Long-term results after open reduction of developmental hip dislocation by an anterior approach first lateral, then medial of the iliopsoas muscle

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Abstract

Background: The technique of and especially the approach to open reduction of developmental dislocation of the hip are still a matter of discussion. The anterior approach first lateral and then medial to the iliopsoas muscle as described by Tönnis is a method that was first published by Tönnis in 1978. A follow-up investigation to adulthood has now been performed.

Material and methods: 87 (118 hips) out of 105 children (83%) who underwent open reduction of developmental dislocation of the hip before the age of 4 were reinvestigated 10-21 years after the operation. An anterior approach first lateral, then medial to the iliopsoas muscle was chosen, since this offers the best access to the joint. Additional operations including transiliac osteotomy for acetabuloplasty, shortening osteotomy, and femoral osteotomies were performed as necessary.

Results: in 92 (78%) of the 118 hips studied the CE angle exceeded 25° and in 98 hips (83%) the VCA angle exceeded 25°. Critical CE angles between 20° and 25° were found in 14% of the hips, and critical VCA angles between 20° and 25° in 4% of patients. Residual dysplasia (<20°) was found in 8% and 13% of the hips respectively. Vascular necroses according to Hirohashi et al. were observed after operation in grade 1 in 5.9% and grade 2 in 1.7%. No necrosis was found following shortening osteotomy of the proximal femur.

Discussion: Compared with the literature, the clinical and radiological results are to be considered very well. However, reduction after the first year of life more frequently necessitates additional pelvic osteotomies.

Conclusion: The anterior approach first lateral, then medial to the iliopsoas muscle offers an optimal access to the medial parts of the Joint with control of reduction, protects the vasculature of the femoral neck, and allows simultaneous poster lateral capsulorrhaphy and pelvic osteotomies.

Introduction

Due to early diagnosis of dysplasia and dislocation of the hip by neonatal screening the number of open reduction procedures decreases and consequently the experience in the field. Therefore long-term results and reports based an a large number of patients seem necessary. Also, the technique and the approach to open reduction are still a problem of discussion.

Since 1970, one of the main activities of our department has been the treatment of developmental dysplasia and dislocation of the hip. A new anterior approach for open reduction was introduced by Tönnis (1, 2, 3). This report presents the results achieved between 1975 and 1983.

Indication for closed and open reduction

Developmental dislocation of the hip was originally investigated by palpation and radiography. In 1983 sonography was introduced (4). In cases of dysplasia without instability treatment consisted in abduction pillows and flexion-abduction splints. In very unstable and higher dislocated or irreducible hips arthrography was performed at all ages to find out whether in 110-120° flexion and 50° abduction of the hip the acetabular introitus was constricted or obstructed (2, 3, 5). lf no deep closed reduction in anaesthesia could be achieved, longitudinal traction with slight abduction and flexion was applied for four weeks. In case of failure (no progress) open reduction was indicated. Neonates with irreducible hips were sent home without treatment. In some infants closed reduction was possible a few months later. In the others open reduction was performed from the fourth month on.

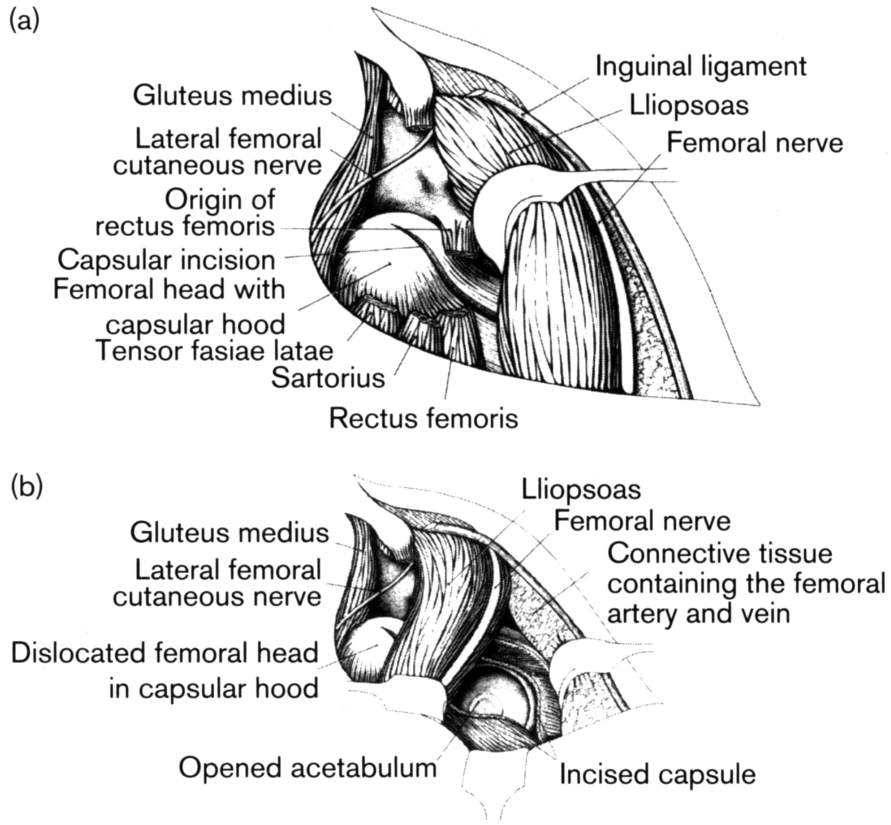
In 1984 (2) we found in an evaluation of closed reductions (n=320) that there were only 0.9% of ischemic necrosis when the femoral ossiffic nucleus was normally developed. When it was missing or small, the rate was 4.5 and 4.7% respectively, and when it appeared late, after the age 8 months, it raised to 12.5% (2, 3, 5). In these patients especially a longitudinal traction was tried first, and if no success was seen after 3-4 weeks open reduction was indicated.

The age in this evaluation ranged between 3 months and 4 years. In the first year of life, after 3 months, 32 joints of 29 children had open reductions without any other simultaneous operations because the spontaneous alignment is high in the first year of life (Fig. 4). In the second this was different.

Technique of open reduction according to Tönnis and indication of additional acetabular and femoral operations

A deep, concentric reduction is very often prevented by the medial portions of the capsule and labrum and the prominent transverse acetabular ligament (2, 3, 5). These structures have to be incised before the head can penetrate to the medial part of the acetabulum. However, with an antero-lateral approach identification of and access to these structures are often difficult. Furthermore, care has to be taken not to damage the underlying acetabular artery and vein in the acetabular fossa. Therefore we gave up the anterolateral approach and changed to an inguinal incision (Fig. 1).

Fig. 1



The fascia is divided just below the inguinal ligament up to the lacuna musculorum.

The muscles are detached from the superior iliac spine and the rectus femoris from the inferior iliac spine as seen in Figure 1.

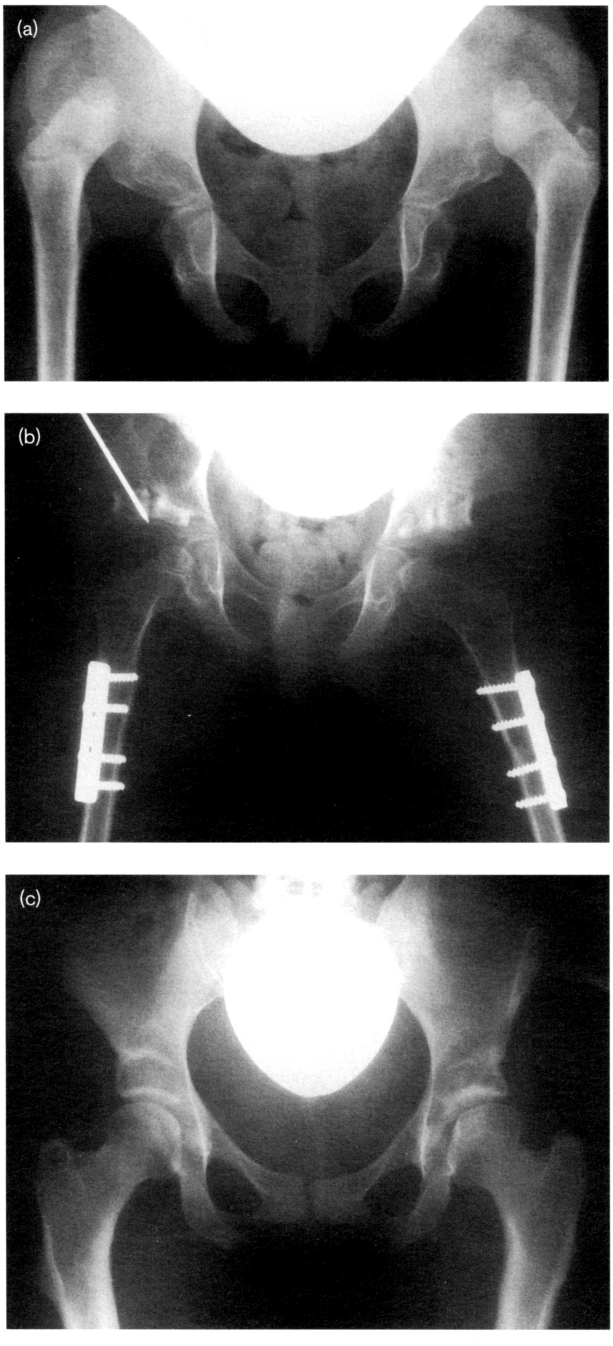
The exposed joint capsule is incised parallel to the acetabular margin at least 0,5 cm below in order to avoid damage to the labrum and the apophyseal growth centres of the acetabular rim. So far, the iliopsoasmuscle was retracted medially. Then it is retracted laterally so that the joint can be approached through the lacuna musculorum from anteriorly (Fig. 1 b).

It is safer to leave the femoral nerve on the muscle and retract it with double curved retractors than to separate it. The iliopsoas tendon should be obliquely divided at the pelvic rim and not at the lesser trochanter (6) to relieve intraarticular pressure and avoid avascular necrosis. The medial soft tissue of the lacuna vasorum with femoral artery and vein has to be held medially with double curved retractors and not with sharp-edged Instruments.

This approach gives excellent exposure of the acetabulum and its medial border and allows to assess the quality of the reduction by direct inspection. (1, 2, 3). The lateral labrum should not be excised, since it readapts to the femoral head and is needed to hold it in place. The acetabular fossa should not be touched. The acetabular artery and vein at its bottom provide the main blood supply to the three pelvic bones at the triradiate cartilage (7, 8).

The operative field of this inguinal incision remains confined to the area of the femoral head and acetabular margin and does not extend to the femoral neck (Fig. 1 a,b).

Fig. 2

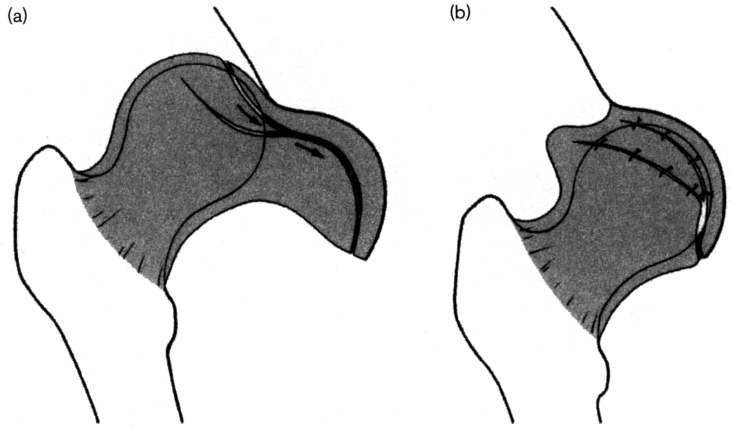


This reduces the risk of injury to the femoral head vessels. If femoral shortening is required, a subtrochanteric osteotomy is performed by a separate short incision in order to avoid damage to the blood supply of the femoral neck (Fig. 2 b). Besides, in the second and third year of life it is easier to apply a short metal plate with 4 holes at the femur than to perform and stabilise an intertrochanteric osteotomy (Fig. 2 a, b, c). In combination with the plaster cast a small plate with 4 screws is sufficient. Only a short lateral incision at the proximal femur is necessary. A detorsion could be performed, but is rarely necessary because anteversion decreases usually when the femoral head is well covered. And a detorsion to zero may stay and cause pain and osteoarthrosis in later years (9).

We stopped varus osteotomies when we found that about 50% caused a capita sub coxa valga deformity (11-13). A recent reinvestigation (15) proved that the valgus-neck-position developed normally, when the acetabular coverage was complete and the acetabular Index less than 150.

Shortening osteotomies (about 2 cm) are recommended if the dislocation is higher than the acetabular rim (Fig. 2 a). This is frequently necessary in children older than one year. It avoids ischemic necrosis as we shall see later. In addition, capsulorrhaphy is possible simultaneously with this approach and is performed by creating a flap of the redundant dorsolaterally extended capsule tissue (Fig. 3 a,b). The flap is pulled anteriorly like a girdle around the femoral head narrowing the capsule dorsolaterally and widening it in the former narrow ventral part. For the sutures Vicryl, a restorable material, is used.

Fig. 3



When the femoral head has been reduced it has to be tested whether there is easy redislocation due to dysplasia of the acetabular roof. If so, and if the acetabular angle is pathological at grades of deviation from normal to 3 and 4 (Tab. 1) (2), acetabuloplasty by a transiliac osteotomy (2, 10-13) directed medially from the lateral side, is bringing the roof into a horizontal position. It can be performed through almost the same incision (Fig. 2 b,c, und Fig. 4). A plaster cast is applied usually twice for six weeks each according to stability and the degree of residual dysplasia.

Table 1.Normal acetabular angles and grades of deviation (classification system)

Age	Grade 1 Normal (˚)	Grade 2 Mildly pathologic (˚)	Grade 3 Moderately pathologic (˚)	Grade 4 Extremely pathologic (˚)
3–4 months	<30	≥30–<35	≥35–<40	≥40
5–24 months	<25	≥25–<30	≥30–<35	≥35
2– 3 years	<23	≥23–<28	≥28–<33	≥33
3–7 years	<20	≥20–<25	≥25–<30	≥30
7–14 years	<15	≥15–<20	≥20–<25	≥25

Fig. 4

Acetabuloplasty is possible at any age up to about 10-12 years. Slight dysplasias (grade 2 of deviation from normal) may be observed for further spontaneous development over several years, but grades 3 and 4 should be corrected simultaneously with the open reduction.

Material

The evaluation of our technique of open reduction considered only children with typical developmental dislocation of the hip. Children with teratological dislocation or neurological disorders were excluded. Age at Operation ranged from 3 months to 4 years. Revision operations of pre-treated infants were also excluded.

87 (70 female and 17 male) (83 %) of 105 originally operated patients attended the follow-up examination. 25 patients had dislocation of the right side, 31 on the left side and 31 patients on both sides; thus, 118 hips were subject to follow-up examination. Age at operation ranged from 3 to 48 months with a mean of 14 months. Follow-up was performed 10 to 21 years later with a mean of 15 years and 3 months.

The distribution of the dislocation grades according to Tönnis (2,16) is the following for 118 hips:

Grade 1 (centre of femoral head medially to the vertical line of Perkins): 0%
Grade 2 (centre of femoral head laterally to line of Perkins): 1%
Grade 3 (centre of femoral head close to level of superior acetabular rim): 18%
Grade 4 (centre of femoral head above superior acetabular rim): 81%

Table 2 shows the type and frequency of the conservative pre-treatment of the hips which must be taken into consideration when evaluating the incidence of necrosis. The surgical methods are shown in Table 3.

Table 2. Conservative treatment before operation in 64 of 87 patients

Treatment	*n*
Broad diapering	5
Becker pillow	16
Pavlik harness and flexion-abduction splints	23
Traction	38
Casts in human positions	28

In 26 patients one method was applied, in 30 patients two and in eight patients three. In 25 patients of the 64 the dislocation was bilateral, in 39 it was unilateral.

Table 3. List of single open hip reductions and concomitant operations (n = 118)

Treatment	*n*	%
Open reduction of hip dislocation	32	27
Open reduction and acetabuloplasty	37	31
Open reduction, acetabuloplasty, DVO	34	29
Open reduction, acetabuloplasty, DVO, shortening-osteotomy	6	5
Open reduction, acetabuloplasty, shortening-osteotomy	4	3
Open reduction, detorsion-varus-osteotomy	5	4

DVO: detorsion-varus osteotomy.

Results

1. Clinical Finding

The clinical findings were graded after Severin (22) and are shown in Table 4. Patients of group A show no limp, no pain and normal endurance. Patients of group B have no limp. But the patient "feels" his hip on any great exertion. The range of motion was also investigated in detail. Only ten hips out of 118 (9%) had less than 125° of flexion, and only six Joints had a 10° or 20° deficit of extension (flexion contracture). Abduction ranged from 30° to 50° with only two exceptions and adduction from 30° to 35° with seven exceptions. Internal rotation ranged from 30° to 85° and external rotation from 30° to 65°. This is due to the syndromes of high and low anteversion, especially when acetabular and femoral anteversion both tend towards low or high grades. This was only recently investigated in detail (9). In decreased anteversion the internal rotation of the hip is low and the external high, in high anteversion internal rotation is high and external low.

Table 4. Clinical classification of the joints according to Severin and others (n = 118)

Classification	*n*	%
Severin A	98	83
Severin B	18	15
Severin C+D	2	2

Limping as a sign of muscular imbalance was assessed according to a classification of the Trendelenburg sign (2). Grade 1 is defined as a mild deviation in the one-leg stance without significant sagging of the pelvis. A fatigue limp develops on prolonged walking. Grade 2 presents a moderate sagging of the pelvis in the one-leg stance. Out of 118 hips only eighteen were classified as grade 1 (15%) and three hips were classified as grade 2 (3%). No hip showed a grade 3 limping. In 97 hips (82%) there was no limping at all.

2. Roentgenologic evaluation

The containment of the reduced femoral head with and without acetabuloplasty was evaluated by means of the lateral CE angle of Wiberg (17) and the anterior VCA angle of Lequesne and de Sèze (18), also called the anterior CE-angle. These authors consider angles exceeding 25° as being normal. However, in adults the normal value for the CE angle we found to range between 30° and 35° (22).

According to our investigations the range of strict normality (maximal pain free state) starts at a CE angle of 30° at the age of 18 years (2). Between 39° and 44° we speak of deep acetabulum and from 45° onwards of protrusion acetabuli, which again means pathologic hips (9, 21). According to our standard, in normal values there is an average of 32° and a lower limit of 25° between the age of 8 and 18 years (2), but 30° are the borderline in adults. This fact is not common knowledge in literature yet. For the sake of statistical comparability we considered the angle of 25° to be a standard limit value for adolescents and adults.

In 78% of the hips the CE angle and in 83 % of the hips the VCA angle increased to >25° and in additional 14% and 4% respectively to the limit angle of 20 to 25°. Thus only 8% (CE angle) or 13% (VCA angle) of the hips showed a residual dysplasia with angles below 20°, that might still need a later operation.

3. Clinical and roentgenologic classification of the results according to Severin, Gibson and Benson, and Williamson.

In order to allow a comparison with other authors a roentgenological and clinical classification of the hip Joints according to Severin was performed (17). In the original roentgenologic classification there is a further subdivision within group 1 of CE angles, namely into type a and type b. Gibson and Benson (23) as well as Williamson et al. (24) introduced a simplification and considered CE angles larger than 15° as normal (and not 19°) for those aged between 6 and 13 and angles exceeding 25° as normal for those aged 14 and above.

Since most authors seem to apply the simplified classification, we also chose this classification for our investigation. Table 4 presents the clinical results according to Severin: 83% belong to group A (asymptomatic), 15% to group B (minor discomfort in case of greater effort) and 2% to groups C and D (limping and limitation of the walking distance to 4-5 km).

Table 5. Radiological classification of the joints according to Severin and others (n = 118)

Classification	n	%
Severin 1	73	62
Severin 2	17	14
Severin 3+4	8	7
CE angle 20–25˚	20	17 (not classified)

Table 5 shows the roentgenologic results: 62% have normal hips with an CE angle according to Wiberg (17) of more than 25° which is appropriate for their age. Group 2 also comprises hips with normal angles, however, there are slight changes of the femoral head or neck or the acetabulum.

These 14 % may also be considered good. Only 7% belong to group 3 and 4 representing residual dysplasia with CE angles below 20°. Severin does not specifically consider angles between 20 - 25°. We found 20 hips in this range and assessed them separately for statistical reasons (Tab. 5). During long-term follow-up no case of redislocation was observed (Severin group 6), however, thirteen of our hips already redislocated while still in plaster cast. They were immediately repositioned with concomitant acetabuloplasty and were reinvestigated with the other patients.

4. Outcome according to age and type of Operation

It is generally known that outcome is age-dependant. The younger the child the more spontaneous acetabular development will occur (Fig. 4). For this reason Table 6 contains one group in which only surgical reduction and no other additional procedure such as acetabuloplasty or femoral osteotomy was performed. 29 of 32 hips were operated in the first year of life after the third month and only three in the second year. Mean age was 7 months.

In the older age group with a mean age of 17 months, 86 joints were operated at the age of 2 to 4 years and only 20 in the first year of life. In 88% of those hips operated mainly during the first year of life, a roentgenologic improvement according to Severin's group 1 could be achieved (healing) (Tab. 6) whereas only 71% of the hips in whom treatment started in their second to fourth year of life achieved healing, although two thirds of these hips had undergone acetabuloplasty already.

Apparently, after the first year of life sufficient spontaneous improvement without additional operative Intervention can not be regularly expected.

Table 6. Results of open reduction alone and with additional operation

	Age at operation	CE Severin >25°	Clinical Severin Grade A+B	Residual dysplasia CE angle <20°	Avascular necrosis (Hirohashi)
Only open reduction *n* = 32	7 months	88% *n* = 29	94%	0%	Including 6% preoperative
With additional procedures *n* = 86	17 months	71% *n* = 61	77%	8%	12% grade 2+3 including 6% preoperative

5. Complications

Table 7 gives an overview of the complications we observed. Coxa magna was determined by comparing the greatest diameter of the femoral heads of both sides in the horizontal plane at neutral leg position. Gamble et al. (25) considered an increase of more than 15% as coxa magna, whereas Imatani et al. (26) used a limit of 20%. In our investigation we applied the latter value of 20%.

Table 7. Complications after open reductions of hip dislocations with and without additional operations (n=118)

Complication	*n*	%
Coxa magna[a] (*n*=54)		
Difference in head diameter 0–20%	10	19
Difference in head diameter >20%	1	2
Avascular necrosis (Hirohashi *et al.*) only postoperative		
Grade 1	7	5.9
Grade 2	2	1.7
Grade 3	0	0
Total	9	7.6
Redislocations short after open reduction	13	11
Superficial wound infections	3	3

[a] Coxa magna was evaluated only in 54 unilateral open reductions.

A vascular necrosis of the femoral head was assessed according to the classification of Hirohashi et al. (27). In brief, mild necrosis does not lead to permanent damage, moderate necrosis leads to partial damage and severe necrosis to complete damage. Out of 118 hips 7 (5.9%) presented postoperatively mild avascular necrosis and 2 (1.7%) partial necrosis (Grade 2), which adds up to a total of 9 (7.6%) (Tab. 7). However, 5 (4.2%) other hips showed already preoperatively corresponding signs after a failing longer conservative treatment.

In one femoral head a necrosis was seen, in the others no ossific nucleus and a small one in 1 hip. All these hips except one were operated in the second year (Tab. 8). The missing nucleus at that time is a sign of preoperative necrosis.

Table 8. Preoperative condition in other patients (n = 5; 4.2%)

Patient Number	Pretreatment	Osseous nucleus	Age at operation (months)	Necrosis grade
1	++	No	13	3
2	++	No	0	2
3	+	No	18	3
4	+	Small	17	1
5	++	Necrosis	14	3

+ moderate; ++ extensive.

The surgical technique of shortening osteotomy, often combined with acetabuloplasty, was additionally examined (Tab. 7). This procedure decreases the pressure exerted on the femoral head after reduction from the high dislocation position and an additional levering down of the acetabular roof. In this group no necrosis was observed although the age at operation was averaging 26 months.

These children were definitely older than the rest of our patients (average age at operation of 17 months) and shortening osteotomy was performed in grade 4 dislocations only. 6 joints of the first group with shortening osteotomies had an age of one year to one year and six months. The joints of 4 children were operated at the age of two years, four months, to four years, four months.

In 13 hips (11%) redislocation occurred while still in plaster cast. These hips were immediately reoperated. As a result, acetabuloplasty at the time of open reduction was performed more and more often, whereas varus and detorsion osteotomies were given up almost completely (see chapter of indication in the beginning). Neither joint nor deep wound infections were observed. Only in 4% superficial infection occurred.

Discussion

When we compare our results 76% of Severin grades 1 and 2 for the x-rays and 98% for the Severin clinical grades A and B with other authors, that have follow-up times of 10 years and more. In Table 9 we find the group of the four best results of 75% and more for grades 1 and 2 of the x-rays. The clinical grades unfortunately were investigated only rarely by other authors.

Table 9. Results of open reduction with and without shortening-osteotomies

	Age at operation	Shortening	Degree of dislocation	Avascular necrosis
Reduction + shortening *n* = 10	26 months	2 cm	All degree 4	None
Other reductions *n* = 108	17 months	None	Degree 4, 83% Degree 3, 3% including 4.2% preoperative	11.8%

See groups in Table 3.

88% of the children who had undergone open reduction mainly within their first year of life achieved grade 1 of the roentgenologic classification of Severin (normal) compared to only 71% of children operated on mainly in the second to fourth year of life (Tab. 6). For the clinical classification of Severin 83% of the cases in both groups reached the standard grade of group A. Considering group A and B as well as 1 and 2 according to Severin together, the values are 98% and 76%, respectively.

Our patients presented with 5.9% grade 1 and 1.7% grade 2% a very low and mild rate of postoperative avasccular necroses when we compare in Table 10 the rate of other approaches to the hip joint. This is certainly due to our anterior approach medial to the iliopsoas muscle which is not touching the vessels of the femoral neck. No necrosis was seen after shortening osteotomies (n=10) (Tab. 9). Since then for all dislocations of higher degrees, reduction was performed sirnultaneously with a subtrochanteric osteotomy (Fig. 2a). The subtrochanteric technique was chosen to avoid damage to the proximal femoral vessels. Additionally, in a child of up to two or three years it is easier to perform a subtrochanteric than an intertrochanteric osteotomy.

Table 10. Results of reinvestigations of open reductions in developmental hip dislocations

Study	Age (months)		Mean follow-up (years)	Number of hips	Avascular necrosis (%)	Redislocations (%)	Severin radiograph	Severin clinical	Operative technique
	Mean	Range							
Berkeley [28]	ND	12–36	6.1	5.1	ND	ND	92 grade I+II	100 grade A+B	Iliofemoral approach, acetabuloplasty
Powell *et al.* [29]	16	4–26	4.3	16	25 grade I+II Salter, Gage, Winter	ND	68.8 grade I different score	ND	Anterior approach
	27	8–80	4.8	18	22.3 grade II+IV	5.6	72.2 grade I different score	ND	Anterior approach + varus osteotomy
	29	15–46	5.6	15	46.7 grade I–IV	26.7	46.7 grade I different score	ND	Anterior approach, varus + Salter osteotomy
Galpin and Wenger [30]	>2	ND	3.7	33	9.1	12.1	72.7	ND	Medial approach, Salter osteotomy
Williamson [24]	4.3	3–9.5	16.7	45	13.3	ND	51 grade I+II	80 grade A+B	Anterior approach of Sommerville
Castillo [31]	19	5–26	7	26	15	12	73 grade I+II modified	ND	Ludloff
Dhar [32]	Different groups	ND	5.6	99	23.2	4	75.8 grade I+II	100 MacKay grade I+II	Anterior approach derotation
Mergen [33]	12.1	3–33	7.1	31	9.7	0	67.7 grade I+II	100 MacKay grade I+II	Medial approach (Ferguson)
Mankey, Staheli [34]	12	2–63	6	66	11	4.6	In 33% pelvic osteotomy later		Ludloff

Sugimoto *et al.* [35]	<84	ND	>15	43	46.5 Kalamchi I+II	ND	41.2 grades I,II,III	ND	Unknown
Doudoulakis, Cavadis [36]	7	2–12	13	69	13	1.5	76.8 successful		Anterior approach (Smith-Petersen)
Gulman *et al.* [37]	ND	19.2–48	13	43	34 grade II, III, IV	71.1	78.9 grade I+II	ND	Anterior approach
	ND	48–96	9		Buchholz, Ogden		Severin		Salter osteotomy
Michiels [38]	8.8	3–21	11	21	38	0	81 grade I+II	47.6 different score	Ludloff and others
Szepesi [39]	13	6–24	6.1	113	0	ND	98 grade I+II	98 grade A+B	Anterior approach + pelvic osteotomy
Haidar [40]	25.4	18–67	7.6	37	8.1	0	83.8 grade I+II	97.3 MacKay grade A+B	Anterior approach + Salter osteotomy
Morcuende *et al.* [41]	14	2–50	11	93	24 grade II; 14 grade III; 3 grade IV; 2 no classification Buchholz, Ogden	2.2	71 grade I+II	ND	Anteromedial (Weinstein)
Koizumi *et al.* [43]	14	5–29	19.4	35	42.9 Kalamchi	ND	54.3	ND	Ludloff, 50% reoperated
Turner [44]	11.2	2–25	8.1	56	8.9	ND	98 grade I+II	ND	Medial approach 19% acetabular osteotomy
Ryan *et al.* [45]	76.8	36–108	10.6	25	44 grades I–III Salter, Buchholz, Ogden	ND	72 grade I+II	ND	Anterior approach Smith-Petersen + short osteotomy
Akagi *et al.* [46]	14	5–26	15	22	31.8 Kalamchi	ND	9.1 grade I; 54.5 garde II	ND	Smith-Petersen, no osteotomies until 15 years
Olney *et al.* [47]	29	15–117	3.6	18	5.5	0	100 grade I+II	100 grade A+B	Anterior approach VDO + pelvic osteotomy
Cordier *et al.*	14	3–48	15.3	118	6 Hirohashi *et al.*	11	76 grade I+II CE 20–25˚, 17%	98 grade A+B	Anterior approach (Tönnis), acetabular osteotomies

DVO: detorsion-varus osteotomy

Another possible complication that needs to be discussed is redislocation. In the literature (Tab. 8) redislocation occurred in 4% to 12%. For the sake of stabilisation of the femoral head a long girdle-like capsular flap was detached from the craniolateral redundant capsule, pulled anteriorly around the femoral head and sutured together with the previously incised capsule at the medial Joint border (Fig. 3).

If the acetabular angle had a pathological grade 3 and 4 of deviation from normal according to age (Tab. 1) acetabuloplasty with transiliac osteotomy was performed in combination with femoral head reduction in Order to lever the acetabular roof down laterally (Fig. 2 and 4). This way the labrum extends more laterally and distally over the femoral head and offers immediate stabilization.

There are different ways to improve the acetabular roof angle by osteotomies. Salter (28) and Pemberton (29) osteotomize in the anterior- to posterior direction, Wiberg, 1953, (10) in the lateral - to medial direction. In Salters osteotomy the distal pelvic fragment with the acetabulum in total is rotated antero-lateral around an axis passing through the pubic symphysis and the posterior part of the osteotomy. Therefore the improvement of the acetabular angle is limited and the acetabulum obtains a decreased anteversion (30). If this does not remodel, especially towards the end of growth, and the femoral anteversion is low in addition, pain and osteoarthrosis are to be expected (9).

The osteotomy from lateral in medial direction (Fig. 4), which we prefer, has the advantage that an Image intensifier can be used all the way and the chisel is directed exactly as wanted. The anterior part of the osteotomy is visible. Posteriorly we can feel the chisel slightly protruding in the sciatic notch and control it with the finger while it moves medially. The osteotomy ends medially shortly above the posterior end of the triradiate cartilage. In the bone and the anterior- to posterior part of the cartilage zone the acetabular roof can be bent down to the highest degrees (50°). Early fusions of the triradiate cartilage have not been observed (11-14).

In the first years acetabuloplasty was combined with varus-detorsion osteoftomy. We used the femoral bone wedge to support the acetabular roof. Later, when we avoided varus osteotomies as Salter does, xenogenic bone wedges of animals were introduced by Braun Co., Melsungen. Today bone wedges from allergenic femoral necks or femoral heads with a firm cortical rim are carefully examined and tested according to standardized bone bank rules and sterilized at 121°C for 20 min. and then kept deep frozen in the bone bank (31).

Conclusions

As our results show, open reduction of developmental dislocation of the hip can achieve in 92 % normal (CE angle >25°) or almost normal hips (20-25°) at the end of growth. The reduction through a ventral approach first lateral, then medial to the iliopsoas muscle, shortening osteotomy and other preventive measures to avoid ischemic necrosis are important. The advantages of the inguinal approach of Tönnis are:

1. Optimal vision into the acetabulum before and after reduction from anteriorly. When dissecting the medial labrum and transverse ligament, trauma to the acetabular artery and vein is easier to avoid. Also, the deep reduction is better controlled than by lateral approaches.

2. The 0peration is confined to the acetabulum and the inguinal region. The femoral neck is left covered. The iliopsoas tendon is obliqually dissected at the height of the pubis and acetabulum. Trauma to the medial femoral circumflex artery is avoided this way.

3. Simultaneously a postero-lateral capsulorraphy and acetabular osteotomies can be performed from the same incision. Only subtrochanteric shortening osteotomies need a short lateral incision at the femur. This more distal shortenig does not impede the proximal femoral blood circulation. Detorsion-varus osteotomies have disadvantages (see chapter of technique of open reduction) and became very rare with our transiliac osteotomy technique close to Wiberg (1953).

4. The abductor muscles have not been damaged as the minimal rate of limping shows in the evaluation.

5. Medial approaches have a higher risk of ischemic necroses (16, 33-36) and need a second approach for acetabular osteotomies, which are frequently necessary in the second year of life and later, but sometimes even before. Postero-lateral capsulorraphies which are important for immediate stability cannot be performed from the medial approach.

6. The iliac apophysis and pelvic wing should not be used as a bone wedge for acetabular osteotomies as Pemberton (29) has proposed it. This can result later in pelvic deformities and muscular functional deficiencies.

Simons (36) as well as Gabudza (37) stated that the indication for a certain operative approach should depend on the exact case. However, this does not apply to the approach described in this paper. Also, disadvantages of the ventral approach mentioned by Gabudza are not relevant for the approach laterally and medially to the iliopsoas muscle. Another advantage are the almost invisible scars in the inguinal region.

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