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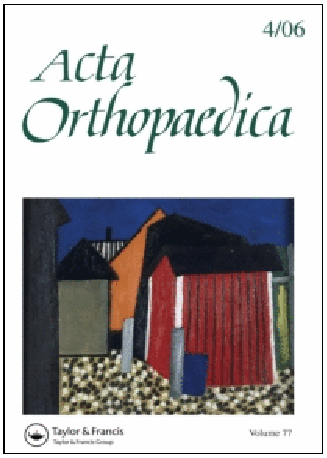

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The Ilizarov hip reconstruction osteotomy for hip dislocation

Outcome after 4–7 years in 14 young patients

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ABSTRACT – Treatment of neglected high dislocation of the hip is difficult in adults. We performed hip reconstruction osteotomy, consisting of a proximal abduction and extension osteotomy, and a distal varisation and lengthening osteotomy, utilizing the Ilizarov external fixator in 14 (12 women) patients having a mean age of 20 (12–33) years. The most frequent preoperative complaints were pain, leg-length discrepancy, limping, reduced activity and limited abduction of the hip.

After an average follow-up of 68 (55–81) months, the outcome was satisfactory; pain subsided in all patients, the Trendelenburg sign became negative in all but 3 patients, no patient had limb-length discrepancy, and alignment of the extremity was reestablished. However, 3 patients still complained of lurch.

The two main treatments for severe pain and limp, caused by hip dislocation in adolescents and adults, are total joint replacement or pelvic support osteotomy. Joint replacement is exposed to high mechanical forces, especially in young patients at risk of failure (McQueary et al. 1988, Paavilainen et al. 1990, Davlin et al. 1991, Garvin et al. 1991, Chmell and Poss 1998). Therefore, pelvic support osteotomy is still regarded as a valuable treatment. The technique was first described by Lorenz with modifications developed by Schanz, Hass and Milch (Hass 1943, Milch 1989). Although these osteotomies can provide sufficient pelvic support, they can provide lateralization of the mechanical axis and a discrepancy in length of the lower extremities. Ilizarov described a hip reconstruction osteotomy, which corrected the length discrepancy and valgisation by a second, more distal femoral osteotomy used for lengthening and varisation (Ilizarov 1983, Catagni et al. 1998).

We report midterm results in 14 hips of 14 patients who had unilateral high dislocation of the hip treated with reconstruction osteotomy.

Patients and method

Our series comprises 14 hips in 14 patients (12 women) with high dislocation. The etiology was neglected developmental dysplasia in 11 patients, paralytic hip dislocation in 2 and sequelae of proximal focal femoral deficiency in 1 patient. Their mean age was 20 (12–33) years. All patients, except one with iatrogenic ankylosis of the hip, initially had an abductor lurch, with pain occurring later in the course of the disease.The mean time between first symptoms and the operation was 5 (1–9) years. The mean preoperative leg-length discrepancy was 4.4 (1.5–10) cm (Table).

Before surgery, an AP radiograph is taken with the patient supine and the pathologic extremity in maximum adduction, which determines the level of the proximal femoral osteotomy and the amount of abduction to be created (Figure 1). The first osteotomy should be at the level of the tuber ossis ischii (Paley 2002).The degree of extension that will be produced during the osteotomy to correct the increased lumbar lordosis and overcome the hip flexion contracture is determined by adding 5 degrees to the amount of the clinically-measured

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Table. Observations

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	17	F	R	DDH	+	–	+	–	0–135	0–120	–	4.5	4.5	0	87	90	0	m	10	81	P
2	29	F	R	PHL	+	–	+	+	0–125	0–115	–	6	6	0	90	88	0.5	m	9	70	–
3	15	F	L	DDH	+	–	+	–	0–140	0–125	+	4	4	0	89	89	1	m	6	74	–
4	18	F	R	DDH	+	–	+	–	0–140	0–110	+	7	6	1	87	89	2	lat	9	69	H
5	21	F	L	CDH	+	–	+	–	0–145	0–130	–	1.5	1.5	0	91	88	0.5	m	4	68	–
6	33	F	R	PS	+	–	+	+	0–95	0–40	–	10	10	0	87	89	0.5	m	13	71	P
7	16	F	L	MMC	+	–	+	+	0–110	0–90	+	4	4	0	88	90	1	m	5	69	–
8	18	M	L	DDH	+	–	+	–	0–150	0–130	–	7	7	0	87	87	1	m	10	64	–
9	16	F	R	DDH	+	–	+	–	0–145	0–125	–	5	4	1	90	91	1	m	7	62	–
10	12	F	R	DDH	+	–	+	–	0–140	0–110	–	5	5	0	89	90	1	m	8	55	–
11	17	F	R	DDH	+	–	+	–	0–150	0–120	–	3	3	0	87	87	1	m	5	71	P
12	23	F	R	DDH	+	–	+	–	0–150	0–120	–	4	4	0	89	91	1	m	5	74	–
13	23	M	L	DDH	+	–	+	–	0–155	0–130	–	2	2	0	90	87	0.5	m	5	66	–
14	26	F	R	DDH	+	–	+	–	0–140	0–120	–	3	3	0	91	88	0.5	m	5	63	–

A Patient
B Age
C Sex
D Side
E Diagnosis
  DDH developmental dislocation of the hip
  MMC myelomeningocele
  PHL paralytic hip luxation
  PS proximal focal femoral deficiency sequelae
F Pain preoperatively
G Pain postoperatively
H Trendelenburg preoperatively
I Trendelenburg postoperatively
J Knee range of motion preoperatively
K Knee range of motion postoperatively
L Limp
M Leg length discrepancy preoperatively, cm
N Lengthening, cm
O Postoperative length discrepancy, cm
P Lateral distal femoral angle
Q Medial proximal tibial angle
R Mechanical axis deviation, cm
S Mechanical axis deviation, medial/lateral
T External fixation time, months
U Follow-up, months
V Complications
  P pin tract infection
  H hypocorrection

fixed hip flexion contracture (Paley 2002). The level of the second compensatory osteotomy is determined on a tracing paper of the pelvis and femur with the proximal femoral segment maximally adducted (Figure 1). The transecting point perpendicular to the pelvis, between the first osteotomy site and the mechanical axis of the femur, determines the level of the second osteotomy site (Figure 2). The amount of lengthening is decided from standing orthoroentgenograms during follow-up examinations. Lengthening is continued until the horizontal axis of the pelvis becomes parallel to the ground in standing orthoroentgenograms.

Surgical technique

The Ilizarov frame is prepared before surgery. It consists of a proximal pelvic arch to fix the proximal femur, a full ring to fix the middle femoral fragment and one or two full distal rings to hold the distal femoral fragment. After routine surgical preparations, the assistant holds the extremity in maximum adduction with the patella pointing

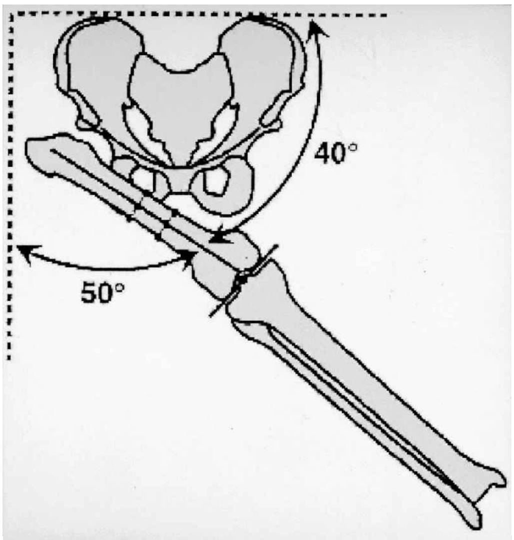

Figure 1. Schematic drawing of AP radiograph with the patient supine and the pathologic extremity in maximum adduction, showing the amount and level of the proximal osteotomy.

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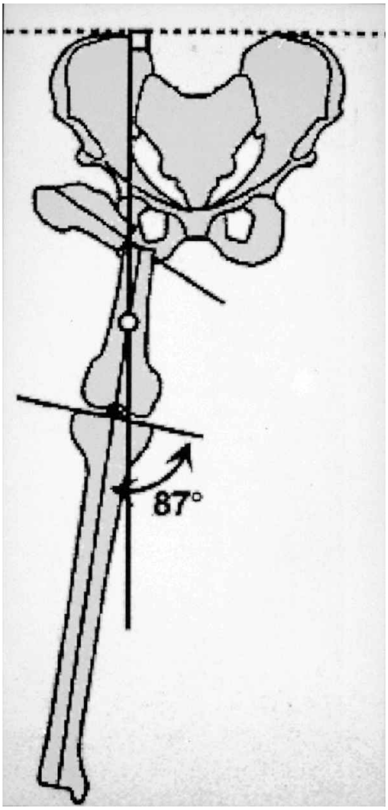

Figure 2. Schematic drawing showing the level of the distal osteotomy.

upward in neutral rotation. This maneuver prevents the gluteal soft tissue from being compressed by the pelvic arch. 3 Schanz pins with a diameter of 6 mm are inserted into the proximal femoral fragment in a direction parallel to the horizontal axis of the pelvis. The pelvic arch should be held inclined in the sagittal plane. The amount of inclination is equal to the amount of extension effect calculated preoperatively. The middle femoral fragment is fixed with 3 Schanz 6 mm pins, inserted perpendicular to the mechanical axis, to its ring and the distal fragment is fixed with a K-wire of 1.8 mm diameter inserted parallel to the knee joint and 2 Schanz pins of 6 mm diameter to the distal ring(s). The operation is completed by proximal and distal corticotomies. Finally, the proximal support osteotomy is locked into its final position and the distal osteotomy is checked for completeness. The mechanical orientation of the frame is checked with intraoperative radiographs.

Evaluation

All patients were evaluated according to pre- and post-operative hip pain, range of motion, lumbar lordosis, hip flexion contracture, Trendelenburg sign, limp, pain-free walking distance, the patient's degree of satisfaction, and the Harris hip score by retrospective patient chart review. Furthermore, pre- and postoperative malalignment and malorientation tests, as described by Paleyand Tetsworth (1992), were done, with emphasis on MAD (mechanical axis deviation), LDFA (lateral distal femoral angle) and MPTA (medial proximal tibial angle). While measuring the MAD and LDFA on postoperative radiographs, the new hip center is regarded as the point between one-third to one-half the distance lateral to the medial edge on the supporting end of the proximal femoral segment (Paley 2002). The leg-length discrepancy and the amount of total bone lengthening were measured. The latest postoperative evaluations were made after a mean of 68 (55–81) months.

Results (Table)

The patients spent a mean of 7 (4–13) months in the external fixator.

The mean preoperative Harris hip score of 64 (42–72) points was increased to mean of 84 (68–92) points postoperatively. All patients were able to walk with varying degrees of pain preoperatively, but pain disappeared in all but 1 patient postoperatively and this patient only experienced pain while climbing stairs. The Trendelenburg limp, which was positive in all patients preoperatively, disappeared in all except 3 patients after surgery (Figure 3).

9 patients had a preoperative pain-free walking distance of 0.5 kilometers while 5 could walk 1 km without pain. During follow-up, 4 patients were able to walk long distances without pain. 4 were pain-free after walking a distance of 3–4 kilometers. 3 patients were pain-free after 1–2 kilometers, and, 3 were able to walk about 1 kilometer without pain. The amount of hip flexion contracture decreased from mean 10 (0–20) degrees to mean 3 (0–6) degrees. The range of abduction increased from mean 12 (0–20) degrees, to mean 26 (5–50) degrees and the range of flexion increased from

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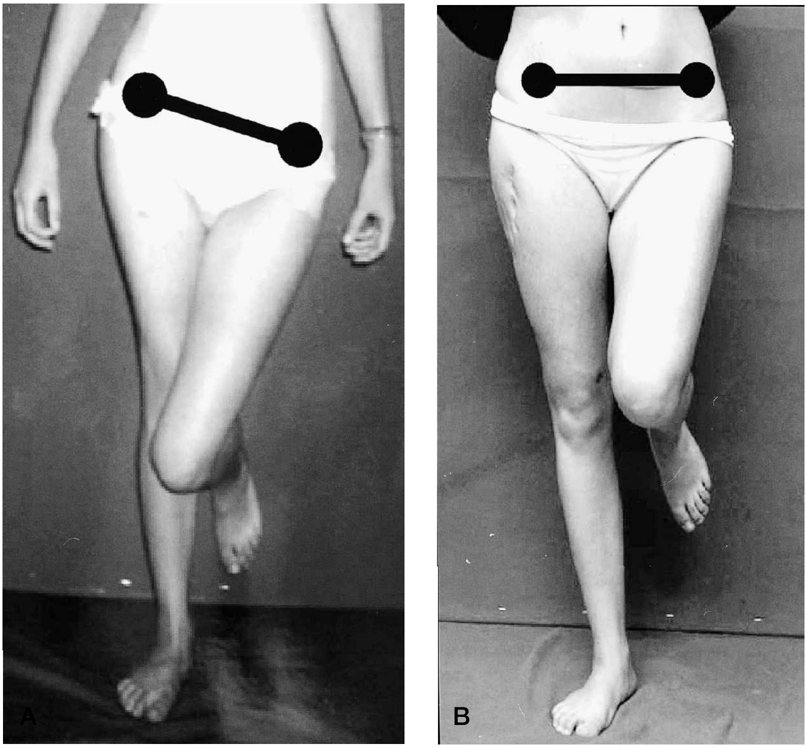

Figure 3. 18-year-old woman (no. 4) with high hip dislocation on the right side.
A. Positive Trendelenburg's sign preoperatively.
B. Negative Trendelenburg's sign postoperatively.

mean 90 (80–118) degrees to mean 108 (100–130) degrees. The increased lumbar lordosis and pre-operative low back pain disappeared completely in 10 patients. A mean leg-length discrepancy of 4.4 (1.5–10) cm was eliminated in all patients by lengthening through the distal corticotomy. In all patients but 1, the pathologic pre-operative mechanical axis deviation (MAD), lateral distal femoral angle (LDFA) and medial proximal tibial angle (MPTA) were normal on their latest follow-up examinations. The proximal osteotomy was performed at a mean of 6 (4–8) cm below the lesser trochanter; the distal osteotomy was performed at a mean of 14 (9–17) cm proximal to the knee joint. The mean valgisation at the proximal osteotomy site was 37 (27–48) degrees, the mean extension 26 (15–33) degrees and the mean varisation at the distal osteotomy site 18 (14–25) degrees.

All patients but 1 were satisfied with the outcome and would recommend it to other patients. The only patient who was dissatisfied had a delay in regenerate healing and the longest external fixation time (13 months).

Complications occurred in 4 patients. 3 patients had minor pin tract problems, which resolved with meticulous local pin site care and oral antibiotics. 1 patient had a residual 2 cm mechanical axis deviation to the lateral side. This lateral shift was accepted by the patient, pending follow-up, as she was pain-free with a good knee range of motion, and had physiologic LDFA and MPTA values.

Discussion

The center of gravity of the body in adult patients with neglected, high dislocation of the hip lies far anterior to the femoral head, which causes a ventral rotation of the pelvis, thus increasing the lumbar lordosis and resulting in low back pain. In addition, the lever arm of the hip abductors is shortened, causing an insufficiency of the gluteus medius, which leads to an abductor lurch. Initially, this lurch is painless but with time, pain develops

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Figure 3. Continued
C. Postoperative standing orthoroentgenogram during the consolidation phase, 18 weeks after surgery.
D. Postoperative standing orthoroentgenogram 6 weeks after removal of the frame.

when the patient stands and walks (Bombelli 1993). The aim of treatment is to reduce the lurch due to abductor insufficiency and leg-length discrepancy, to reduce the amount of lumbar lordosis and to increase the range of hip abduction. Thanks to the development of new surgical techniques and prosthesis designs, total joint replacement has become the first choice of treatment for patients with neglected high dislocation of the hip. This gives the patients painless hips and a good range of motion (McQueary et al. 1988, Paavilainen et al. 1990, Davlin et al. 1991, Garvin et al. 1991, Bombelli 1993). Nevertheless, these prostheses are subject to significant mechanical stresses, and prone to implant loosening, necessitating revision procedures (McQueary et al. 1988, Paavilainen et al. 1990, Davlin et al. 1991, Garvin et al. 1991). In patients with congenital hip dysplasia treated with

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total joint replacement, an acetabular loosening rate of 32% after 16 years of follow-up was found (Mac Kenzie et al 1996). Thus, pelvic support osteotomy is a valuable reconstruction alternative for adolescent and young adult patients with neglected high dislocation.

The aims of pelvic support osteotomy are to create an abduction and extension effect in the femur at the level of the ischium to increase the range of abduction, support the femur on the pelvis, reduce lumbar lordosis and increase the distance of the greater trochanter from the pelvis, which tightens the gluteus medius muscle and prevents Trendelenburg's limp (Bombelli 1993). Milch described a similar angulation osteotomy, with the addition of femoral head resection in patients with anterior dislocation who had developed arthrosis of the neocotile (Milch 1989). We performed femoral head resection in 3 patients with anterior dislocations, who had severe pain in the neocotile. These patients were cured of the pain and had no functional problems related to femoral head resection.

The classic Schanz osteotomy is advisedly performed between 9 and 40 years of age (Bombelli 1993). Bone remodeling and loss of angulation remain important considerations (Pauwels 1983, Bombelli 1993). In patients of 9–17 years, loss of correction is reported to vary between 3 and 13 degrees (Ilizarov 1983, Milch 1989). The youngest of our patients was 12 and the oldest was 33 years of age. The latter patient had no adaptation problems and a perfect range of motion, no Trendelenburg's limp, and a substantial increase in walking distance. The etiology in this patient was proximal focal femoral deficiency requiring a 10 cm lengthening of the femur. This lengthening and the long external fixation time caused some loss of knee motion; the range of motion of the knee was 0–60 degrees at the latest follow-up examination. We agree that pelvic support osteotomies give best results in patients over 15 years old (Milch 1989, Bombelli 1993).

In cases with bilateral high dislocation of the hip, the shortness created by the Schanz osteotomy does not cause a problem, if performed bilaterally. However, the unilateral Schanz osteotomy causes considerable leg-length discrepancy (Bombelli 1993, Catagni et al. 1998). Although an apparent lengthening may be obtained by over-abduction of the distal femoral fragment, this excessive abduction causes genu valgum, increases the shearing stresses on the knee joint, as well as knee pain and low back pain (Bombelli 1993).

All of our patients had unilateral hip dislocation and a mean leg-length discrepancy of 4.4 (1.5–10) cm. The length discrepancy caused functional and esthetic problems. Ilizarov's hip reconstruction osteotomy provided simultaneous lengthening of the extremity. In all patients, leg-length discrepancy was equalized with this second osteotomy using the distraction osteogenesis method.

Another complication of the Schanz osteotomy is the secondary genu valgum induced by the excessive valgus of the support osteotomy (Bombelli 1993, Catagni et al. 1998). If the patient has genu valgum before surgery, it will become worse after surgery. Mechanical axis deviation in the lateral direction increases loads in the lateral knee compartment and leads to arthrosis later. This lateral shift of the mechanical axis can be corrected by the second osteotomy. Postoperative radiographs showed correction of the mechanical axis deviation, lateral distal femoral angle and medial proximal tibial angle in all patients except 1. This patient had poor compliance and failed to walk with protected weight bearing after fixator removal, resulting in a late loss of correction and a 2 cm lateralization of the mechanical axis.

One weakness of our study is the shortness of the follow-up period. We cannot predict whether this osteotomy can prevent degenerative changes at the pelvic support point in the long term. There are no precise data about this matter in the literature dealing with classic Schanz osteotomy. We believe that in classic pelvic support osteotomy, genu valgum creates a mechanical axis, which does not pass through the pelvic support point and results in shearing stresses leading to arthrosis. On the other hand, hip reconstruction osteotomy normalizes the valgus effect created by the proximal support osteotomy by a second osteotomy and, finally, the mechanical axis passes through the pelvic support point.

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