Osteotomy for femoral anteversion

Complications in 95 children

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Totally, 95 children with increased femoral anteversion had derotational subtrochanteric osteotomy with plate fixation. The mean anteversion angle was reduced from 48° to 4°, internal hip rotation from 81° to 42°, and external rotation increased from 9° to 48°.

All the osteotomies healed, but serious complications occurred in 13 of the 95 patients. Because of the risk for complications and the trend towards spontaneous regression of femoral anteversion with age, we recommend a much more conservative attitude with regard to operative treatment.

The management of children with increased femoral anteversion is controversial (Somerville 1957, Alvik 1962, Weiner and Weiner 1979, Salter 1983), but only a few studies exist in which the results and complications of derotational osteotomy in children with increased femoral anteversion have been analyzed (Staheli et al. 1980).

We report the early results and complications of subtrochanteric osteotomy for femoral anteversion.

Patients and methods

Totally, 95 patients, 62 girls and 33 boys, had 188 derotational osteotomies during the years 1977–1980. The mean age at operation was 7 (4–18) years (Table 1).

The study was prospectively designed. Patients with known neuromuscular diseases were excluded from the study. The indications for operation were based on clinical and radiographic evaluation. The patients were examined in the same way preoperatively and at 4 months, 1 year, and 2 years postoperatively; 2 patients missed the 2-year follow-up.

The patients were questioned about complaints, such as stumbling, clumsiness, reduced endurance compared with children of the same age, and pain in the thighs. An intoeing gait was noted. The hip rotation was measured with the patient lying prone with extended hips, and the passive motion recorded with a goniometer.

Radiography

The femoral anteversion (AV) angle, the collum-shaft (CCD) angle, and the center-edge (CE) angle of Wiberg were measured during the year prior to operation and at follow-up using the biplanar Dunlap-Rippstein radiographic method (Dunlap et al. 1953, Rippstein 1955). In order to examine whether the AV angle changed during the first postoperative months, we measured the AV angles at the end of the operation in 14 children using the same radiographic method.

To eliminate the interobserver variance and to reduce the sources of error connected with the radiographic method (Gross and Haike 1970), all the clinical and radiographic measurements were done by the same person (SS).

The operation

With the patient lying on the side, a straight lateral incision was made. After exposing the upper part of the femur subperiostally, the osteotomy site was marked just below the lesser trochanter (Figure 1). Two strong Kirschner pins were drilled parallel through both cor-

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Table 1. Femoral osteotomy in 95 patients

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1	2	5	1	0	0	0	1	0	1	0	80	80	50	50	10	10	40	40	52	52	-	-	20	27	132	132	118	105	35	35	0
2	1	9	1	0	1	0	1	0	1	0	80	80	20	20	10	10	65	65	45	45	-	-	-3	-6	131	131	130	125	32	34	4
3	1	7	1	0	0	0	1	0	1	0	80	80	50	50	10	10	45	45	45	45	-	-	5	5	131	131	130	110	16	16	0
4	1	8	1	0	0	0	1	0	1	0	85	85	45	50	5	5	50	50	52	54	-	-	23	19	132	138	128	128	31	28	0
5	2	9	0	0	0	0	1	0	1	0	80	80	25	20	5	5	60	70	50	550	-	-	8	2	140	142	135	135	24	21	0
6	2	9	0	0	0	0	1	0	1	0	80	80	25	40	5	5	75	60	48	448	-	-	-5	10	138	139	135	135	26	21	0
7	1	5	1	0	1	0	1	0	1	0	90	90	40	40	0	0	50	50	57	62	-	-	-4	0	137	145	126	126	23	25	0
8	2	5	1	0	0	0	1	0	1	0	85	85	50	25	5	5	30	40	62	55	-	-	9	-6	130	130	128	120	28	30	0
9	1	6	1	1	0	0	1	1	1	0	75	85	45	60	15	5	35	50	35	50	-	-	-12	-6	135	133	118	123	30	25	2,4
10	2	6	1	0	0	0	1	0	1	1	85	85	45	45	5	5	45	45	60	62	-	-	7	3	135	137	128	125	22	25	0
11	1	8	1	1	0	0	1	0	1	0	90	90	30	50	0	5	55	35	65	65	-	-	-10	10	135	135	118	115	40	40	2
12	2	6	1	0	1	0	1	0	1	0	75	85	40	40	15	0	50	55	35	47	-	-	-6	-20	135	135	120	118	35	35	4
13	1	6	0	0	0	0	1	0	1	0	80	70	50	50	10	20	50	50	40	32	-	-	1	-2	135	135	132	130	25	22	0
14	2	6	1	0	0	0	1	0	1	0	85	85	35	5	5	5	40	50	55	55	-	-	18	6	128	128	115	120	30	26	0
15	2	7	1	0	0	0	1	0	1	1	90	85	55	40	0	5	40	55	55	50	-	-	20	-4	132	130	120	115	27	27	0
16	2	5	1	0	0	0	1	0	1	1	85	85	55	55	5	5	35	35	60	60	-	-	27	26	135	135	130	127	28	26	0
17	1	6	1	0	0	0	0	0	1	0	80	80	45	50	10	10	45	40	48	44	-	-	0	0	125	127	110	115	33	32	0
18	1	10	1	0	1	0	1	0	1	0	85	85	35	55	5	5	60	40	55	57	-	-	0	26	145	149	138	148	35	38	0
19	1	7	1	0	0	1	1	0	1	0	85	85	30	45	15	15	50	40	46	449	-	-	-20	-5	147	150	125	125	20	20	4
20	2	5	1	0	0	0	1	0	1	0	80	80	30	30	10	10	60	60	49	500	-	-	0	0	127	128	120	120	35	35	0
21	1	10	0	0	0	0	1	0	1	0	75	75	25	30	15	15	55	50	46	49	-	-	7	7	145	140	135	135	40	40	0
22	1	6	1	0	1	0	1	0	1	0	85	85	45	45	5	5	45	45	47	47	-	-	2	-2	135	135	127	127	25	20	0
23	1	13	1	1	0	0	1	0	1	1	80	80	50	55	10	10	40	20	35	35	-	-	-13	3	131	131	125	124	32	30	4
24	1	6	1	0	1	0	1	0	1	0	85	80	30	30	0	5	60	60	45	4	-	-	5	0	136	135	120	120	22	22	0
25	2	5	1	0	0	0	1	0	1	0	85	85	40	40	5	5	60	500	48	48	-	-	0	0	135	135	112	129	30	30	0
26	1	6	0	0	0	0	0	0	1	1	85	85	55	45	5	5	50	45	52	55	-	-	15	3	132	135	117	115	34	34	0
27	1	8	0	0	0	0	0	0	1	0	85	80	45	45	5	10	35	35	43	40	-	-	-12	5	132	133	131	130	30	31	1,4
28	1	9	0	0	0	0	0	0	1	0	80	80	45	45	10	15	45	45	41	41	-	-	2	0	136	137	128	130	37	40	2
29	1	6	0	0	0	0	0	0	1	1	85	80	45	45	5	5	45	45	48	45	-	-	0	3	131	130	116	116	36	36	0
30	1	7	1	1	0	0	0	0	1	1	80	75	30	45	15	20	60	45	41	42	-	-	-13	2	138	140	130	135	28	26	4
31	1	5	0	0	0	0	0	0	1	0	85	80	35	35	5	10	55	55	52	44	-	-	4	2	142	138	118	120	25	30	0
32	2	5	1	0	0	0	1	0	1	0	80	85	45	45	5	5	45	45	40	46	-	-	0	5	130	130	120	123	16	18	0
33	1	6	1	0	1	0	1	0	1	0	90	90	40	45	15	15	50	45	41	42	0	0	-3	0	133	133	120	125	25	23	0
34	1	6	0	0	0	0	1	0	1	0	85	85	35	35	5	5	55	55	40	40	-8	-6	-5	-1	130	130	118	117	25	29	0
35	2	13	1	0	0	0	1	0	1	0	80	80	40	30	15	15	60	60	50	50	-	-	18	5	135	135	130	128	29	30	0
36	1	8	1	0	1	0	1	0	1	0	80	80	45	45	20	15	45	45	37	36	-3	5	-1	3	133	130	125	123	28	27	0
37	1	6	1	0	1	0	1	0	1	0	90	85	55	55	5	10	45	45	47	42	0	0	0	0	140	140	135	135	22	29	0
38	2	7	1	0	0	0	1	0	1	0	75	75	20	40	15	15	40	40	46	44	-4	12	-7	10	131	130	125	130	31	31	3
39	1	10	1	0	1	0	1	0	1	0	75	75	30	35	15	15	65	50	40	43	-2	0	-3	-2	125	127	121	128	50	50	0
40	2	11	1	0	0	0	1	0	1	0	75	75	45	50	15	15	45	40	59	59	-	-	34	28	138	138	152	143	45	45	0
41	1	10	1	0	0	0	1	0	1	0	85	85	45	35	15	10	50	60	48	38	-	-	3	-5	125	129	127	125	32	30	0
42	2	6	0	0	0	0	1	0	1	0	80	90	45	45	10	0	45	45	446	55	-	-	0	0	148	148	130	130	21	21	0
43	2	6	0	0	0	0	0	0	1	0	85	85	45	45	5	5	45	45	57	57	-	-	13	10	141	141	127	123	30	30	0
44	1	8	1	1	0	0	1	0	1	0	85	85	40	40	20	20	60	60	40	40	-	-	0	0	133	133	126	123	35	35	0
45	2	8	0	0	0	0	1	0	1	0	80	80	35	35	15	15	60	60	43	43	-	-	0	6	148	149	143	143	41	42	0
46	1	8	0	0	0	0	1	0	1	1	85	85	55	55	5	5	35	35	49	46	-	-	20	15	137	135	130	130	23	25	0
47	1	7	1	0	0	0	1	0	1	0	75	75	35	40	15	15	45	40	28	36	-	-	-2	-3	126	124	118	120	35	37	0
48	1	10	1	0	0	0	0	0	1	1	80	80	40	50	15	15	50	40	39	39	-	-	4	6	138	135	128	129	42	42	0
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53	2	7	0	0	0	0	1	0	1	1	80	75	55	50	15	20	40	45	43	42	-	-	18	7	137	136	125	125	25	25	0
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55	1	6	1	0	0	0	1	0	1	0	70	85	60	25	20	10	30	40	30	45	-	-	30	0	125	124	125	125	30	31	0
56	1	10	0	0	0	0	1	0	1	0	80	80	35	30	10	10	35	60	42	40	-	-	3	-8	133	133	130	123	32	28	0
57	2	4	0	0	0	0	1	0	1	0	85	85	30	50	10	10	60	35	65	66	-	-	0	29	144	145	125	126	25	25	0
58	1	4	0	0	0	0	1	0	1	1	85	85	50	75	5	5	40	15	63	68	-	-	5	40	140	140	125	125	18	16	0
59	1	6	1	1	0	0	1	0	1	0	85	85	45	40	5	5	45	50	55	55	-	-	-6	-10	138	138	122	125	25	27	0
60	1	4	1	0	0	0	1	0	1	1	90	90	45	45	0	0	45	45	63	60	-	-	2	7	133	133	110	120	17	17	0
61	1	4	0	0	0	0	1	0	1	0	80	80	45	55	15	15	45	35	53	55	-	-	3	15	144	143	135	135	22	22	0
62	2	5	0	0	0	0	1	0	1	0	85	85	40	30	5	5	50	60	65	63	12	0	10	0	128	128	115	120	30	30	0
63	1	4	1	0	1	0	1	0	1	0	85	80	45	40	5	10	45	50	60	60	4	4	3	2	130	130	126	121	30	30	0
64	1	4	1	0	0	0	1	0	1	0	85	80	40	40	5	5	50	50	48	50	-4	-2	0	0	128	130	122	122	17	16	0
65	2	5	1	0	0	0	1	0	1	0	85	85	60	45	10	10	30	45	53	53	-	-	1	3	128	128	115	120	30	30	0
66	1	5	1	1	0	0	1	0	1	0	85	80	40	40	5	5	50	50	50	50	-3	-3	2	0	133	133	135	128	23	25	0
67	1	11	1	0	1	0	1	0	1	0	80	75	40	40	10	15	55	55	37	30	2	0	0	0	145	145	140	137	32	32	0
68	1	4	1	0	1	0	1	0	1	0	80	80	50	40	10	10	40	50	55	52	14	5	12	2	137	139	132	130	27	27	0
69	1	4	0	0	0	0	1	0	1	1	75	80	45	35	15	10	45	55	51	55	6	0	10	0	145	140	130	122	30	24	0
70	1	4	0	1	0	0	1	0	1	0	80	80	41	43	10	10	45	55	47	52	-	-	0	-8	135	132	115	115	30	30	1
71	2	4	1	0	0	0	1	0	1	0	85	80	55	45	5	10	35	45	60	56	-	-	13	0	122	126	122	122	23	25	0
72	1	4	1	0	0	0	1	0	1	0	80	80	45	45	10	10	45	45	50	50	-	-	5	9	140	140	120	120	30	28	0
73	1	5	0	0	0	0	1	0	1	0	90	90	25	45	0	0	70	45	54	60	-	-	0	13	135	133	112	113	27	27	0
74	1	5	0	0	0	0	1	0	1	0	80	80	50	55	10	10	50	45	45	45	-7	0	-6	0	135	135	118	120	22	22	0
75	2	5	1	1	0	0	1	0	1	0	75	75	45	45	15	15	45	45	42	40	-	-	-4	3	133	133	120	122	21	24	0
76	1	4	1	1	0	0	1	0	1	0	80	80	40	50	10	10	50	40	52	54	-	-	-2	15	140	138	125	125	25	25	0
77	2	4	0	0	0	0	1	0	1	0	80	80	35	35	5	5	60	60	49	46	-	-	1	-2	128	127	110	110	36	33	0
78	1	5	0	0	0	0	1	0	1	0	85	85	45	40	5	5	50	55	48	43	-	-	3	0	134	136	121	125	30	30	0
79	1	4	0	0	0	0	1	0	1	0	85	85	35	35	5	5	55	55	48	50	-	-	0	4	126	128	116	110	26	25	0
80	1	4	1	0	1	0	1	0	1	0	90	90	45	45	0	0	40	40	55	53	-	-	-2	3	128	128	115	115	25	25	0
81	2	5	0	0	0	0	1	0	1	0	90	90	45	45	0	0	45	45	60	60	-	-	8	7	140	140	137	131	30	30	0
82	2	14	1	0	1	0	1	0	1	0	65	75	55	40	25	5	30	50	27	45	-	-	28	8	134	133	130	125	30	35	0
83	1	6	1	0	1	0	1	0	1	0	80	80	50	55	5	5	50	45	48	45	-	-	-2	5	138	135	125	125	26	30	0
84	1	6	1	0	0	0	1	0	1	0	80	80	40	30	10	10	50	60	56	52	-	-	19	2	127	130	125	117	36	34	0
85	1	5	0	0	0	0	1	0	1	1	80	80	45	40	15	15	45	50	37	43	-	-	3	-1	131	130	128	124	36	36	0
86	2	6	1	0	0	0	1	0	1	1	85	85	30	35	10	10	65	60	58	54	-	-	-2	2	140	138	136	126	30	27	0
87	1	6	1	0	0	0	1	0	1	1	70	80	45	60	15	10	45	30	39	40	-	-	-6	5	133	136	121	121	27	22	0
88	1	6	1	0	0	0	1	0	1	1	85	85	70	50	5	5	20	45	45	52	-	-	35	3	131	132	120	118	30	30	0
89	1	5	1	0	0	0	1	0	1	0	80	80	45	40	10	10	45	45	45	45	-	-	-3	3	131	131	118	128	30	30	0
90	2	5	0	0	0	0	1	0	1	0	75	75	50	50	5	5	30	30	41	44	-	-	12	20	122	127	119	124	34	40	0
91	1	4	1	0	0	0	1	0	1	0	80	80	35	45	10	10	45	40	48	51	-	-	15	21	31	130	120	125	32	30	0
92	2	4	1	0	0	0	1	0	1	0	80	80	30	45	10	10	60	45	44	37	-	-	-3	12	136	135	124	125	20	21	0
93	1	4	1	1	0	0	1	0	1	1	80	80	60	65	15	15	45	40	51	53	-	-	5	12	141	140	130	129	21	19	2
94	1	6	1	0	0	0	1	0	1	0	85	85	40	55	20	20	50	40	45	43	-	-	-6	3	132	130	120	125	33	30	0
95	1	18	1	0	0	0	1	0	1	0	65	65	35	40	20	15	55	50	37	41	-	-	1	6	134	134	130	135	40	43	0

A case
B sex: 1 female, 2 male.
C age.
D reduced endurance preoperatively: 1 yes, 0 no.
E reduced endurance 2 years postoperatively: 1 yes, 0 no.
F thigh pain preoperatively: 1 yes, 0 no.
G thigh pain 2 years postoperatively: 1 yes, 0 no.
H stumbling preoperatively: 1 yes, 0 no.
I stumbling 2 years postoperatively: 1 yes, 0 no.
J intoeing preoperatively: 1 yes, 0 no.
K intoeing 2 years postoperatively: yes, 0 no.
L internal rotation right hip preoperatively (degrees).
M internal rotation left hip preoperatively.
N internal rotation right hip 1 year postoperatively.
O internal rotation left hip 1 year postoperatively.
P external rotation right hip preoperatively.
Q external rotation left hip preoperatively.
R external rotation right hip 1 year postoperatively.
S external rotation left hip 1 year postoperatively
T AV angle right hip preoperatively (degrees).
U AV angle left hip preoperatively.
V AV angle right hip peroperatively.
X AV angle left hip peroperatively.
Y AV angle right hip 4 months postoperatively.
Z AV angle left hip 4 months postoperatively.
AA CCD angle right hip preoperatively.
AB CCD angle left hip preoperatively.
AC CCD angle right hip 4 months postoperatively.
AD CCD angle left hip 4 months postoperatively.
AE CE angle right hip preoperatively.
AF CE angle left hip preoperatively.
AG complications: 1 infection, 2 femoral fracture, 3 osteonecrosis, 4 retroversion between 11° and 20°.

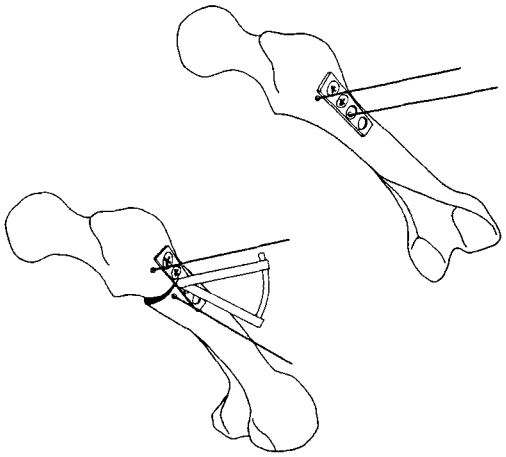

Figure 1. Osteotomy for femoral anteversion.

Figure 2. The proximal femur after derotational osteotomy.

Table 2. Signs and symptoms preoperatively and 2 years postoperatively in 95 patients treated for increased femoral anteversion

	Preoperatively	Postoperatively
Intoeing gait	95	19
Stumbling	85	1
Reduced endurance	65	11
Thigh pain	17	1

tices of the femur on each side of the intended osteotomy site. A 4–6-hole plate was used to fix the osteotomy. The proximal screws were placed first, and care was taken not to damage the apophyseal plate of the greater trochanter. Then, the osteotomy was performed with a Gigli saw and the distal part of the femur rotated externally to the desired angle. The degree of outward rotation was controlled with the two Kirschner pins and a goniometer. Finally, the distal screws were placed (Figure 2).

In children younger than 7 years, a small 4-hole plate was used, and a hip cast served as additional fixation, whereas in the older patients we used a stronger ASIF tibial plate, and the patients were mobilized in a wheelchair. Full weight bearing was allowed 3–4 months postoperatively. Except for 2 patients, the two hips were operated on at 14 days' interval. The plates were removed after 1 year. Fifteen surgeons, all orthopedic residents, performed the operations.

Results

All the osteotomies healed. There was no loss of position, and no reosteotomy was performed because of malrotation.

In children without complications, the operation was effective against the preoperative problems (Table 2), and the parents were satisfied with the results. The gait was markedly improved. However, 19 of the children still had a mild intoeing at the 2-year follow-up.

Deep infection developed in two osteotomies in 2 patients. One of the infections (*Staphylococcus aureus*) subsided with removal of the plate and fistulectomy 1 year after the osteotomy. The other patient still has symptomatic chronic osteomyelitis 9 years after the operation; only *Staphylococcus epidermis* was cultured from the infected bone.

Femoral fracture occurred in 4 children. In 3 cases the fracture was located just below the plate. One fracture was at the osteotomy site and occurred 1 month after plate removal. Two of the fractures were treated with plating and two with femoral traction on a Weber (1969) bock. All healed without complications.

Osteonecrosis of the right femoral head developed in a 7-year-old boy 6 months postoperatively, with hip pain and decreased hip rotation. Radiographically, the femoral head was irregular and radiolucent. At the 2-year follow-up, he had no symptoms and was normal at a 5-year radiographic examination.

Retroversion between 11° and 20° occurred in six osteotomies. These children had more problems postoperatively than the others, the main symptoms being an ugly out-toeing gait and a long-lasting limp.

Thus, serious complications occurred in 13 of our 95

Table 3. The preoperative and 4 months' postoperative AV and CCD angles in 188 hips. Mean *SD* range

		AV angle			CCD angle	
Preoperatively	48	*7.9*	28–68	135	*5.7*	122–150
Postoperatively	4	*9.3*	–20–40	124	*7.5*	105–152

Table 4. Anteversion angle in 188 hips 4 months' postoperatively

Degrees	n
–20 to –11	6
–10 to –1	41
0 to +10	106
+11 to +20	26
+21 to +30	6
+31 to +40	3

Table 5. Errors in the amount of derotation in 188 hips

Derotation (degrees)	n
–35 to –26	5
–25 to –16	13
–15 to –6	79
–5 to + 5	86
+6 to +15	5

Obtained derotation more (+) or less (–) than that intended.

patients.

Effects of the osteotomy

The mean AV angle was reduced from 48° to 4° (Table 3). In the 14 children, where the AV angles were measured radiographically at the end of the operation, the mean difference between the peroperative and the 4-month AV angle was + 0.5°(– 3° to + 5°).

In 78 per cent of the 188 osteotomies, a postoperative AV angle within ±10° was obtained (Table 4). However, in six osteotomies a postoperative retroversion between 11° and 20° and in three osteotomies an AV angle between 31° and 40° occurred.

The intended derotation, judged during the operation by the surgeon, was 51°(30°–60°). The radiographically determined derotation, estimated as the difference between the preoperative and postoperative AV angles was 44°(10°–75°). The difference between the intended and the radiographically determined derotation can be used as a measure of the accuracy of the method. We found that the surgeon on an average had derotated 7°(–35° to +13°) less than intended (Table 5). In 86 of the 188 osteotomies, the error was within ± 5°.

The mean preoperative CE angle was 30°(16°–50°), and 11 of the 188 hips had CE angle below 20°.

The mean internal hip rotation was reduced from 81° (SD 5.9) preoperatively to 42°(SD 8.3) 1 year postoperatively. The mean external hip rotation was 9°(SD 8.6) preoperatively and 48°(SD 8.6) postoperatively.

Discussion

Many fixation techniques have been described for derotational osteotomies. Plate fixation was recommended by Somerville (1957) and Alvik (1962), while others used pins (Staheli 1987) and external fixation (Mittelmeier and Jäger 1969). The osteotomy level also varies. The intertrochanteric level was preferred by Mittelmeier and Jäger (1969) and Staheli (1987), the subtrochanteric level by Somerville (1957) and Alvik (1962), whereas Scholder (1979) employed a supracondylar osteotomy. We used the subtrochanteric osteotomy with plate fixation. This osteotomy is technically less demanding than the intertrochanteric one, and there is less risk of damaging the apophyseal plate. Further, there is no need of an image intensifier. With this osteotomy, we had no healing complications and no loss of fixation.

In six osteotomies a postoperative retroversion between 11° and 20° occurred. Schulitz (1970) found that only half of the hips with postoperative retroversion showed any sign of normalization. Theoretically, an excessive retroversion would be just as unsound for the hip joint as an increased femoral anteversion (Schulitz 1970). A postoperative retroversion should therefore be avoided.

In 18 osteotomies, our derotation error was 16°–35°. There could be several reasons for such considerable rotation errors. Unintentionally, the surgeon could have drilled the Kirschner pin through the nearest femoral cortex only, and this pin might change its direction during the operation. Secondly, the pin might have been so thin that it could have been bent by the plate or pressure from soft tissue. Thirdly, the osteotomy is not always performed at exactly 90° to the femoral axis, which, together with some variation, could give unpredictable results.

Several authors have assumed that the intended postoperative AV angles is equal to that really obtained (Mittelmeier and Jäger 1969, Kleine 1961, Reikerås and Bjerkreim 1982). They measured the AV angle ret-

rospectively in follow-up studies at approximately 15 years of age. Angles differing from the intended postoperative angles were interpreted as recurrence of the femoral anteversion. An AV recurrence up to 40°is described (Mittelmeier and Jäger 1969). Our results indicate that part of this gross AV recurrence in the previously cited studies was probably an intraoperative error in the obtained derotation compared with that intended.

For the AV angle the biplanar method of Dunlap/Rippstein is found to be reliable, with an accuracy of approximately ±5° (Reikerås et al. 1985). One of the sources of error in the measurement of the CCD and AV angles after a derotational osteotomy is the definition of the long axis of the femur. The upper lateral part of the femur is approximately 5°–10°concave, but the plate was not prebent accordingly (Figure 2). Thus, we intended to obtain a certain degree of variation of the femoral neck (Table 3). In both the preoperative and the postoperative measurements, we followed the recommendation of Müller (1971) and used the central third of the femur as the femoral axis.

The indications for operative treatment of increased femoral anteversion are controversial. Some studies indicate that persisting increased femoral anteversion in adults is a predisposing factor for coxarthrosis (Terjesen et al. 1982, Reikerås et al. 1982). Thus, derotational osteotomy may be regarded as a prophylactic procedure.

In our material serious complications occurred in 14 percent of the children after derotational osteotomy, which is approximately the same percentage as reported by Staheli et al. (1980). Partly because of the risk for such complications and partly because of the trend towards spontaneous regression of both the AV angle and the intoeing gait during growth (Jani 1979, Svenningsen et al. 1989), we now practice more restrictive indications for operation. The number of operated on children has been reduced from approximately 30 per year at the time of this study to 5 per year at present.

In general, we now follow the children with increased femoral anteversion until approximately 12 years of age. If the child at this age still has trouble with an intoeing gait, external rotation of the hip below 20°, and an AV angles above 40°, we consider a derotational osteotomy.

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