Intertrochanteric osteotomy combined with acetabular shelfplasty in young patients with severe deformity of the femoral head and secondary osteoarthritis

A LONG-TERM FOLLOW-UP STUDY

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Intertrochanteric osteotomy may postpone the need for total hip replacement (THR). In young patients with an acquired deformity of the femoral head and secondary osteoarthritis, a valgus intertrochanteric osteotomy may allow better congruency but the acetabular cover may become insufficient because of subluxation of the femoral head. In patients with a spherical femoral head and acetabular dysplasia, cover can still remain insufficient after varus displacement osteotomy. We present the long-term results of intertrochanteric osteotomy combined with an acetabular shelfplasty in both these circumstances.

Sixteen hips (15 patients) with a deformed femoral head, and ten (seven patients) with a spherical femoral head, underwent an intertrochanteric osteotomy and acetabular shelfplasty. The mean age at the time of surgery was 30 and 37 years and the mean final follow-up was 15 and 19 years, respectively. Six patients in the deformed group, but only one in the spherical group, had required a THR by the time of their final follow-up. In both groups, those who had not undergone a THR had a good result.

Acetabular shelfplasty is an excellent addition to an intertrochanteric osteotomy and gives full cover of the femoral head in patients with a deformity of the head and secondary osteoarthritis.

Intertrochanteric osteotomy is an effective procedure which preserves the joint and can postpone total hip replacement (THR) in young patients with secondary osteoarthritis (OA) of the hip.¹⁻⁵ The long-term results of THR in young patients remain unsatisfactory.⁶⁻⁹ For certain types of hip pathology, an intertrochanteric osteotomy may be beneficial although it fails to provide full cover of the femoral head when performed in isolation. The first type consists of deformity of the femoral head with secondary OA, such as may be seen in patients who have suffered from Perthes' disease, avascular necrosis (AVN) of the femoral head or acetabular dysplasia with subluxation. The existing congruency can be improved by valgus osteotomy of the proximal femur although the weight-bearing surface of the femoral head remains reduced.^{4,10,11} The second type of pathology is the combination of a spherical femoral head and acetabular dysplasia where containment of the femoral head, as measured by the CE angle, may remain insufficient after varus osteotomy of the femur alone.

In both types of abnormal hip the acetabular cover either remains, or becomes insufficient, after an intertrochanteric osteotomy, thereby allowing further lateralisation of the head and progression of OA.¹⁰ In such patients the acetabulum must also be addressed in order to prevent further lateralisation.

The senior author (RKM) has developed a technique for adding superolateral bone grafts to the acetabulum in combination with an intertrochanteric osteotomy.^{12,13} In our clinic, 4% of the osteotomies performed were for patients with both a deformity of the femoral head and secondary OA, who also required an additional shelfplasty.

We describe the long-term results of the use of multidirectional intertrochanteric osteotomy combined with superolateral acetabular bone grafting with both types of hip pathology.

Patients and Methods

Between 1974 and 1993 the senior author (RKM) combined 16 intertrochanteric osteotomies with shelfplasty for deformity of the femoral head with secondary OA in 15 patients

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Table I. Details of the patients in both groups

Case	Age (yrs)	Gender	Indication	Pre-operative				Type of osteotomy*
				Sharp ¹⁵ angle (°)	CE ¹⁶ angle (°)	Crowe classification ¹⁶	OA (Tönnis ²¹)	
Femoral head deformity								
1	50	F	Dysplasia	48	0	II	II	Valg, med, rot
2	24	M	AVN	52	0	I	II	Valg, flex
3	49	M	Perthes' disease	39	11	I	I	Var, med
4	39	F	Dysplasia	48	0	II	III	Valg, med
5	16	M	Secondary AVN	43	18	I	II	Valg, med
6	19	M	Dysplasia	50	20	I	I	Valg, rot
7	35	M	AVN	42	13	II	I	Valg
8	19	M	Perthes' disease	44	13	II	I	Valg
9a	23	M	Perthes' disease	44	6	II	I	Var, med
9b	22	M	Perthes' disease	46	0	II	I	Valg
10	31	F	Dysplasia	48	0	II	II	Valg, flex
11	30	F	Dysplasia	42	0	I	I	Var, med
12	30	M	Dysplasia	43	9	I	I	Valg, rot
13	23	F	Dysplasia	34	0	III	II	Var, med
14	46	F	Dysplasia	48	5	I	I	Var, med
15	35	M	AVN	36	35	I	III	Valg
Spherical femoral head								
1	36	F	Dysplasia	53	4	I	I	Var, med, rot
2	31	F	Dysplasia	55	0	I	I	Var, med
3a	42	F	Dysplasia	58	0	II	I	Var, med, rot
3b	45	F	Dysplasia	50	0	I	I	Var, med
4a	36	F	Dysplasia	49	11	I	I	Var, med
4b	36	F	Dysplasia	39	10	I	I	Var, med
5a	40	F	Dysplasia	39	6	II	I	Var, med
5b	40	F	Dysplasia	50	20	II	I	Var, med
6	32	F	Dysplasia	40	9	II	III	Var, rot, med
7	29	F	Dysplasia	43	6	I	I	Valg

* Valg, valgus; Var, varus; med, medialisation; rot, rotation; flex, flexion; AVN, avascular necrosis

with a mean age of 30 years (16 to 50). The male to female ratio was 8 to 7. Congenital dysplasia, with subluxation and a Perthes'-like deformity of the femoral head, was present in seven patients. Four (five hips) had OA after true Perthes' disease with secondary acetabular dysplasia and four AVN of the femoral head, which was post-traumatic in two. These four hips were graded as a Ficat and Arlet stage IV.¹⁴

In the same period, intertrochanteric osteotomy combined with a shelfplasty was undertaken in seven patients (ten hips) with a spherical femoral head and mild OA secondary to acetabular dysplasia. The mean age of these patients was 36.7 years (29 to 45). The mean pre-operative Sharp angle¹⁵ was 47.6° (39 to 58) and the mean pre-operative CE angle¹⁶ was 6.6° (0 to 20). Lateralisation of the femoral head was measured by the classification of Crowe, Mani and Ranawat.¹⁷ Six hips were classified as grade I and four as grade II. None was subluxed by more than 75%. The clinical details, pre-operative radiological analysis and the type of operation are shown in Table I.

In all patients pre-operative radiographs were taken in adduction and abduction. Valgus or varus correction was decided after assessing the position which showed the best congruency between the acetabulum and femoral head (Fig. 1), as was the decision to undertake a shelfplasty.

For the survival analysis, patients were considered to have reached an end-point if an arthrodesis or THR had been performed on the affected hip. A second osteotomy was not considered as an end-point since the original hip remained preserved, leaving the possibility of a THR in the future.¹⁸⁻²⁰

For those patients in whom the hip was still preserved, a radiological and clinical analysis was carried out at their final follow-up. The radiographs were assessed and the severity of the OA scored according to Tönnis.²¹ The Merle d'Aubigné score²² and Harris hip²³ score (HHS) were also obtained.

Operative technique.¹³ This is shown in Figure 2. An antero-lateral approach was used. The gluteal muscles were released by an osteotomy of the greater trochanter (Fig. 2). A corticocancellous bone graft was harvested from the ipsilateral inner iliac crest, cut into two or three blocks and pre-drilled for fixation of screws. The joint capsule remained intact but was thinned on its superolateral aspect until movement of the femoral head was just visible. The supra-acetabular iliac bone was decorticated and the bone graft fixed using 3.5 or 4.5 mm lag screws with the leg positioned in the calculated position of adduction or abduction (Fig. 2b). When function is tested in adduction the graft should

Fig. 1a

Fig. 1b

Diagrams and radiographs of the left hip of a 24-year-old man with idiopathic avascular necrosis at the age of 16 years. Figure 1a – His Harris hip score was 79, flexion/extension 110-10-0° and abduction/adduction 0-0-20°. Figure 1b – With 15° of valgus displacement the congruency is improved, but cover of the femoral head is insufficient.

show plastic deformity. Some cancellous bone was pressed between the thinned joint capsule and the bone graft. Temporary screw fixation of the greater trochanter was then carried out with distal displacement in three patients in whom the tip of the greater trochanter was positioned higher than the centre of rotation of the femoral head after correction. A standard intertrochanteric osteotomy was then undertaken (Fig. 2c). This technique is well described in the literature.¹⁰⁻¹³

Statistical analysis. Multiple logistic regression analysis was performed to establish which determinants significantly predicted the outcome of the intertrochanteric osteotomy. A *p* value of <0.05 was regarded as significant.

Results

One patient developed a wound infection which was successfully treated with antibiotics and drainage. Pseudarthrosis of either the osteotomy or a shelfplasty was not seen.

Deformity of the femoral head with secondary osteoarthritis. The mean follow-up was 15 years (9 to 28). In six (40%) a THR was performed at a mean of 14.5 years (8.6 to 20.9). For the ten patients who still had their own functional hip, nine had a good to excellent HHS. The clinical and radiological results at final follow-up are given in Table II.

Function in these patients neither improved nor deteriorated significantly. At final follow-up those who had not received either a THR or an arthrodesis still had a good range of movement. The mean flexion changed from 105° (90 to 135) to 92° (60 to 120). In two of these patients flex-

ion was less than 90°. In one patient there was a flexion contracture of 15°. Four patients had a minor external rotation contracture (Table III).

All showed a significant improvement in their HHS from a mean of 62 before operation to 81 after. For the patients who still had their own hip at follow-up the mean pre-operative HHS was 67, the mean post-operative score was 93 and, at final follow-up, it was 89 (Table IV). None of these patients had a positive Trendelenburg sign when last seen. For those patients who did not undergo a THR or an arthrodesis, a full radiological assessment was obtained. This showed remodelling of the acetabulum and femoral head with augmentation of the weight-bearing surface. There was no evidence of progression of OA in nine patients (Fig. 3), and one showed clear regression.

When the pre-operative radiological and clinical criteria were entered into a multiple logistic regression model, only age was a significant predictor (*p* < 0.05) of outcome.

Spherical femoral head with secondary osteoarthritis. The mean follow-up for these patients was 19 years (16 to 24). THR was required in only one of the ten hips after 22 years. For the patients who still had their own hip at the final follow-up, six had a good to excellent HHS. One patient had required a second osteotomy to both hips after 9.6 and 9.8 years. The clinical and radiological results at final follow-up are summarised in Table II. Pre-operative function was excellent in these patients. At final follow-up the mean function was still good, although internal rotation and adduction had diminished. One patient had flexion of 80°

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

Diagrams of the operative technique. Figure 2a – An extracapsular osteotomy of the greater trochanter is performed. Figure 2b – A corticocancellous bone graft is harvested from the inner iliac crest, cut into two or three blocks and predrilled for screw fixation. After thinning of the capsule the prepared bone graft is fixed by lag screws with the leg positioned in the calculated position of adduction or abduction. Figure 2c – A standard intertrochanteric osteotomy is then performed. Figure 2d – The shelfplasty gives good three-dimensional cover of the femoral head.

but the remainder had more than 90°. The mean abduction was 24° in those with a varus osteotomy. Only one patient had less than 15° of abduction.

The Trendelenburg sign remained negative in all patients, while the pre-operative HHS improved from a mean of 53 to 73 points. The nine patients who did not receive a THR had a mean HHS of 80 at their final follow-up.

At the final radiological review, only one patient showed progression of her OA. She had a HHS of 74. In one patient, clear regression of OA was visible, while for the remaining patients no progression was seen.

Discussion

In OA secondary to Perthes' disease, there is a flattened, mushroom-shaped femoral head and a secondary dysplas-

tic acetabulum. This can be treated by an intertrochanteric valgus osteotomy which has the advantage of treating the hinge on abduction at the same time.²⁴ When moving in a valgus direction the femoral head subluxes but a better partial congruency is created, particularly in the medial part of the acetabulum. However, lateral cover then becomes insufficient. This can be resolved by an acetabular roofplasty. The indication for pelvic osteotomy is limited in this situation, especially in the presence of reduced hip function.

In OA with deformity of the femoral head and dysplasia, or in hips with AVN, the same anatomical problem can occur. Congruency improves with valgus movement but subluxation of the femoral head occurs. An acetabular shelfplasty can provide cover of the severely deformed head.

Fig. 3a

Fig. 3b

Fig. 3c

Fig. 3d

Figure 3a – Radiograph from a 19-year-old man with necrosis of the femoral head after a fracture of the femoral neck as a child. The Harris hip score is 83. Figure 3b – Radiograph ten months after a 20° valgus and 20° external rotation on intertrochanteric osteotomy. The Harris hip score is 93. Figures 3c and 3d – Anteroposterior (c) and lateral (d) radiographs taken 27 years after the osteotomy. The patient had no complaints and had a Harris hip score of 100.

Excellent results were achieved in the ten hips with a spherical femoral head and mild OA secondary to acetabular dysplasia. However, we would now consider performing an acetabular redirection osteotomy if the pre-operative correction radiographs showed insufficient containment in abduction. We would eventually combine this with an intertrochanteric osteotomy.

Several authors have reported the long-term results of peri-acetabular osteotomies for the treatment of secondary

OA in young patients. These were mostly for those with acetabular dysplasia and a spherical femoral head. Siebenrock et al²⁵ described a ten-year survival of 82% for the Bernese peri-acetabular osteotomy in young patients with OA secondary to dysplasia, while de Kleuver et al²⁶ found a survival rate of 93% at a minimum follow-up of eight years for the Tönnis triple pelvic osteotomy in an identical population. Although our group of patients is small, the mean follow-up (19 years) is longer than that in other stud-

Table II. Results at final follow-up in both groups

Case	Severity of OA (Tönnis ²¹)	Second osteotomy (yrs)	Primary end-point	Time to end-point (yrs)	Hip score		Length of follow-up (yrs)
					Merle d'Aubigné ²²	Harris ²³	
Femoral head deformity							
1	-	-	THR	12.6	-	-	-
2	II	21.0	-	-	17	93	24
3	-	-	THR	20.9	-	-	-
4	-	-	THR	9.6	-	-	-
5	I	-	-	-	18	100	17
6	I	-	-	-	18	100	28
7	-	5.0	THR	10.0	-	-	-
8	I	-	-	-	15	87	16
9a	I	-	-	-	14	74	10
9b	I	-	-	-	16	86	11
10	II	-	-	-	16	86	16
11	I	-	-	-	16	81	12
12	I	-	-	-	17	97	17
13	-	-	THR	8.6	-	-	-
14	-	-	THR	17.0	-	-	-
15	II	-	-	-	18	100	11
Spherical femoral head							
1	I	-	-	-	9	55	18
2*	I	-	-	-	14	73	23
3a	I	-	-	-	17	87	24
3b	I	-	-	-	17	87	21
4a	0	-	-	-	18	100	19
4b	0	-	-	-	18	100	19
5a	I	9.8	-	-	11	61	16
5b	I	9.6	-	-	12	71	16
6	-	-	THR	22.0	-	-	-
7	I	-	-	-	18	100	21

* shelfplasty added as a second operation

Table III. Mean pre-operative function compared with that at final follow-up for both groups

Movement (°)	Spherical femoral head		Deformed femoral head	
	Pre-operative	Follow-up	Pre-operative	Follow-up
Flexion	111	101	105	92
Extension	5	0	-6	-2
Abduction	30	24	18	14
Adduction	30	16	22	17
External rotation	25	18	20	17
Lateral rotation	18	5	9	-3

Table IV. Harris hip score (HHS)²³ before and after operation and at maximum follow-up for patients who did not receive a THR or an arthrodesis

HHS	Spherical femoral head	Deformed femoral head
Pre-operative	53 (45 to 70)	67 (46 to 83)
Post-operative	80 (56 to 96)	93 (79 to 100)
Maximum follow-up	80 (55 to 100)	89 (74 to 100)

ies. For our ten patients a survival of 100% was reached at 20 years. To our knowledge no other procedures have reported such an excellent survival.

Our technique allows three-dimensional cover by cancellous graft which fully adapts to the femoral head. Extra cancellous bone is placed between the thinned joint capsule

and the graft and slight tension is applied to the graft by abduction or adduction while it is fixed in place.

In our view, preserving the joint by a multidirectional intertrochanteric osteotomy in managing secondary OA in relatively young adults is preferable to THR, even in patients with an acquired deformity of the femoral head. A major advantage of an intertrochanteric osteotomy is that it leaves the possibility of performing a further osteotomy or THR at a later stage.¹⁷⁻¹⁹ When the corrective osteotomy fails to provide enough cover of the femoral head, this can be achieved by an acetabular redirection osteotomy or an augmentation procedure in order to prolong the life of the hip without pain and with a good range of movement.

A superolateral acetabular shelfplasty requires attention to specific operative details. Placement of the bone graft is very important. If the joint capsule is too thick, the grafts can be placed far above the acetabular rim and fail to provide the containment which is required. Problems with the fixation of the greater trochanter can occur which is why we chose to stabilise it by a screw before performing the intertrochanteric osteotomy. This screw is removed after plate fixation of the osteotomy.

The results described after THR in young patients show a wide variation. Porsch and Siegel⁸ assessed a group of patients who were less than 20 years of age and who had received a THR for congenital dysplasia of the hip. The survival rate of the prosthesis at ten years was 64%.⁸ Dudkiewicz et al⁹ showed a similarly poor result for patients who were under 30 years of age. Our study shows a ten-year survival of 90% for patients with deformity of the femoral head and secondary OA who had undergone surgery at a mean age of 30 years. Eleven of our patients with deformity of the femoral head and secondary OA were less than 30 years old at the time of the osteotomy. This group had a survival of 82% at 15 years. Even if the results of an intertrochanteric osteotomy and THR become comparable because of improvements in prosthetic design we would still prefer the former because the bone stock is preserved and the original joint remains. This leaves open the opportunity of performing a THR at a later date.

Several studies have reported the long-term results of periacetabular osteotomy for the treatment of secondary OA in young patients.^{25,26} Only a few have included conditions with an acquired deformity of the femoral head but even these do not specify the outcome for this specific group of patients.^{25,26}

In order to show that further lateralisation is truly prevented by an additional shelfplasty in these patients, our results should be compared with those of an identical group who had received an intertrochanteric osteotomy alone. Toyama et al²⁷ reported 67 hips with a deformity of the femoral head and OA secondary to congenital dislocation which had been treated by a valgus extension intertrochanteric osteotomy. Thirty-one procedures were combined with a shelfplasty. The survival at ten years for the whole group, including those with a valgus osteotomy without a shelfplasty, was 79%. Unfortunately, they did not indicate the survival rate for the group without a shelfplasty, although they did record that patients who had had an additional shelfplasty experienced a longer-lasting relief from pain. In our study, comparable patients had a survival rate of 90% at ten years and of 83% at 15 years.

We consider that an acetabular roofplasty is a useful addition to an intertrochanteric osteotomy for young patients with deformity of the femoral head and secondary OA. Furthermore, in patients with a spherical femoral head and acetabular dysplasia, excellent results can also be achieved.

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