Acta orthop. scand. *52*, 339–344, 1981

351 TOTAL HIP REPLACEMENTS ACCORDING TO CHARNLEY

A Review of Complications and Function

ÅKE S. CARLSSON

Department of Orthopaedic Surgery, Malmö General Hospital, (University of Lund), Malmö, Sweden.

Three hundred and forty-two out of 351 consecutive Charnley total hip arthroplasties performed during a period of 5 years were reviewed once, and 233 of the non-infected hips, a second time on average 5 years postoperatively.

The initially high infection rate – 16 per cent – was reduced by antibiotic prophylaxis. The systemic complications did not differ from those described by others. Non-infectious stem loosening was observed in almost 36 per cent, but only 3 per cent required revision. Three sockets (1 per cent) were loose. The relief of pain and the improvement in function were rewarding and, with the exception of some cases with stem loosening, did not deteriorate with time.

Key words: arthroplasty; coxarthrosis; hip; infection

Accepted 1.xi.80.

Total hip replacement is a well documented and widely used procedure, and the number of hip replacements performed each year still seems to be increasing. In 1979 in Sweden, which has a population of about 8 million, approximately 4000 hips were replaced.

The aim of this study was to present the function of the patients and the complications encountered in a material which had undergone a comparatively long observation.

The hips included constitute the base material of previously published investigations concerning postoperative dislocation (Carlsson & Gentz 1977), peroperative bleeding (Carlsson et al. 1977b) and mechanical loosening of the stem prostheses (Carlsson & Gentz 1980). These hips also form part of a larger group in which deep infection has been investigated.

Financial support was obtained from the Swedish Medical Research Council (project no. B 80-17X-02737-12) and the Herman Järnhardt Foundation.

PATIENTS AND METHODS

Between 1968 and 1972, 351 total hip replacements were performed in 310 patients in the Department of Orthopaedic Surgery, Malmö General Hospital. The annual number of operations during the above-mentioned period and in the following years is presented in Figure 1. The hips were operated upon according to Charnley's original technique and approach by 18 surgeons with varying degrees of experience.

All surviving patients were re-examined by the author during the years 1973–1974, and again in 1976–1977. In the presentation of deep infection and mechanical loosening of the stem prosthesis nine hips were excluded from the base material, six because the patients died within 1 year postoperatively (all within 6 months) and three because of insufficient radiographic information. Thus, 342 hips in 303 patients remained.

In the presentation of function, only hips re-examined twice clinically and radiographically are included. Thus re-operation or death excluded some patients. The interval between the operation and the first re-examination averaged 36 ± 14 months, and between the operation and the second re-examination 72 ± 15 months. There was no difference in the observation time between category A, B and C patients (see below).

The numerical system of grading hip function, originally devised by Merle d'Aubigné & Postel and

0001-6470/81/030339-06 $02.50/0

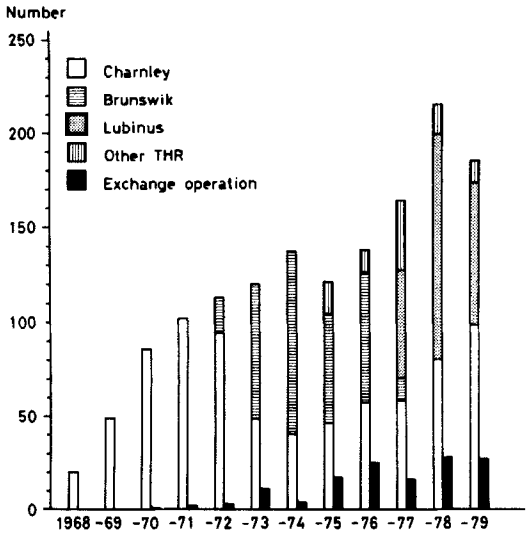

Figure 1. The annual number of THR performed at Malmö General Hospital.

modified by Charnley, was used (Merle d'Aubigné & Postel 1954, Charnley 1972 and 1979) (Table 1).

By adding prefixes A, B and C to the numerical grading the patients can be grouped into categories (Charnley 1972 and 1979). A category A patient is physically fit in all respects relating to function and has no disability other than the affected hip. Category B patients have both hips affected but are otherwise physically fit. Patients with both hips replaced by a total hip at the time of re-examination were categorized BB (Charnley 1979). Category C was reserved for patients with conditions directly impairing the act of walking such as cardiac insufficiency, gonarthrosis or rheumatoid arthritis. The distribution between groups A, B and C is shown in Table 7.

Previous hip surgery

Seventy of the 342 hips had previously been operated upon using the following procedures: Osteotomy 21, hemi-arthroplasty 6, nailing because of femoral neck fracture 20, arthrodesis 5, mould arthroplasty 7 and various other methods 11.

RESULTS

Sex, age and diagnosis

Sex, age and diagnosis are presented in Table 2. The female/male ratio was 1.5:1. Patients operated upon for rheumatoid arthritis and fracture complications were significantly younger than patients with primary osteoarthritis ($P < 0.001$). The men were significantly younger than the women at the time of the operation ($P < 0.05$).

Table 1. Method of grading functional status of the hip (Merle D'Aubigné & Postel, modified by Charnley)

Grade	1	2	3	4	5	6
PAIN	Severe Spontaneous	Severe on attempting to walk. Prevents all activity	Pain tolerable permitting limited activity	Pain only after some activity; disappears quickly with rest	Slight or intermittent pain on starting to walk but getting less with normal activity	No pain
WALKING ABILITY	Bedridden or can walk a few yards; two sticks or crutches	Time and distance very limited with or without sticks	Limited with one stick (less than 1 hour). Difficult without stick. Able to stand long periods	Long distance with one stick; limited without a stick	No stick but a limp	Normal
	Passive range: sum of flexion, rotation, abduction – adduction.					
RANGE OF MOTION	0–30	31–60	61–100	101–160	161–210	211–260

Table 2. Sex, age and diagnosis

	Primary osteoarthritis	Rheumatoid disease	Fracture complications	Various	Total
Men	65.9±6.7	58.6±6.7	54.8±17.5	61.2±15.3	64.3±8.5
	n=114	n=13	n=9	n=4	n=140
Women	68.6±7.6	61.0±9.7	58.9±11.5	63.3±11.9	66.3±9.3
	n=147	n=29	n=18	n=17	n=211
Total	67.4±7.3	60.3±8.2	57.5±13.8	62.9±12.3	65.5±9.0
	n=261	n=42	n=27	n=21	n=351

Table 3. Deep infection correlated with the surgeon performing the operation. M represents 13 surgeons with 1–12 operations each

Surgeon	No. of hips	No. infected	Per cent infections	Per cent infected. (Only primary osteoarthrosis without previous hip surgery)
A	80	24	30%	22%
B	61	4	7%	3%
C	57	5	9%	12%
D	55	9	16%	19%
E	22	2	9%	13%
M	67	10	15%	16%
Total	342	54	16%	14%

Deep infection

The diagnosis of deep infection in 54 cases was based on the presence of an abscess or a sinus – 34 cases – and pain and elevated ESR in 20 cases. During the period covered by this investigation systemic antibiotic prophylaxis was introduced. This was followed by a significant reduction in the number of deep infections (Carlsson et al. 1977a).

The rate of deep infection varied significantly ($P < 0.01$) depending on the surgeon (Table 3). This could not be explained by one surgeon operating upon technically more difficult hips than the other surgeons since the differences remained after exclusion of hips with conditions other than primary osteoarthritis without previous surgery. Nor did experience reduce the rate of infection.

No preoperative diagnosis was over-represented among infected hips. The rate was 17 per cent in primary osteoarthritis as compared to 13 per cent in rheumatoid arthritis (Table 4). There was no tendency towards a higher rate of deep infection in previously operated hips in either group.

No attempt was made to analyze superficial infections.

Other complications

Other complications are presented in Table 5. There was no peroperative mortality except for one man who died after 6 weeks because of pulmonary embolism.

The thromboembolic complications were suspected on clinical grounds and 20 of the deep vein thromboses were verified by venography.

The 17 postoperative dislocations have been

Table 4. Preoperative diagnosis in infected and non-infected hips

	Primary osteoarthritis	Rheumatoid disease	Fracture complications	Various	Total
Non-infected hips	212	35	24	17	288
Deep infection	43	5	2	4	54
Total	255	40	26	21	342

Table 5. Systemic and early local complications

Pulmonary embolus (one fatal incl.)	6
Deep vein thrombosis	29
Pneumonia	12
Cardiac complications	9
Cerebral ischaemia	5
Gastric bleeding	4
Urinary tract infection	65
Permanent peroneal paralysis	1
Transient peroneal paralysis	6
Femoral nerve injury	1
Perforation of the femoral shaft	4
Postoperative dislocation	17
Miscellaneous	5

discussed in a previous paper (Carlsson & Gentz 1977).

Mechanical loosening of the femoral head prosthesis, defined as a radiolucent zone developing between the cement and the metallic shaft proximally and laterally, was observed in 36 per cent of 288 non-infected hips. For a detailed analysis, the reader is referred to a previous paper (Carlsson & Gentz 1980).

Non-infectious loosening of the acetabular prosthesis occurred in 3/288 hips (1 per cent). One was a woman suffering from primary coxarthrosis. In two patients with rheumatoid arthritis the sockets migrated centrally into the pelvis.

Function

Patients with deep infection are excluded when analyzing function. All other patients are included provided they have been re-examined twice. With regard to pain and range of motion, patient categories A, B and C are grouped together since the differences were negligible. The average *pain* score was the same at the first and the second re-examination (Figure 2a). The score for *range of motion* was slightly increased at the second re-examination (Figure 2c). The average score for *walking function* was 5.0 in category A patients and the slight decrease at the second follow-up was non-significant (Figure 2b, Table 6). The average score was lower – 4.5 – in category B patients, the same on both occasions. The average score was lowest in category C patients – 3.7 and 3.2, respectively – without any significant difference between the two re-examinations (Table 6). All 13 category BB patients were pain-free and, as demonstrated in Table 7, walking function was satisfactory.

The patients' opinion

Deep infection is always regarded as a failure and therefore only non-infected hips are considered under this headline. The patients were asked to

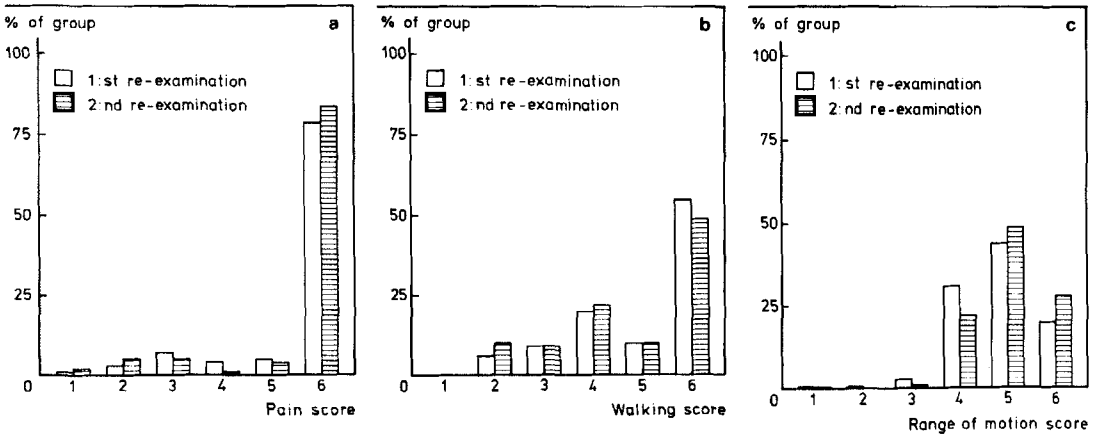

Figure 2. Assessment of hip function according to Merle d'Aubigné & Postel (1954), modified by Charnley (1972 and 1979), in hips re-examined twice.
a. Pain. Patient categories A, B, BB and C (237 hips).
b. Walking function. Only category A patients (69 hips).
c. Range of motion. Patient categories A, B, BB and C (237 hips).

Table 6. Walking function in non-infected category A, B and C hips at the first and second re-examination. Group B includes BB

		No. of hips	1	2	3	4	5	6	Average
29%	A 1	69		4	6	14	7	38	5.0
	A 2	69		7	6	15	7	34	4.8
33%	B 1	79		6	12	24	14	24	4.5
	B 2	79		9	12	22	5	31	4.5
38%	C 1	89		22	23	22	5	17	3.7
	C 2	89	7	28	22	13	5	14	3.2

Table 7. Assessment of pain (P), walking function (W) and range of motion (M) in all 13 patients with bilateral total hip arthroplasties both performed between 1968 and 1972 (category BB patients)

	Age at follow-up years	Right hip			Left hip		
		P	W	M	P	W	M
1	66	6	4	4	6	4	4
2	60	6	6	5	6	6	6
3	76	6	6	5	6	6	6
4	74	6	4	5	6	4	5
5	74	6	6	5	6	6	5
6	73	6	6	5	6	6	5
7	70	6	4	5	6	4	5
8	66	6	6	5	6	6	5
9	56	6	6	6	6	6	6
10	45	6	5	5	6	5	5
11	84	6	3	4	6	3	5
12	82	6	4	5	6	4	4
13	80	6	6	5	6	6	5
Average		6.0	5.1	4.9	6.0	5.1	5.1

describe their hip function using the terms asymptomatic, better, unimproved or worse. At the first re-examination 44 per cent of the hips were completely asymptomatic and 55 per cent were better than before the arthroplasty. Only three patients claimed that their symptoms were unchanged. At the second re-examination the corresponding values were 38 and 58 per cent. Four hips were unimproved and 5 worse than before the arthroplasty. In 7 of these 9 cases there were radiographic signs of loosening of the stem prosthesis, and of these, 4 hips subsequently have been replaced. Finally, there were 2 cases of unexplained pain at the second re-examination.

DISCUSSION

The distribution of the patients and hips with regard to diagnosis, sex and age does not differ from most of the clinical materials previously presented in the literature (Eftekhar & Stinchfield 1973, Beckenbaugh & Ilstrup 1978, Griffith et al. 1978). Remarkable in this investigation is the high rate of deep infections. This rate was reduced by systemic antibiotic prophylaxis (Carlsson et al. 1977a). The reason for the great variation in the rate of deep infection between surgeons remains obscure.

Another remarkable phenomenon in this material is the high rate of radiographically loose femoral prostheses. However, only a small proportion – about 3 per cent – of all non-infected hips required re-operation. This figure should be compared with the rates of re-operation – 2 per cent – presented by Beckenbaugh & Ilstrup (1978) and Gruen et al. (1979).

The systemic complications are those ordinarily found in conjunction with THR (Eftekhar 1978). However, it cannot be sufficiently emphasized that the thromboembolic complications are based on clinical diagnosis in the majority of the cases and that the figures reported do not therefore represent the true incidence (Nillius & Nylander 1979).

The hip function following revision corresponds with that reported by others (Eftekhar & Stinchfield 1973, Griffith et al. 1978). Since 1972 the surgical technique has been continually improved, and there is therefore reason to believe that the complications will become less frequent and the results will further improve.

REFERENCES

Beckenbaugh, R. D. & Ilstrup, D. M. (1978) Total hip arthroplasty. *J. Bone Joint Surg.* **60**–A, 306–313.

Carlsson, Å. S. & Gentz, C.-F. (1977) Postoperative dislocation in the Charnley and Brunswik total hip arthroplasty. *Clin. Orthop.* **125**, 177–182.

Carlsson, Å. S., Lidgren, L. & Lindberg, L. (1977a) Prophylactic antibiotics against early and late deep infections after total hip replacements. *Acta Orthop. Scand.* **48**, 405–410.

Carlsson, Å., Hedner, U., Nilsson, I. M. & Udén, A. (1977b) Blood loss in total hip replacement (in Swedish with English summary). *Läkartidningen* **74**, 918–920.

Carlsson, Å. S. & Gentz, C.-F. (1980) Mechanical loosening of the femoral head prosthesis in the Charnley total hip arthroplasty. *Clin. Orthop.* **147**, 260–270.

Charnley, J. (1972) The long-term results of low-friction arthroplasty of the hip performed as a primary intervention. *J. Bone Joint Surg.* **54**–B, 61–76.

Charnley, J. (1979) *Low friction arthroplasty of the hip.* Springer Verlag, Berlin, Heidelberg, New York.

Eftekhar, N. S. & Stinchfield, F. E. (1973) Experience with low-friction arthroplasty. *Clin. Orthop.* **95**, 60–68.

Eftekhar, N. S. (1978) *Principles of total hip arthroplasty.* The C. V. Mosby Company, Saint Louis.

Griffith, M. J., Seidenstein, M. L., Williams, D. & Charnley, J. (1978) Eight year results of Charnley arthroplasties of the hip with special reference to the behaviour of cement. *Clin. Orthop.* **137**, 24–36.

Gruen, T. A., McNeice, G. M. & Amstutz, H. C. (1979) "Modes of failure" of cemented stem-type femoral components. *Clin. Orthop.* **141**, 17–27.

Merle d'Aubigné, R. & Postel, M. (1954) Functional results of hip arthroplasty with acrylic prosthesis. *J. Bone Joint Surg.* **36**–A, 451–475.

Nillius, A. S. & Nylander, G. (1979) Deep vein thrombosis after total hip replacement: a clinical and phlebographic study. *Br. J. Surg.* **66**, 324–326.

Correspondence to: Åke S. Carlsson, M.D., Department of Orthopaedic Surgery, Malmö General Hospital, (University of Lund), S-241 01 Malmö, Sweden.