the chi-square test.

RESULTS

By Bombelli's classification, nine hips were defined as atrophic (21%), 19 were normotrophic (44%) and 15 hypertrophic (35%, Table II). HBF developed in 20 hips (46.5%). The tendency to HBF was least marked in atrophic osteoarthritis (Table III), where only one hip

Fig. 1a

Fig. 1b

Fig. 1c

The morphological types of osteoarthritis of the hip: (a) atrophic (b) normotrophic (c) hypertrophic.

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

Grades of heterotopic bone formation: (a) grade I, (b) grade II, (c) grade III, (d) grade IV.

Table II. Number, age and follow-up of 40 patients with each of the three morphological types of idiopathic osteoarthritis of the hip

Type of osteoarthritis	Number of hips (patients)		Age at operation Mean, SD (yr)	Follow-up Mean, SD (mth)
	Male	Female		
Atrophic	3 (3)	6 (6)	73.5 ± 6.6	13.1 ± 6.4
Normotrophic	12 (10)	7 (7)	68.5 ± 9.2	15.9 ± 8.3
Hypertrophic	9 (8)	6 (6)	73.6 ± 7.7	13.3 ± 3.3

Table III. Incidence of heterotopic ossification in 43 hips of patients with three morphological types of idiopathic osteoarthritis of the hip

	Absent (Grade 0)		Present (Grades I to IV, see text)					
	Number	%	I	II	III	IV	Total	%
Atrophic	8	89	0	1	0	0	1	11*
Normotrophic	13	68	2	0	2	2	6	32*
Hypertrophic	2	13	8	3	2	0	13	87*
Total	23	53	10	4	4	2	20	

* significance of difference: chi-squared = 16, df = 2, $p < 0.001$

developed HBF (11%), while it was most marked in the hypertrophic group (13, 87%). Normotrophic osteoarthritis gave intermediate results with six hips (32%) showing HBF.

The three groups of osteoarthritis showed no significant differences regarding age, sex and length of follow-up. The differing incidence of HBF developing in each osteoarthritic group was found to be significant (chi-squared = 15.958, df = 2, $p < 0.001$).

DISCUSSION

In our study a wide range of grades of HBF was seen, from small, barely visible spots to virtual ankylosis of the hip. The time limit of six months was chosen because HBF is said not to develop later (Brooker et al 1973; Ling 1984). The lower incidence of HBF as compared to other recent studies may be attributable to the fact that we studied an uncemented prosthesis which did not require acetabular reaming and so less tissue trauma. A strong correlation emerges between HBF and the type of osteoarthritis, with the hypertrophic type showing the greatest incidence, and the atrophic the least. Previous studies of the development of HBF after hip replacement for osteoarthritis have shown that of various factors such as age, sex, size of osteophytes, operative approach, and prosthetic design, the most important is an 'individual reactivity' or predisposition to HBF after surgery (DeLee et al 1976; Ritter and Vaughan 1977; Ling 1984; Thomas and Amstutz 1985; Sodemann et al 1988).

The authors are unaware of any study that has tried to establish the nature of this 'individual reactivity'. Our study demonstrates that this predisposition correlates strongly with the morphological type of osteoarthritis. Three differing morphological types of osteoarthritis are thought to reflect differing osteoblastic responses (Solomon 1978; Bombelli 1983). There is no direct evidence to support this, but biomechanical studies reflect differing mechanical properties of the subchondral bone of the femoral head in these morphological types (Tanner et al 1988). Furthermore, an increased incidence of acetabular component loosening has been observed in total hip

replacements performed for the treatment of the atrophic type of osteoarthritis (Saito et al 1987). This suggests that there is a fundamental difference of bone behaviour in these various types of osteoarthritis, our study supports this.

Our findings will help to identify those patients who are predisposed to develop HBF after a hip replacement.

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