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Abstract

Twenty-five patients (30 hips) have had a total hip replacement using the cup supporter developed in our department. This report describes the follow-up findings on these patients. The mean period after hip replacement was 2 years and 8 months (range from 6 months to 6 years). The cup supporter was used in patients with rheumatoid arthritis with acetabular protrusions, central migration of the prosthesis after hemi-arthroplasty, revision operation for a defecting acetabular floor, primary acetabular protrusions (including osteoarthritis with acetabular protrusions) and traumatic fracture-dislocation of the hip. In five cases, autograft of bone was used in addition to the cup supporter for reinforcement of a thin acetabular floor. This combination appeared to provide good clinical results. The cup supporter was of value in revision operations due to loosening of the acetabular cup with severe acetabular protrusions.

KEYWORDS: total hip replacement, cup supporter, acetabular protrusion, revision

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FOLLOW-UP STUDY OF THE CUP SUPPORTER (F-S TYPE) IN TOTAL HIP REPLACEMENT

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Abstract. Twenty-five patients (30 hips) have had a total hip replacement using the cup supporter developed in our department. This report describes the follow-up findings on these patients. The mean period after hip replacement was 2 years and 8 months (range from 6 months to 6 years). The cup supporter was used in patients with rheumatoid arthritis with acetabular protrusions, central migration of the prosthesis after hemi-arthroplasty, revision operation for a defecting acetabular floor, primary acetabular protrusions (including osteoarthritis with acetabular protrusions) and traumatic fracture-dislocation of the hip. In five cases, autograft of bone was used in addition to the cup supporter for reinforcement of a thin acetabular floor. This combination appeared to provide good clinical results. The cup supporter was of value in revision operations due to loosening of the acetabular cup with severe acetabular protrusions.

Key words : total hip replacement, cup supporter, acetabular protrusion, revision.

Patients with acetabular protrusions have problems after total hip replacement (THR). These problems include improper setting of the acetabular cup and loosening of the components. Various attempts have been made to design suitable prosthetics and devise operative techniques.

Eichler (1) reported a useful cup supporting ring for acetabular protrusions, but it was too large for Japanese. A suitable cup supporter was developed in our department in 1977 (2). It was not only for acetabular protrusions but also for patients with a poor acetabulum. This paper describes a follow-up study of patients who underwent THR with this cup supporter. Surgical procedures and the design of the cup supporter are also discussed.

MATERIALS AND METHODS

Twenty-five patients who underwent THR using the cup supporter were studied (total of 30 THR). There were 19 females and 6 males, ranging in age from 39 to 71 years old (average, 54.5 years old). The follow-up intervals after THR ranged from 6 months to 6 years (average, 2.8 years). Patient diagnoses included 15 rheumatoid arthritis (20 joints), 7 osteoarthritis (7 joints), 2 salvage operations of hemi-arthroplasty (2 joints), and a poor reduced traumatic fracture-dislocation of the hip. Six of the osteoarthritis patients and one of the rheumatoid arthritis patients had replacement previously and had loose prostheses. The acetabulum of all cases was in poor condition with protrusions or bone destruction. The protrusions were



Grading system by Sotelo-Garza

Grade 1	mild	1~5mm
Grade 2	moderate	6~15mm
Grade 3	severe	15mm~

Fig. 1. Measurement of acetabular protrusion.

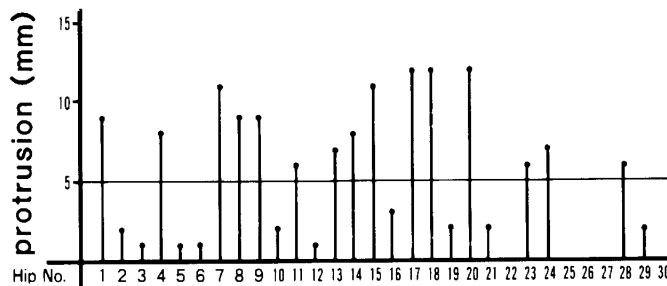


Fig. 2. Pre-operative X-ray evaluation of the degree of acetabular protrusion.

graded by the system of Sotero-Garza (3-5) (Figs. 1, 2). Charnley type prosthesis was used in 24 hips and Charnley-Müller type prosthesis in 6 hips.

The operative procedures followed standard methods except for capsular resection, *i.e.*, the attachment site of the capsule at the pubic, ischial and iliac bone was partially dissected to place the cup supporter directly on the bone. The acetabular bottom was usually thin and minimum reaming was necessary.

In 5 cases, autograft was made to the base of acetabulum because of severe deterioration. Cement was applied first to the acetabulum, then the pegs of the cup supporter were fixed to the bone. A second coating of cement was applied to the cup supporter, and the cup was fixed. The Hip Score of the Japanese Orthopedic Association was used for the clinical evaluation.

X-ray photographs were taken at 100 cm, focused on the pelvic symphysis. The inclination of the cup and cup supporter and the clear zone were evaluated on the X-ray film. The inclination angle was the angle between the horizontal line and base-line of the cup and cup supporter (Fig. 3). The clear zone was evaluated by the Uno (6) classification; no clear zone in stage 0, stage 1 with clear zone of 1-2 mm partially, stage 2 with clear zone of 1-2 mm circumferentially, stage 3 with clear zone over 2 mm circumferentially around the bone cement, and stage 4 with the cup moved or dislocated. Other X-ray findings, such as ectopic bone formation, absorption and sclerosis of the grafted bone and loosening of the femoral stem were also noted.

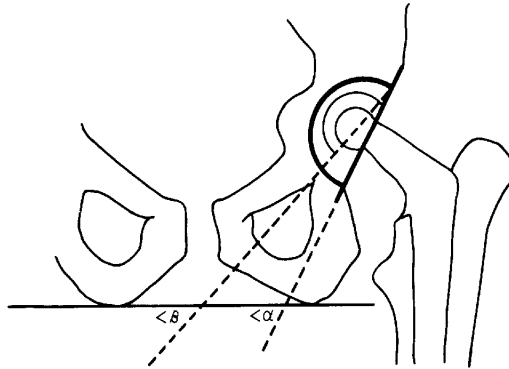


Fig. 3. Measurement of the angle of the cup and the cup supporter. $<\alpha$ Angle of the cup supporter $<\beta$ Angle of the cup.

RESULTS

Clinical Evaluation.

The average preoperative scores for pain, range of motion, walking ability, and activities in daily living were 7.3, 13.5, 5.5 and 3.7 respectively. At the follow-up, the scores were 34.7, 17.2, 11.7 and 7.2, respectively. The preoperative total score was 30.7, and at the follow-up, the total score was 71.0 (Table 1, Fig. 4). Immediately after the operation, the inclination angle of the cup ranged from 36 to 60 degrees (average, 49.3 degrees). The inclination angle of the cup supporter ranged from 48 to 80 degrees (average, 57 degrees) (Fig. 5). There was little change in these angles at the follow up. Fifteen joints (50 %) showed no clear zone, 10 joints (33.3 %) had clear zones at stage 1, 3 joints (10 %) showed clear zones at stage 2, and 2 joints (6.7 %) indicated clear zones at stage 3 (Fig. 5). There was an aggravation of the acetabular protrusion in one hip. There was non-union of the greater trochanter in one joint, and ectopic bone formation in three joints. Loosening of the femoral component was not seen. There were neither infections nor dislocations. The general clinical result and representative cases are described.

Rheumatoid Arthritis (RA) (15 patients, 20 joints)

All patients were women and their ages ranged from 44 to 67 years old (average, 55.2). They were all classified as classical RA by the criteria of the American Rheumatism Association and belonged to class 3 or 4 under the Steinblocker system. All cases had an acetabular protrusion: 8 patients with grade 1 protrusion, and 12 patients with grade 2.

Fig. 4 summarizes the results. Pain was markedly relieved, but walking ability and activities in daily living were not greatly improved. The inclination angle of the cup ranged from 42 to 48 degrees (average, 47.7 degrees), and that of the cup supporter ranged from 43 to 68 degrees (average, 52.9 degrees). Eight joints had no clear zone. Seven joints had stage 1 clear zones, 3 joints had stage 2 clear

TABLE 1. CLINICAL ASSESSMENT OF TOTAL HIP REPLACEMENT (THR) WITH THE CUP SUPPORTER

Cause	Case number	Age	Sex	Side	Hip number	Follow-up period	Clinical Assessment ^a				Total
							Pain	Movement	Walking ability	ADL	
RA	1	53	F	Rt.	1	2 y. 6 m.	10-30	11-18	5-5	3-6	29-61
	2	56	F	Rt.	2	2 t. 3 m.	0-40	13-17	5-10	1-3	19-70
	3			Lt.	3	1 y. 10 m.	0-40	13-17	5-10	1-3	19-70
	4	56	F	Rt.	4	4 y. 0 m.	0-30	0-20	5-10	1-5	6-65
	5			Lt.	5	3 y. 6 m.	0-30	8-16	5-10	1-5	14-61
	6	59	F	Rt.	6	2 y. 11 m.	10-30	15-20	10-15	5-7	40-72
	7	54	F	Lt.	7	8 m.	10-40	13-20	5-10	5-7	33-77
	8	46	F	Rt.	8	3 y. 7 m.	10-40	13-20	5-15	0-8	28-83
	9			Lt.	9	4 y. 0 m.	10-40	0-20	5-15	0-8	15-83
	10	61	F	Lt.	10	2 y. 0 m.	10-30	16-17	5-10	3-3	34-60
	11	52	F	Lt.	11	2 y. 8 m.	10-40	15-15	5-15	5-6	35-76
	12	50	F	Rt.	12	2 y. 0 m.	10-30	15-15	5-10	3-3	33-58
	13	62	F	Rt.	13	4 y. 6 m.	0-20	15-20	5-10	3-8	23-58
	14			Lt.	14	4 y. 9 m.	0-20	15-20	5-10	3-8	23-58
	15	67	F	Rt.	15	5 y. 0 m.	10-30	14-8	5-5	1-1	30-44
	16	44	F	Lt.	16	1 y. 0 m.	10-40	20-20	5-10	3-4	38-74
	17	67	F	Rt.	17 ^b	1 y. 1 m.	0-40	13-15	0-5	0-1	13-61
	18			Lt.	18 ^b	1 y. 3 m.	0-40	13-15	0-5	0-1	13-61
	19	50	F	Lt.	19	6 m.	10-30	13-13	5-5	1-3	29-51
	20	52	F	Rt.	20 ^b	2 y. 3 m.	10-30	13-20	5-10	5-5	28-65
	21					2 y. 7 m.	6.0-33.5	12.4-17.3	4.8-9.5	2.2-4.7	25.4-65.0
OA	16	69	F	Lt.	21	6 y. 0 m.	10-40	13-15	0-15	3-13	26-83
	17	56	M	Lt.	22	1 y. 7 m.	10-30	18-17	10-15	6-12	40-84
	18	55	M	Rt.	23	2 y. 0 m.	10-30	20-20	10-20	8-12	48-82
	19	71	M	Rt.	24	2 y. 5 m.	10-40	16-15	5-15	10-13	41-83
	20	65	M	Rt.	25	1 y. 4 m.	10-40	15-17	10-15	9-10	44-82
	21	62	F	Lt.	26 ^b	6 m.	10-30	13-20	5-15	1-17	29-82
	22	58	F	Rt.	27	1 y. 11 m.	10-40	15-20	5-15	6-16	36-91
	23					1 y. 7 m.	10.0-35.0	16.2-18.2	7.5-15.8	6.7-13.3	40.3-84.0
	24	39	F	Lt.	28 ^b	2 y. 4 m.	10-40	13-13	10-15	7-9	40-77
	25	66	M	Lt.	29	2 y. 2 m.	20-40	18-20	10-20	10-13	58-93
Post-hemiarthroplasty	26	46	M	Rt.	30	4 y. 2 m.	0-40	15-20	5-15	5-8	26-83
	27					2 y. 8 m.	7.3-34.7	13.5-17.4	5.5-11.7	3.7-7.2	30.0-71.0
	28										

^a The clinical assessment was made according to the Hip Score of the Japanese Orthopedic Association. ^b With bone graft Abbreviation: ADL, Activities in daily living; RA, Rheumatoid arthritis; OA, Osteoarthritis

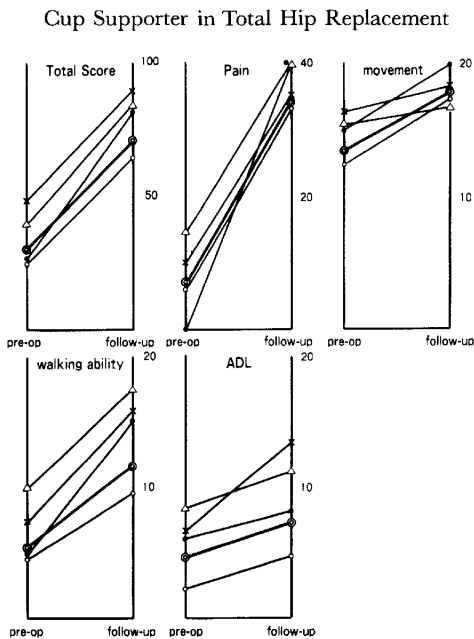


Fig. 4. Clinical results (Jpn. Orthop. Assoc. Hip Score). ○ RA; × OA; △ Post-hemiarthroplasty; ● Fracture-dislocation; ◎ Total cases.

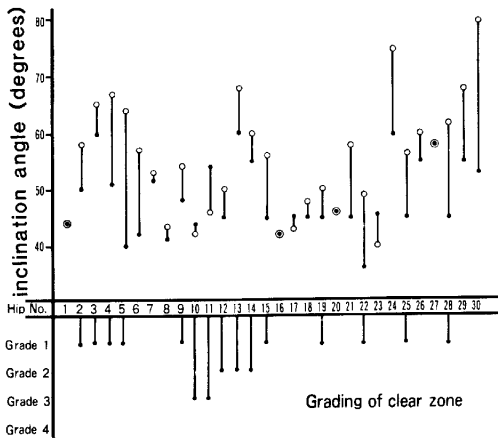


Fig. 5. Post-operative X-ray evaluation in prosthesis setting. ○ Angle of cup supporter, ● angle of cup.

zones, and 2 joints had stage 3 clear zones. One hip at stage 2 showed a slight aggravation of an acetabular protrusion. Some cases showed mostly newly formed bone at edge of the cup supporter.

Case report. Case No. 15, 52-year-old woman, classical RA, stage, 4, class 4. A right THR was performed in 1974. Right coxalgia recurred in 1980, and a hip

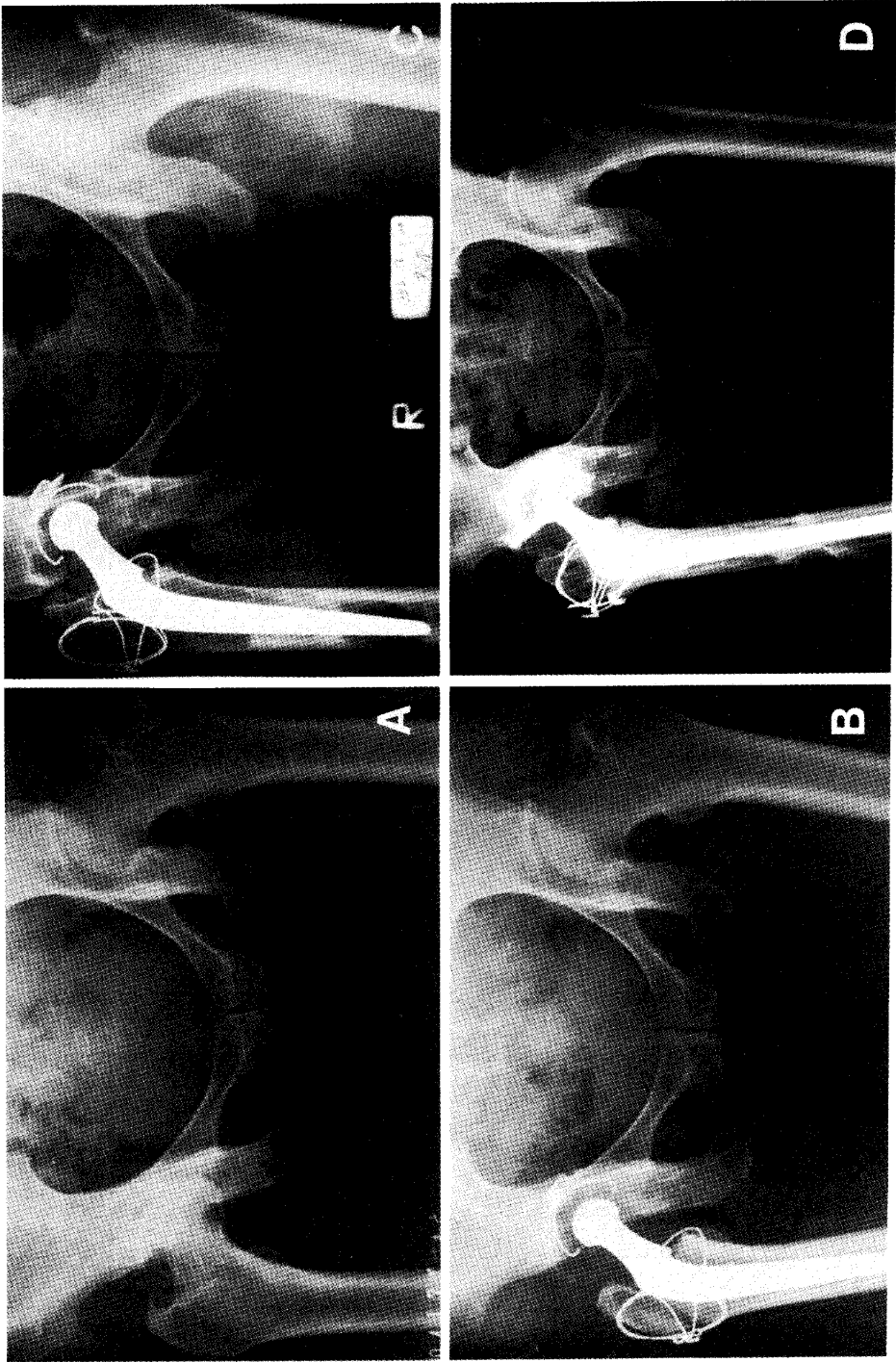


Fig. 6.

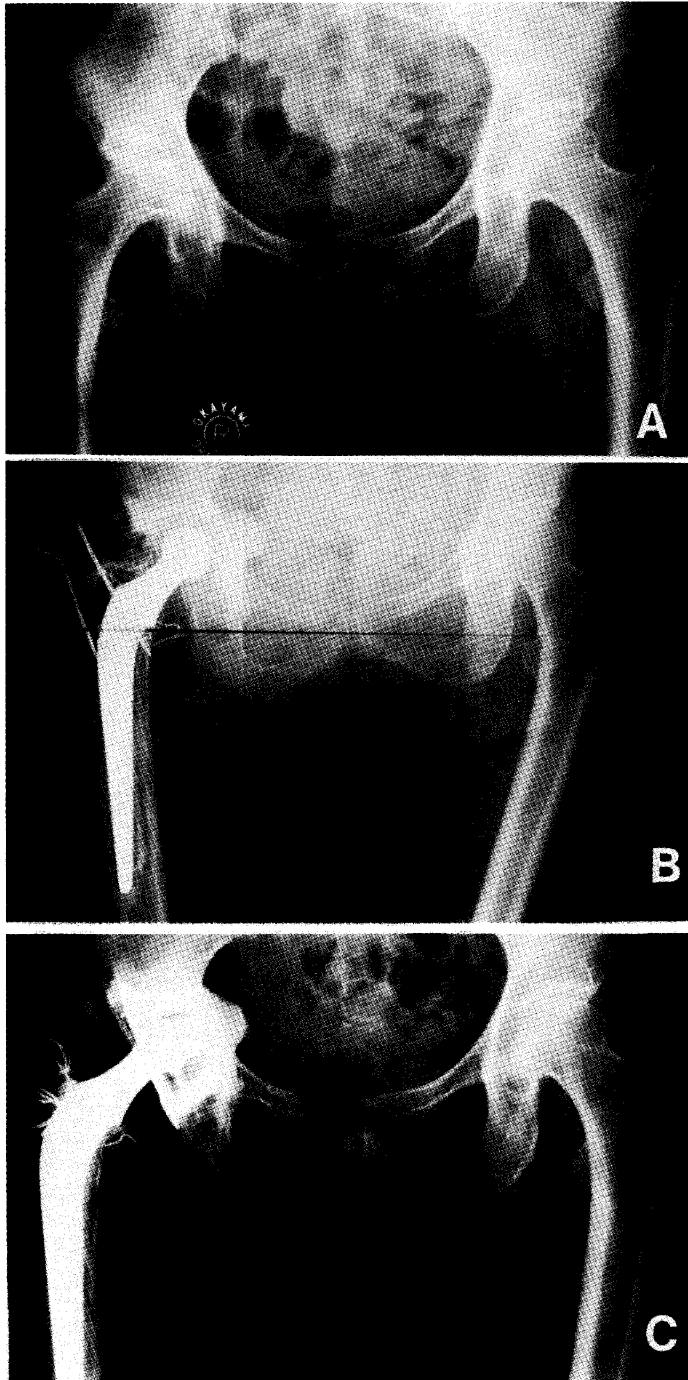


Fig. 7.

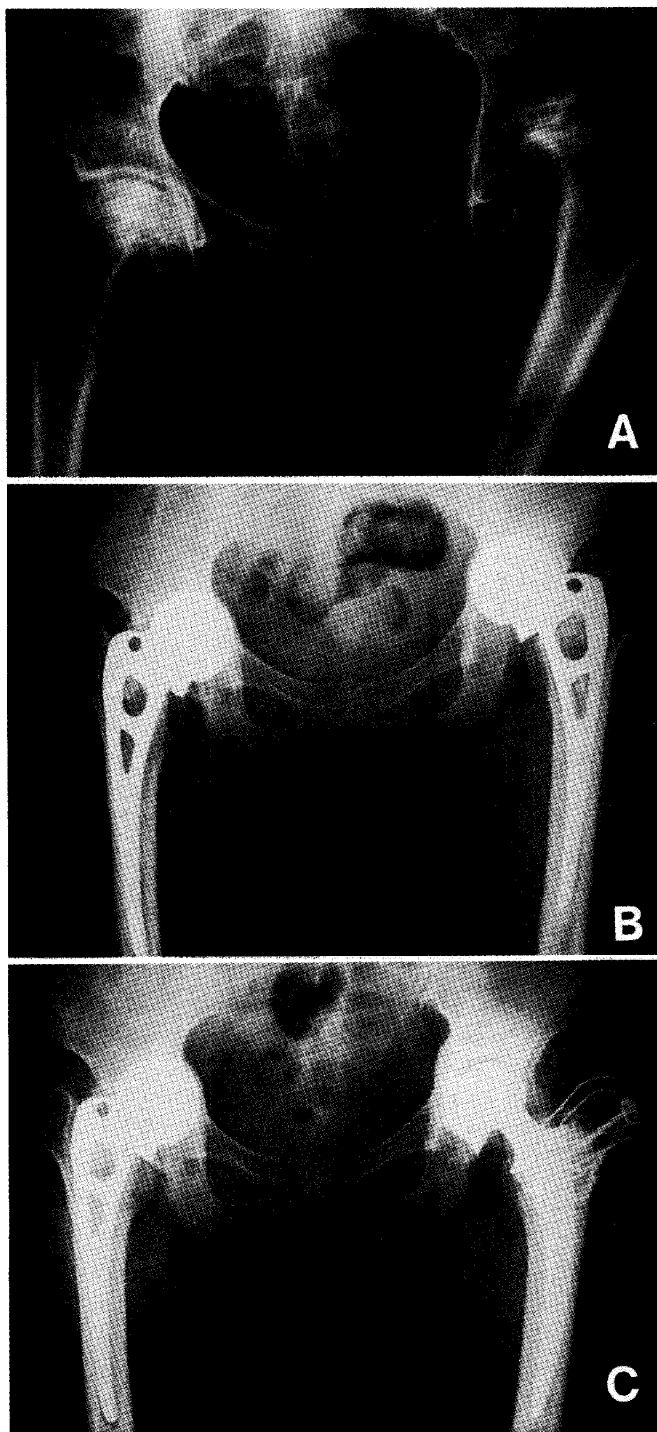


Fig. 8.

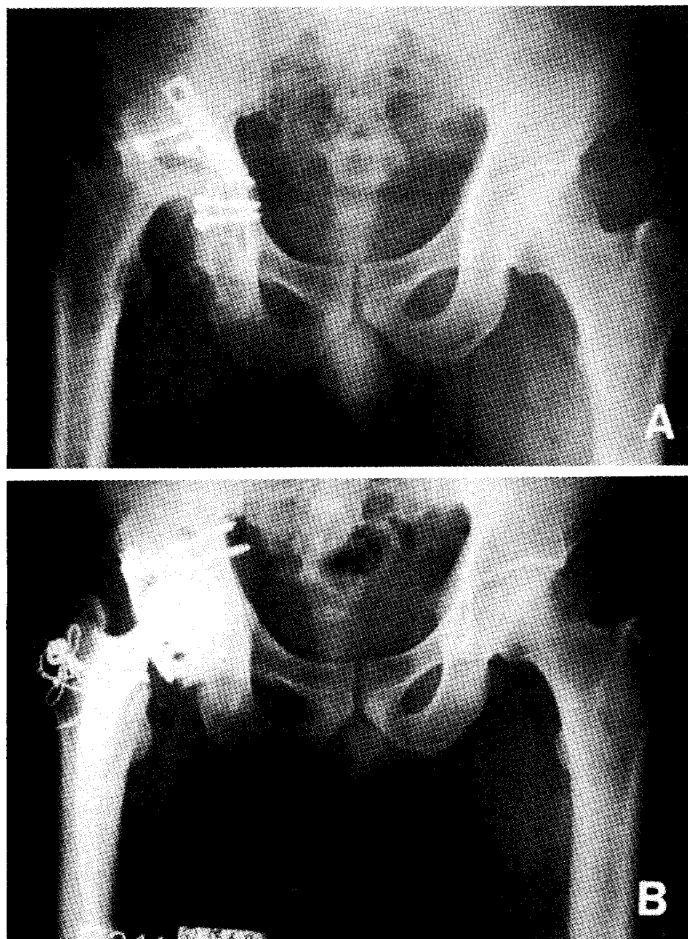


Fig. 9.

Fig. 6. Case 15. 52-year-old woman, RA, stage 4, class 4. A: Before primary operation. B: Just after primary operation. C: Just before revision. D: Two years after revision. Grafted bone was well incorporated.

Fig. 7. Case 19. 71-year-old woman, Osteoarthritis of the right hip. A: Before primary operation. B: Six years after the primary operation, the patient complained of severe right coxalgia, and a revision operation was performed. C: Two years 5 months after the revision. No pain, and no clear zone.

Fig. 8. Case 23. 39-year-old woman, Aseptic necrosis of both hips. A: Before primary operation. B: 6 years after the primary operation, left severe coxalgia with 1st grade protrusion. C: Two years 4 months after salvage THR with bone graft. The patient still complained of right coxalgia. Clear zone at stage 1.

Fig. 9. Case 25. 46-year-old man, traumatic fracture-dislocation of the right hip. A: One year after the initial open reduction, the femoral head showed aseptic necrosis. B: Four years 2 months after THR, no clear zone was detected, but ectopic bone formation was visible.

X-ray showed an acetabular protrusion (grade 2) and destruction of the acetabulum. A revisional THR with the cup supporter was performed in 1980. The preoperative total score of 28 points improved to 65 points at the follow-up. No clear zone was present. Autogenous bone grafting was performed, and good consolidation occurred (Fig. 6).

Osteoarthritis (7 cases, 7 joints)

Six of the 7 cases were revision cases, and one primary case (Case No. 16). Of the six revision cases two hips had an acetabular protrusion of stage 2, and the other cases showed a thinning in upper region of the acetabulum. Fig. 4 shows the clinical results. The inclination angle of the cup ranged from 36 to 58 degrees (average, 49.8 degrees). Two joints showed clear zones of stage 1, and the other cases showed no clear zone. One joint had abnormal ectopic bone formation. An intramedullary stem was used in the Charnley operation, and a trochanteric plate and long stem were used in the Charnley-Müller operation. No loosening of these stems was found.

Case report. Case No. 19, 71-year-old woman, osteoarthritis of the right hip. A right THR was performed in 1974. For the next 4 years, she had gradually increasing right coxalgia. A revision THR with the cup supporter was performed in January 1981. The preoperative X-ray showed an acetabular protrusion of grade 2. Her total score improved from 41 points to 83 points, and no loosening was found (Fig. 7).

Salvage Procedure after Hemi-Arthroplasty

In hemi-arthroplasty, proximal migration of the metal head with the acetabular protrusion was a major late complication. Two cases were treated by THR with our cup supporter, and favorable clinical results were obtained (Fig. 4).

Case report. Case No. 23, 39 year-old woman, bilateral idiopathic osteonecrosis of the femoral heads. A bilateral hemi-arthroplasty was performed in March 1975, because of severe coxalgia due to osteonecrosis in both femoral heads. In August 1980, a left coxalgia recurred and a grade 2 acetabular protrusion was evident. In March 1981, a left THR using our cup supporter was performed. The preoperative total score of 40 points was improved to 77 points (Fig. 8).

Traumatic Fracture-Dislocation of the Hip

Case report. Case No. 25, 46 year-old man. The patient's right hip with a posterior fracture-dislocation was treated by open reduction in July 1978. However, aseptic necrosis of the head occurred, and a THR with the cup supporter was performed in July 1979. The inclination angle of the cup and that of the cup supporter was 50 and 80 degrees, respectively. Favorable results were obtained (Fig. 9).

DISCUSSION

In 1978, Sotero-Garza *et al.* (5), reporting their results on acetabular protrusion cases in the Wrightington Hospital, found that setting the cup deep into the base

of the acetabulum was beneficial. They emphasized that Charnley's femoral component moved the femur 15 mm laterally because of its design. They stated that avoidance of over reaming was important. The results of most of their cases were good. However, in one of their RA cases, the cup migrated deeply into the pelvic cavity. Intrapelvic protrusion of the prosthesis was also reported by Salvati *et al.* (7) and Hasting *et al.* (8). Charnley (9) also reported aggravation of acetabular protrusions. Inoue (10) has reported a case of restriction of hip abduction in a deep setting of the cup.

The importance of lateral setting of the cup has been discussed. The resultant force transferred to the femur from the pelvis is at an angle of 16 degrees medial to the superior pole of the femoral head. Poss (11) found that the cup should be placed so that these forces are directed and supported by the iliac bone rather than by the weak inner wall of the acetabulum. Crawnshied (12) also emphasized lateralization of the cup based on experimental work.

In order to lateralize the cup, Welch *et al.* (13) used a large quantity of bone cement. However, the pushing force against the cup was weak. Harris *et al.* (14) developed a vitallium mesh. Bone cement might be stronger with a vitallium mesh, but the force of pushing the cup was weak. Liang *et al.* (15) reported a cup with a flange. The entire capsular attachment needed to be detached, and the cup's anatomical setting on the defected acetabulum was impossible. Eichler (1) developed a cup supporting ring that we used in some cases before 1977. The ring was too large for the average Japanese and was modified in our clinic (2). Biomechanical testing confirmed that the cup supporter was stronger against the pushing force at the base of the acetabulum than Eichler's ring.

In our operation, the capsule was only partially detached, whereas it needed to be detached circumferentially in the Eichler procedure. It was helpful in THR to preserve the capsule even partially, as the hip capsule is important in stabilizing the prosthesis.

In this study, no loosening (stage 0 and stage 1) was recognized in the 25 hips examined (83.3 %). In 16 hips (57 %), there was ideal placement of the cup (inclination angle, 40 to 50 degrees). Stage 2 or stage 3 cases were RA cases, and other disorders revealed no problems. This study indicate that a THR with our cup supporter was suitable for all these kinds of disorders. However, in using the cup supporter, a slight aggravation of an acetabular protrusion was found in one RA case, and thinning of the acetabulum in another RA case. Both of these patients were treated for a long time with corticosteroids and had severe osteoporosis. In such cases, autogenous bone grafting into the acetabular floor might be considered.

Beriter *et al.* (16) found that bone grafting was useful in revisional operations with a deeply migrated and loose cup. Ranawat *et al.* (17) have recommended bone grafting with a vitallium mesh. McCollum *et al.* (18) have reported that the union of grafted bone into the base of the acetabulum was rapid. In five auto-

ogenous bone grafts, we observed rapid consolidation of the grafted bone. Combining our cup supporter with autogenous bone graft is recommended for severely destroyed hips. Harris (19) used allografts in revision THR but the clinical results are as yet unknown.

There was no apparent problem in the design of our cup supporter. The edge of the acetabulum may widen with partial bone defect in revision THR. Slightly bent pegs may be more adaptable and fixed firmly. Further modifications of the cup supporter design should be considered if the long term results are not satisfactory.

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