Acta orthop. scand. *54*, 584–588, 1983

FACTORS ASSOCIATED WITH CALCAR RESORPTION IN CEMENTED TOTAL HIP PROSTHESES

CLAËS HIERTON, GUDMUND BLOMGREN & URBAN LINDGREN

Department of Orthopaedic Surgery, Karolinska Institutet, Huddinge Hospital, Stockholm, Sweden

Patient data and radiograms from a series of 237 total hip replacements were evaluated by means of a computer program. Middle-aged patients and those without other dysfunctions of the lower extremities than the primary hip disease were prone to develop calcar resorption. Patients who did not use supportive aids preoperatively and subjects doing well without aids postoperatively were more frequently represented in the group with calcar resorption. The CAD-prosthesis (Computer Assisted Design, Howmedica), was positively correlated to resorption at calcar at 6 months postoperatively compared to the Charnley-Müller prosthesis. A negative correlation to valgus oriented femoral components was noted. Vertical placement of the acetabular cup, large cups and a long distance between the femur and the pelvis was noted to occur more often in the group with calcar resorption. Mechanical factors are concluded to be predominant in early calcar resorption and are suggested to be of clinical importance for the long term results.

Key words: aseptic loosening; bone cement; calcar resorption; hip prosthesis; postoperative complication

Accepted 21.xii.82

The pathogenesis of the calcar resorption following total hip replacement (THR) is not fully understood. Mechanical, microcirculatory and chemical factors are believed to be responsible for this complication (Oh & Harris 1978, Griss et al. 1978, Cupic 1979).

On the assumption that factors of the greatest clinical relevance in the development of calcar resorption are traced early, the aim of this project was to study factors associated with calcar resorption during the first 3 years postoperatively.

MATERIAL AND METHODS

A series of 237 THR was investigated. Prophylactic antibiotics were not used. The clinical infection rate was 2 per cent. An anterolateral approach was used in 94 per cent. Trochanter osteotomy was done in 7 per cent. The patients were allowed to stand up on the day following surgery. As a routine procedure, patients attended the outpatient clinic for physical examination, including radiogram, 6 months, 1 year and 3 years after the operation.

We collected data from the patient records and from the radiograms. 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 were dead in total before 3 years) (Table 1). The criterion for calcar resorption was a radiolucent zone of 3 mm or more at the medial femoral neck stump (Blacker & Charnley 1978).

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

Table 1. Material encountered in the study

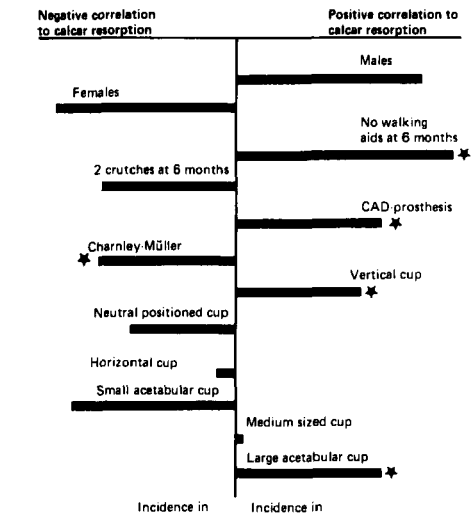
No. of hips	Males*	Females*	Osteoarthritis*	Rheumatoid arthritis*	Charnley-Müller-prosthesis*	CAD-prosthesis*
237	45	55	88	10	87	13

* In per cent.

RESULTS

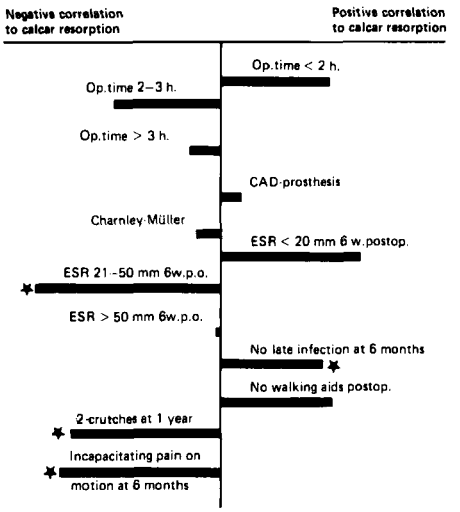
The incidence of calcar resorption during this 3-year follow-up was 37 per cent. At 6 months postoperatively patients doing well without supportive aids more frequently had calcar resorption. Concerning the implant, the CAD-prosthesis (Computer Assisted Design, Howmedica) was overrepresented in the group with calcar resorption. Vertically placed acetabular cups and large acetabular cups were also more frequent when resorption at calcar occurred (Figure 1).

One year after the operation, incapacitating pain on motion was relatively infrequent in patients with calcar resorption. Two crutches were also less commonly used through the observation period by patients with calcar resorption. Up to 6 months there was no case with signs of late infection in the group with resorption. With reference to patient characteristics, it was noted that middle aged patients and subjects who did not use supportive aids postoperatively were more prone to



	Incidence in calcar resorption group	Incidence in normal group	
CAD-prosthesis	26.5 %	10.7 %	P< 0.05
Large acetabular cup	23.3 %	9.1 %	P< 0.05
Vertical cup	17.6 %	6.1 %	P< 0.05
No walking aids at 6 months	100 %	90.3 %	P< 0.05

Figure 1. Illustration of factors correlated to calcar resorption at 6 months postoperatively. The length of the bars is based on the relative differences in incidence between the calcar resorption group and the normal group.



	Incidence in calcar resorption group	Incidence in normal group	
ESR 21–50 mm 6 weeks postoperatively	29.4 %	46.7 %	P< 0.05
No late infection at 6 months	100.0 %	90.3 %	P< 0.05
2 crutches at 1 year	7.8 %	21.8 %	P< 0.05
Incapacitating pain on motion at 6 months	3.9 %	18.8 %	P = 0.02

Figure 2. Illustration of factors correlated to calcar resorption at 1 year postoperatively. The length of the bars is based on the relative differences in incidence between the calcar resorption group and the normal group.

Table 2. Factors correlated to calcar resorption at 3 years after THR

	Incidence in the calcar resorption group*	Incidence in the normal group*	
Age between 51 and 61 years	29	15	$P<0.05$
Other dysfunctions of the lower extremities	8	21	$P<0.05$
No walking aids preoperation	14	3	$P=0.01$
ESR < 20 mm 6 weeks preoperation	50	31	$P=0.02$
No late infection at 3 years	98	86	$P<0.02$
No walking aids at 6 months	32	14	$P<0.01$
2 crutches at 6 months	12	27	$P<0.05$
2 crutches at 1 year	8	22	$P=0.02$
Incapacitating pain on motion at 6 months	6	18	$P<0.05$
No reoperation considered at 6 months	100	91	$P<0.05$
Femur component in valgus position	3	16	$P<0.02$
Long distance femur-pelvis	22	11	$P<0.05$
No resorption around femoral cement-bone interface at 6 months	74	55	$P=0.02$
No resorption around femoral cement-bone interface at 1 year	69	42	$P<0.001$
No resorption around femoral cement-bone interface at 3 years	62	27	$P<0.001$

* In per cent.

Table 3. Factors correlated to calcar resorption in the absence of loosening during 3 years after THR (55 cases)

	Incidence in the calcar resorption group*	Incidence in the normal group*	
No walking aids preoperation	15	4	$P<0.02$
No walking aids at 6 months postoperatively	35	15	$P<0.01$
2 crutches at 6 months	11	27	$P<0.05$
No walking aids at 1 year	36	21	$P<0.05$
2 crutches at 1 year	8	22	$P<0.05$
No walking aids at 3 years	56	26	$P<0.001$
Incapacitating pain on motion at 1 year	4	17	$P<0.05$
No late infection at 3 years	98	87	$P<0.05$
Operation time <2 hours	19	7	$P<0.02$
Short prosthetic neck length	0	13	$P=0.01$
Medium prosthetic neck length	75	55	$P=0.02$
Short distance between femur and the pelvis	4	21	$P<0.01$
Long distance between femur and the pelvis	25	11	$P=0.02$

* In per cent.

develop calcar resorption. An inverse correlation to resorption at calcar was also noted for cases with dysfunctions of the lower extremities other than the primary hip disease.

A long distance between the femur and the pelvis was more frequent in the group with calcar resorption. Valgus positioning of the femoral component was inversely correlated to calcar resorption. Late infection as well as indication for revision surgery was less frequent in the group with resorption at calcar femoris.

Concerning factors of clinical relevance it was

Table 4. Factors without significant correlation to calcar resorption (n = 237)

	Incidence in the total material*
Rheumatoid arthritis	10
Osteoarthritis	
following infection	3
following osteonecrosis	10
Diabetes	4
Osteoporosis	5
Glucocorticoid treatment	6
Bilateral THR	17
General anaesthesia	46
Epidural anaesthesia	49
>3 hours of surgery	23
Trochanter osteotomy	7
Postoperative haematoma	3
Postoperative dislocation	3
Postoperative deep vein thrombosis	4
Fever (>38°C) at 5 days postoperatively	28

* In per cent.

noted that a higher number of patients with calcar resorption did well without any supportive aid as compared with the normal group. Correspondingly, two crutches were less often used by the patients with calcar resorption than by patients in the normal group. Incapacitating pain on motion was rarely encountered in patients in the calcar resorption group when compared with the normal group. Referring to radiological characteristics, resorption around the femoral cement-bone interface was clearly inversely correlated to calcar resorption (Table 2).

In 55 cases calcar resorption without radiological loosening of the femoral component was observed in the 3 years after the operation. The incidence of certain factors at surgery and the incidence of factors with clinical relevance in cases with calcar resorption without radiological loosening of the femoral component are given in Table 3.

The incidence of some factors without statistically significant correlation to calcar resorption are shown in Table 4.

DISCUSSION

The incidence of calcar resorption was 37 per cent during the first 3 years after THR in this study. This is in accordance with the findings of Blacker & Charnly (1978) in that the average onset time of calcar resorption was 13 months although the incidence of calcar resorption at 7–13 years postoperatively was 70 per cent. Beckenbaugh & Ilstrup (1978), on the other hand, noted only 16 per cent resorption at calcar in a 5-year follow-up of their material.

The clinical condition of the patient as well as factors at surgery, such as the prosthetic design, the surgical technique, the positioning of the prostheses and the cementing technique may be responsible for the development of calcar resorption.

With reference to clinical factors it was found that patients with a high degree of physical activity more often developed the complication at study. The reason for this appears to be the abnormal stresses imposed by the implant on the proximal femur, i.e. tension of circumferential fibres, compression of axial fibres and shear stresses (Huiskes 1980, McBeath & Foltz 1979). In addition the production of wear debris may be of aetiological importance in this group of patients. Such debris leads to the formation of foreign body granuloma causing bone resorption around the implant (Willert et al. 1978).

With reference to factors at surgery, the positive correlation found with large acetabular cups, vertical cups, varus positioning of the femoral component and a long distance between the femur and the pelvis, all point to mechanical factors. Large acetabular cups in this study were often used in heavy and tall patients. When calcar resorption occurred and where the acetabular cups were placed in a vertical position, the femoral components were correspondingly oriented in varus except in two cases. In these two cases a CAD-prosthesis had been used and these patients were physically active without radiographic signs of loosening. The present observation that varus-oriented femoral components were associated with increased incidence of resorption at calcar femoris is in agreement with the findings of Sarmiento et al. (1979). The rela-

tive preponderance of the CAD-prosthesis in the group with calcar resorption at 6 months after surgery may reflect a different mechanical pattern of this prosthesis compared with the Charnley-Müller prosthesis. It may also reflect a greater trauma at surgery. As pointed out by Cupic (1979) calcar resorption may be the consequence of a disturbed circulation due to the surgical trauma. However, several of these mechanical factors may not lead to a worse final outcome of a THR. Accordingly, the CAD-prosthesis was with reference to our results (Hierton et al. 1982) a safety factor of relevance for the early radiological loosening rate. In the long term perspective, however, calcar resorption becomes a negative factor because it leads to greater stresses on the prosthesis and the bone-cement interface.

Bone as a living material responds to forces acting on it and bone resorption can occur from either insufficient or excessive forces (Brockhurst & Svensson 1977). With regard to the *in vitro* comparison of strain distribution in the intact femur and after insertion of different femoral components by Oh & Harris (1978), the CAD-prosthesis was found by the same authors to restore at least 40 per cent of the load normally carried by the calcar, mainly due to its collar. Our result showing an overrepresentation of calcar resorption in the group with CAD-prostheses may be ascribed to difficulties in making an appropriate cut of the calcar, leading to areas of excessive load and bone resorption. On the other hand the higher incidence of calcar resorption may simply reflect a better functional result with the CAD-prosthesis via the factors discussed above.

In conclusion, the abnormality imposed on the proximal femur by a THR may cause progressive calcar resorption and late loosening or fracture of the femoral component. Its relation to the positioning of the prosthesis shows that mechanical factors are of aetiological importance. The positive correlation with the unrestricted use of the prosthesis indicates the possibility that wear of the polyethylene may also have aetiological importance. The higher tendency for symptom-free cases to develop resorption at calcar femoris identifies the limited ability of a conventional THR to offer a permanent solution for hip disability.

REFERENCES

Beckenbaugh, R. D. & Ilstrup, D. M. (1978) Total hip arthroplasty. A review of three hundred and thirty three cases with long follow-up. *J. Bone Joint Surg.* **60**-A, 306–313.

Blacker, G. J. & Charnley, J. (1978) Changes in the upper femur after low friction arthroplasty. *Clin. Orthop.* **137**, 15–23.

Brockhurst, P. J. & Svensson, N. L. (1977) Design of total hip prosthesis. The femoral stem. *Med. Progr. Technol.* **5**, 73–102.

Cupic, Z. (1979) Long-term follow-up of Charnley arthroplasty of the hip. *Clin. Orthop.* **141**, 28–43.

Griss, P., Heimke, G., Werner, E., Bleicher, J. & Jentschura, G. (1978) Was bedeutet die Resorption des Calcar Femoris nach der Totalendoprothesenoperationen der Hüfte? *Arch. Orthop. Traumat. Surg.* **92**, 225–232.

Hierton, C., Blomgren, G. & Lindgren, U. (1983) Factors associated with early loosening of Cemented Total Hip Prostheses. *Acta Orthop. Scand.*, in press.

Huiskes, R. (1980) Some fundamental aspects of human joint replacement. *Acta Orthop. Scand.*, Suppl. 185.

McBeath, A. A. & Foltz, R. N. (1979) Femoral components loosening after total hip arthroplasty. *Clin. Orthop.* **141**, 66–70.

Oh, I. & Harris, W. H. (1978) Proximal strain distribution in the loaded femur. An in vitro comparison of the distribution in the intact femur and after insertion of different hip replacement femoral components. *J. Bone Joint Surg.* **60**-A, 75–85.

Sarmiento, A., Turner, T. M., Latta, L. L., Eng, P. & Tarr, R. R. (1979) Factors contributing to lysis of the femoral neck in total hip arthroplasty. *Clin. Orthop.* **145**, 208–212.

Weissman, B. (1981) Radiographic evaluation of total joint replacement. In: *Textbook of Rheumatology.* (Eds. Keley, W., Harris, E., Ruddy, S. & Sledge, C.), W. B. Saunders, Philadelphia.

Willert, H.-G., Semlitsch, M., Buchhorn, G. & Kriete, U. (1978) Materialverschleiss und Gewerbereaktion bei künstlichen Gelenken. *Orthopäde* **7**, 62–83.

Correspondence to: Urban Lindgren M.D., Department of Orthopaedic Surgery, Huddinge Hospital, S-41 86 Huddinge, Sweden.