

FACTORS ASSOCIATED WITH HETEROTOPIC BONE FORMATION IN CEMENTED TOTAL HIP PROSTHESES

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A series of 237 total hip replacements were analysed by means of a computer program. High body weight and postoperative fever, as well as several indications of a technically demanding operation, occurred significantly more often in the group of patients which developed paraarticular ossification postoperatively. The results point to a causal relation between tissue trauma and heterotopic bone formation.

We wish to underline the importance of a gentle handling of tissues in the performance of a total hip replacement if the rate of ectopic bone is to be reduced to a minimum.

Key words: epidural anaesthesia; heterotopic bone; hip prosthesis; postoperative complications; tissue trauma

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The pathogenesis of ectopic bone formation following total hip replacement (THR) is poorly understood. Paraarticular ossification has been reported to occur as early as 2–3 weeks after a THR (Nollen & Sloof 1973). In severe cases the condition leads to stiffness of the joint and since there is no recognized method of preventing heterotopic bone formation once it has started to develop, it sometimes leads to failure of the operation. The aim of this project was to analyse factors correlated to ectopic bone formation during the first 3 years postoperatively.

MATERIAL AND METHODS

We studied 237 THR from one orthopaedic department operated via an anterolateral approach (Table 1). Trochanter osteotomy was performed only in selected cases (7 per cent of total). Patients were permitted to

stand up on the day following surgery. A stick or crutches were commonly used by the patients for 6 weeks after the operation and longer if desired. As a routine procedure, patients attended the outpatient clinic for physical examination including radiogram and ESR 6 months, 1 year and 3 years after the operation. Seven hips were missing at the examination after 6 months. At the 1 year control 10 hips were missing (one patient had died). Twenty one hips were lost at the 3-year follow up (11 patients had died before the 3-year control).

Cases with heterotopic bone 2 cm or more in size measured in the frontal or lateral radiogram a) on the medial side of the hip joint or b) on the lateral side of the hip joint, and cases with overbridging ossification were included. This corresponds approximately to Charnley's class II and III with subclasses 2 and 3 of ectopic bone respectively (Charnley 1979).

In the present study, the pre- and postoperative radiograms of all hips were examined together with current standard radiograms, which included a–p and lateral views of the hip. All information collected was analysed using a computer program. The statistical significance between differences was evaluated by the chi-square test.

Table 1. Patient material encountered in the study

No. of hips	No. of patients	Males*	Females*	Osteoarthritis*	Rheumatoid* arthritis	Charnley-Müller* prosthesis	CAD** prosthesis
237	195	45	55	88	10	87	13

* In per cent.

** Computer Assisted Design, Howmedica.

RESULTS

The incidence of heterotopic bone during this 3-year follow up was 24 per cent. The incidence of medical ectopic bone was 14 per cent and the incidence of lateral ectopic bone was 18 per cent.

Most cases occurred within the first 6 months after THR, increasing up to 1 year with only a few new cases developing after 1 year postoperatively. The loosening rate was not higher in the group with ectopic bone than in the normal group. In the following text, cases without signs of ectopic bone are referred to as the normal group. The clinical condition of the patient as well as factors at surgery were correlated to heterotopic bone.

Males tended to be more frequently affected with ectopic bone than females. High body weight was positively correlated as was also higher age of the patients operated on. It was also observed that osteoporosis was more frequently diagnosed preoperatively in the cases that developed ectopic bone after THR. Primary osteoarthritis of the affected hip was the predominant diagnosis and the patients had significantly more often only unilateral hip disease without other dysfunctions of the lower extremities when heterotopic bone was formed. Patients with rheumatoid arthritis were significantly less often affected. None of the cases treated with cortisone preoperatively developed ectopic bone. The cases that developed heterotopic bone often did well without supportive aids or with only one stick preoperatively and their physical activity was often fairly unrestricted before THR (Figure 1 and Table 2).

Concerning factors at surgery, it was observed that there was a slight and insignificant increase

in the operating time in the group with ectopic bone but the degree of bleeding estimated as the number of transfusions given per- and post-operatively was not higher. The CAD-prosthesis (Computer Assisted Design, Howmedica), had

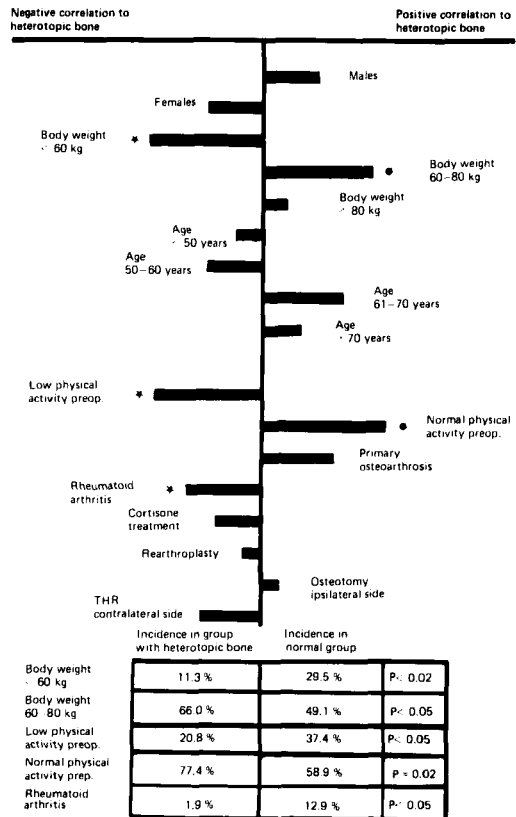


Figure 1. Illustration of clinical factors preoperatively correlated to heterotopic bone during 3 years after THR. The length of the bars is based on the relative differences in incidence between heterotopic bone group and normal group.

Table 2. Preoperative clinical factors with correlation to location of heterotopic bone

Factor correlating to heterotopic bone	Location and observation time of heterotopic bone	Incidence in group with heterotopic bone*	Incidence in normal group*	
High physical activity preop.	<i>lateral</i> , at 6 months	87	60	$P < 0.02$
Body weight below 60 kg	<i>lateral</i> , during 3 years	7	29	$P < 0.01$
General disease impairing locomotion	<i>lateral</i> , at 3 years	4	26	$P < 0.05$
Osteoporosis	<i>medial</i> , at 6 months	14	2	$P < 0.05$
No other disease impairing locomotion	<i>medial</i> , at 6 months	59	33	$P < 0.05$
No other disease impairing locomotion	<i>Medial</i> , during 3 years	55	33	$P < 0.05$

* In per cent.

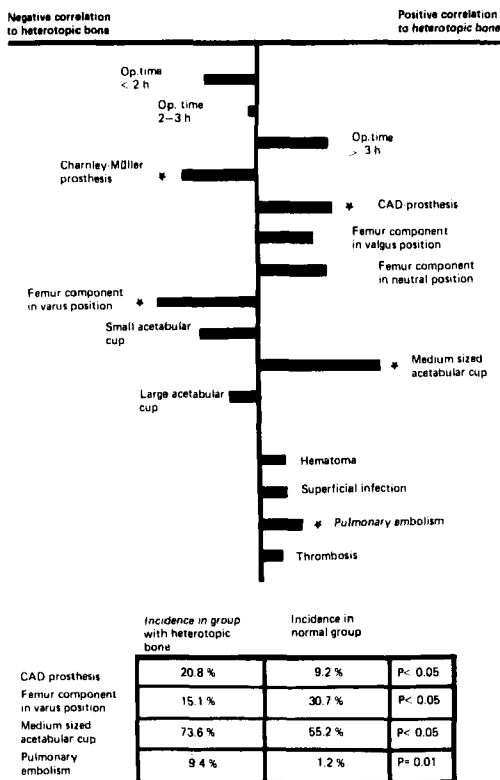


Figure 2. Factors at surgery correlated to heterotopic bone formation during 3 years after THR. The length of the bars is based on the relative differences in incidence between heterotopic bone group and normal group.

more often been used when heterotopic bone was formed. A valgus oriented femoral prosthesis and a short or a long distance between the femur and the pelvis was often obtained when ectopic bone occurred.

Approximately 50 per cent of the material was operated under general anaesthesia and 50 per cent under epidural anaesthesia. The rate of ectopic bone formation was found to be 60 per cent higher after epidural anaesthesia compared with general anaesthesia ($P < 0.02$). The bleeding also differed and accordingly more than 5 units were given in 41 per cent of THR under general anaesthesia and in 31 per cent in THR under epidural anaesthesia (not significant). Only 2 per cent haematomas were diagnosed after epidural anaesthesia as compared with 5 per cent under general anaesthesia (not significant).

When considering the postoperative condition of the patient, it was noted that fever for more than 5 days postoperatively significantly more often preceded the formation of heterotopic bone. Moreover there was a higher rate of pulmonary embolism in the group with ectopic bone. Moderate to severe pain on motion at 6 months postoperatively was often present in the patients when lateral ectopic bone had developed. Patients with heterotopic bone were more frequently afflicted with a greatly restricted range of

Table 3. Factors at surgery and postoperatively correlating to the location of heterotopic bone

Factors correlating to heterotopic bone	Location and observation time of heterotopic bone	Incidence in group with heterotopic bone*	Incidence in normal group*	
Femoral component in valgus position	<i>lateral</i> , at 3 years	32	10	$P < 0.01$
Epidural anaesthesia	<i>medial</i> , at 6 months	77	48	$P < 0.02$
Fever during more than 5 days postop.	<i>lateral</i> , at 6 months	54	24	$P < 0.01$
Moderate to severe pain on motion at 6 months postop.	<i>lateral</i> , at 1 year	28	13	$P < 0.05$
Greatly restricted range of motion at 1 year postop.	<i>lateral</i> , at 1 year	19	4	$P < 0.01$
Greatly restricted range of motion at 3 years postop.	<i>lateral</i> , at 3 years	36	6	$P < 0.001$

* In per cent.

motion than patients in the normal group but in most cases they did well without supportive aids or with only one stick or crutch. Only four cases with ectopic bone were selected for rearthroplasty (Figure 2 and Table 3).

DISCUSSION

In the present study 23 per cent of the cases with ectopic bone had a greatly restricted range of motion and 30 per cent suffered from pain on motion. This is in accordance with Ilstrup et al. (1973) and Rosendahl et al. (1977), who also found that ectopic bone significantly influences hip function.

The incidence of heterotopic bone in the present study was 24 per cent, which is in accordance with the findings of several other investigators (Nollen & Sloof 1973, Harris et al. 1972, Brooker et al. 1973). Kromann-Andersen et al. (1980) noted 34 per cent ectopic bone of moderate to severe degree in their study. However, Charnley (1979) reports incidences which are considerably lower or about 10 per cent. A factor of importance may be the exclusive use of general anaesthesia in his series.

Heavy patients were overrepresented and an insignificant preponderance of male patients was noted in the group with ectopic bone in the pres-

ent study. In heavy patients more traumatizing force may have been exerted when using the retractors to get good access. Trochanteric osteotomy was performed only in selected cases among our patients and in a number of cases strain of the musculo-tendinous insertion on the greater trochanter may have resulted for this reason.

The present results, showing a preponderance of the CAD-prosthesis in the group with ectopic bone may simply reflect the fact that the femur preparation procedure is somewhat more difficult with this prosthesis due to its thick stem. Without trochanter osteotomy the CAD-prosthesis may require greater force to achieve correct positioning than is the case with the Charnley-müller prosthesis.

Valgus oriented femoral prostheses were positively correlated to ectopic bone. A normal femur-pelvis distance was significantly less frequently obtained than a long or short distance when ectopic bone occurred. These relations were apparently a functional result of technical difficulties and increased surgical tissue trauma.

As to the higher incidence of ectopic bone noted for cases operated under epidural anaesthesia compared to general anaesthesia this may reflect the effect of the higher muscular tone necessitating more force in order to obtain good access during the operation. We noted a 60 per

cent higher incidence of ectopic bone formation in cases operated under epidural anaesthesia and in particular the medial ectopic bone was increased corresponding to the iliopsoas musculo-tendinous apparatus.

Our observation that rheumatoid arthritis was negatively correlated to the development of heterotopic bone is recognized by several investigators, although not often with statistical significance (Nollen & Sloof 1973, DeLee et al. 1976). A more frequent use of prostaglandin synthesis inhibitors with this disease as compared with unilateral primary osteoarthritis may relate to this difference. None of the patients treated with cortisone preoperatively developed ectopic bone, which may partly be the result of its ability to depress the local tissue response to trauma. Osteoporosis diagnosed preoperatively was found to be positively correlated to ectopic bone formation. The cause of this is obscure strain on musculo-tendinous insertions on porotic bone may cause more microfractures and tears than normal. A preponderance of osteoporotic patients with ectopic bone formation was also reported by Chapchal (1973). The hypothesis that trauma is the main cause of ectopic bone formation is supported by a recent experimental study in rabbits (Hierton 1982). Following tissue trauma there is also risk of complications such as haematoma formation, thromboses, pulmonary embolism and infections, all of which add to the risk of developing ectopic bone. We found that the rate of concomitant infections, haematomas and pulmonary embolism or thromboses when ectopic bone formation occurred was increased by about 60 per cent (Figure 2).

From these results it seems justifiable to conclude that tissue trauma is a common denominator of ectopic bone formation. Injured cells cause an inflammatory reaction which is mediated by, among other factors, prostaglandins. At present the cellular pathomechanism has not been resolved and the preferred way to

minimize ectopic bone seems to be by controlling tissue trauma. We believe that the surgical approach as well as muscle relaxation are the most important factors whereby tissue trauma can be influenced in the normal routine, but the administration of diphosphonates (Nollen & Sloof 1973), radiation therapy (Coventry & Scanlon 1981) or prostaglandin synthesis inhibitors may be useful under special circumstances.

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