Painless period after Spitzzy shelf operation for residual hip dysplasia—A long-term study of 47 children and young adults

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ARTICLE INFO

Keywords:

Hip dysplasia
Hip pain
Hip-shelf operation
Long-term follow-up

ABSTRACT

Objective: To study the effects of the Spitzzy shelf operation on hip pain.

Method: A modified Spitzzy shelf procedure was performed in 60 hips with residual hip dysplasia. The mean age at surgery was 11.7 years (range 5.5–22.4 years).

Results: Twenty-one hips had pain preoperatively. One year postoperatively 57 hips (95%) were painless. The mean postoperative painless period in patients with > 10 years follow-up was 24.1 years (range 5.0–51.5 years). The only independent predictor of long duration of painlessness was preoperative CE angle $\geq 10^\circ$.

Conclusion: The Spitzzy procedure had favorable short- and long-term effects on hip pain.

1. Introduction

Hip shelf operation is a procedure aimed at correcting residual acetabular dysplasia and subluxation in patients with developmental dysplasia of the hip (DDH). The intention is to improve hip stability and avoid deterioration of residual dysplasia, thus postponing the occurrence of secondary hip osteoarthritis (OA). Another intention is to eliminate or reduce hip pain in patients who have such complaints. Multiple surgical techniques of the shelf operation have been described. In our hospital a modification of the technique described by Spitzzy¹ was the preferred method for joint-preserving surgery during several decades. Most of the primary radiographs and case records were still available for this long-term study.

There is no consensus with regard to the usefulness of the shelf operation. Whereas the operation is considered merely a salvage procedure by some authors,^{2,3} other studies in children and adolescents have shown good clinical and radiographic results in 70–80% of the patients at short-term and medium-term follow-up.^{4,5} No studies on children with a follow-up longer than 17 years have been published,⁶ apart from a recent report which focused on the need of total hip replacement (THR) after the Spitzzy procedure.⁷ In the present study the long-term clinical effects, especially on pain, were analyzed. We asked the following questions:

1. What are the short- and long-term effects of the Spitzzy shelf operation on hip pain?
2. Which clinical and radiographic factors are predictors for the

duration of painless period postoperatively?

2. Methods

The patients for this retrospective study were recruited from a search through the protocols of surgical procedures at Sophies Minde Orthopaedic Hospital (now Orthopedic Department, Oslo University Hospital) for the period 1954–1976. Sixty-one patients who had undergone hip shelf operation were identified. Fourteen patients were not included because there was no clinical information for 9 patients, another procedure than the Spitzzy technique had been performed in 4 patients, and one patient had been operated for a femoral head cyst 3 years after Spitzzy operation. Of the remaining 47 patients, 42 were girls (89%) and 5 were boys. Their mean age at surgery was 11.7 years (range, 5.5–22.4 years). Age at surgery was < 8 years in 15 hips, 8–14.⁹ years in 34 hips and ≥ 15 years in 11 hips. A bilateral shelf procedure had been performed in 13 patients. The study was approved by the hospital's privacy and data protection officer, and informed consent was received from all patients.

All patients had developmental dysplasia or dislocation of the hip (DDH), but no other congenital or neurological disorders. 42 patients had previously been treated for DDH (total dislocation in 43 hips and subluxation in 7 hips; missing information in 4 hips). Mean age at hip reduction was 2.2 years (range, 0.7–5.4 years). In the remaining 5 patients (6 hips) subluxation had been detected at a mean age of 11.8 years (range, 7–20 years) and they had not had any previous treatment. Before the shelf operation, 16 of the hips that had previous

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treatment developed avascular necrosis of the femoral epiphysis (AVN), Groups II–IV.⁸ In 9 hips a femoral varus and derotation osteotomy had been performed before or after the shelf operation, at a mean patient age of 16.3 years (range, 16–23 years).

Indication for Spitzzy shelf operation was acetabular dysplasia, defined as CE angle⁹ below 20°, with or without subluxation and hip pain. Because the old radiographs of some of the patients had disappeared over the years, exact information on preoperative femoral head coverage was available in 40 hips.

2.1. Surgical technique

A technique modified from Spitzzy¹ was employed. A Smith-Petersen anterior skin incision approach was used. The outer surface of the iliac bone was exposed subperiosteally down to the lateral joint capsule. The reflected head of the rectus femoris tendon was divided to expose the underlying joint capsule. The lateral capsule was usually thick and was made somewhat thinner by partial resection. A broad osteotome was used to make a slot for the shelf in the iliac bone, just proximal to the acetabular labrum and in a medial and slightly proximal direction. A trapezoid cortico-cancellous bone graft was obtained from the antero-lateral iliac crest. The bone graft (approximately 4 and 2 cm long, 4 cm deep and 3–5 mm thick) was impacted into the slot with the slightly concave cortical side downwards. It was aimed at placing the graft as near the joint capsule over the lateral femoral head as possible (Fig. 1). No internal fixation was used. Cancellous bone chips from the iliac wing were packed into the triangular space between the shelf and lateral iliac surface. The reflected rectus femoris tendon was sutured to the antero-lateral aspect of the capsule. The postoperative regime was skin traction for 10 weeks followed by partial weight-bearing with crutches for 4 weeks. Full weight-bearing walking was allowed approximately 3 months postoperatively.

2.2. Follow-up evaluation

Information on pre- and postoperative pain was obtained from the case records. Most patients were followed by routine clinical and radiographic examinations for many years. However, some patients had only a few years follow-up, usually because they had no complaints about their hips and lived long away from the hospital.

Long-term follow-up included information on total hip replacement (THR), which was provided from The Norwegian Arthroplasty Register. Patients who had not undergone THR were invited to a long-term follow-up examination including radiographic examination and evaluation by the Harris hip score (HHS).¹⁰ Those who refused to attend this examination were contacted by telephone and evaluated by HHS.

2.3. Statistics

SPSS software, version 21 (IBM, Armonk, NY, USA) was used for statistical analysis. Continuous variables were analyzed with the *t*-test for independent samples and categorical variables were assessed by Pearson's chi-squared test. Potential factors associated with painless period postoperatively were first assessed by univariable analysis. Variables with *p*-value < 0.05 were tested by multivariable linear regression. The Kaplan-Meier product-limit method was used for survival analysis, with length of painless period postoperatively as "survival". All tests were 2-sided. Differences were considered significant when the *P*-value was < 0.05.

3. Results

3.1. Short-term results

Preoperative hip pain was present in 21 hips (35%), whereas 39 hips had no pain. The mean duration of pain was 2.5 years (range, 1–8

Fig. 1. A–D Radiographs of a girl who underwent bilateral Spitzzy shelf operation. (A) Preoperative radiograph at patient age 8.4 years shows bilateral dysplasia (CE angle 8° in the right hip and 11° in the left). Bilateral Spitzzy procedures were performed at an interval of 3 weeks. (B) Radiograph 3 months postoperatively show that the shelves have been very steeply placed, but considerably increase in femoral head coverage occurred. (C) At age 18 years good remodeling of the shelf has taken place bilaterally. (D) Radiograph 44 years postoperatively shows bilateral osteoarthritis (Harris Hip Score was 76 on the right side and 45 on the left).

Table 1
Association between preoperative pain and age at Spitzzy procedure.

Age at Spitzzy	Preoperative hip pain			
	No pain		Hip pain	
	N	Percentage	N	Percentage
< 8 years	14	93	1	7
8–14.9 years	23	68	11	32
15–22 years	2	18	9	82

N, number of hips.

years). Mean age at Spitzzy operation was significantly larger in hips with pain compared with those without pain (15.5 years vs. 9.6 years; $P < 0.001$). The frequency of preoperative pain increased from 7% when age at surgery was less than 8 years to 82% when age was ≥ 15 years (Table 1). One year postoperatively, 57 of 60 hips (95%) were painless. Hip pain was present in 3 hips, of which all had preoperative pain, and they also had pain during further follow-up.

The mean preoperative CE angle was 5.9° (range, -12 to 17°). One year postoperatively the mean CE angle was 31.3° (range, 4 – 51°). The mean difference between preoperative and postoperative CE angles was 24.2° . The shelf had been totally or partially resorbed in 5 hips. The mean patient age at surgery in these hips was 8.3 years (range, 5.5–11.4 years). There was no significant difference in preoperative CE angle between these hips and those without resorption (1.8° vs. 6.4° ; $p = 0.222$), but the hips with shelf resorption had a lower CE angle one year postoperatively (11.8° vs. 33.8° ; $P < 0.001$).

Postoperative complications occurred in 5 hips (8%), including deep infection in 4 hips. The infection destroyed the hip joint, leading to early OA, in 3 patients, whereas one patient recovered after treatment with antibiotics and had a good long-term outcome. One patient experienced peroneal paresis postoperatively, but the paresis was transitory with almost full recovery.

3.2. Long-term results

Ten patients had a follow-up of less than 10 years. They had no hip pain, but were excluded from the long-term analysis of pain because of short follow-up. Also the 3 patients with pain one year postoperatively were excluded from this analysis. Thus, long-term pain analysis was performed in the remaining 34 patients (47 hips) with more than 10 years follow-up and with no pain one year postoperatively. The mean follow-up time was 32.8 years (range, 11.7–52.0 years). The mean painless period was 24.1 years (range, 5.0–51.5 years). Kaplan-Meier survival analysis, with duration of painless period as “survival”, is shown in Fig. 2. The survival curve showed a steadily decreasing survival from 100% one year postoperatively to 27% after 40 years; thereafter no further reduction up to 51 years follow-up occurred.

Possible variables associated with duration of postoperative painless period are shown in Table 2. In univariable analysis the painless period was significantly longer in hips with preoperative CE angle $\geq 10^\circ$ than in those with CE angle $< 10^\circ$ and longer in hips with no AVN (avascular necrosis) at the time of shelf operation than in those with AVN. There were no significant associations between painless period and the following variables: gender, age at Spitzzy operation, uni- or bilateral Spitzzy, preoperative hip pain or not, and whether or not a femoral osteotomy had been performed. When the variables with a P -value < 0.05 in univariable analysis were tested with multivariable linear regression, the only independent variable for longer painless period was a preoperative CE angle $\geq 10^\circ$.

During the long-term follow-up 44 of 60 hips had undergone THR. The mean interval between Spitzzy operation and THR was 36.7 years (range, 21–50 years). Of the 16 hips that had not undergone THR one patient had chronic obstructive lung disease and sat in a wheel-chair

and one patient was not available for clinical evaluation. Thus, 14 hips were examined clinically with a mean follow-up period of 46.9 years (range, 39–52 years). The mean HHS was 80.9 points (range, 22–100 points). Of 15 hips with long-term radiographs, OA was present in 8 hips and not in 7 hips. Mean HHS was larger in hips without OA than in those with OA (87.3 vs. 74.4 points) but the difference was not statistically significant ($P = 0.343$).

4. Discussion

The answers to the study questions were that the Spitzzy shelf operation had favorable short- and long-term effects on hip pain and functional activities and that the procedure had better outcome when the preoperative CE angle was $\geq 10^\circ$ compared with hips with CE angle $< 10^\circ$.

This study had several limitations. First, the study was retrospective and there was no control group. Second, the number of patients was limited and radiographs were not available in some patients, which reduced the reliability of the statistical evaluation. Moreover, information about hip pain based on old patient records could imply questionable reliability. The strengths of the study were the long period of follow-up and that no patients were lost to follow-up.

From a clinical point of view, the intention of the shelf procedure is to eliminate or reduce preoperative hip pain and avoid pain problems as far as possible during the postoperative years. Preoperative hip pain was reported in 69% of the hips by Love et al⁵ and in 70% by Summers et al⁶. Our pain rate was 35% and thus considerably lower, but there was a clear trend to increasing pain rate with age at surgery, since less than 10% of children < 8 years and more than 80% at age ≥ 15 years complained of preoperative pain. With a mean follow-up of 17 years, Summers et al⁶ reported pain relief for a mean postoperative period of 12 years in hips that had been painful preoperatively. Good pain relief was also found in the present study since 18 of 21 patients (86%) with preoperative pain became painless postoperatively. Most previous studies had a relatively short follow-up period. The longest previous mean follow-up after modified Spitzzy procedures in children and adults seems to be 24 years.¹¹ Using Kaplan-Meier survivorship analysis in patients younger than 25 years at surgery, with poor clinical result as endpoint, they predicted a survival rate for the shelf operation of 80% at 15 years follow-up and concluded that the operation was indicated for acetabular dysplasia or subluxation without advanced OA. This is in accordance with the present results, with 77% survival (painless hips) at 15 years of follow-up. Satisfactory outcome lasted for an even longer time, since the mean painless period postoperatively in patients with more than 10 years follow-up was 24 years.

The only significant risk factor for poor long-term outcome was a low preoperative CE angle $< 10^\circ$. This indicates that Spitzzy procedure should be performed before the CE angle is too much reduced. In patients with especially low CE angle ($< 0^\circ$), alternative procedures should be considered. Regarding other possible prognostic factors involved with the shelf procedure, poor placement of the shelf has been emphasized.⁴ Too high location of the shelf was associated with resorption of the graft.¹² We planned to examine the effects of graft placement on long-term outcome, but found that measurements of graft angle (angle between graft and horizontal axis) and height (distance between undersurface of graft and lateral acetabular rim) were rather unreliable and changed with time, as the graft remodeled (as seen in Fig. 1).

The shelf procedure gave a marked improvement of femoral head coverage, with a mean increase of the CE angle of 24° . Some previous studies have reported even larger differences, with a mean increase in CE angle postoperatively of approximately 40° .^{12,13} This marked grade of correction could be harmful in some patients, as it would predispose to impingement between the shelf and the proximal femur. However, the optimal grade of correction has not been settled. Resorption of the graft would imply undercorrection of the deficient femoral head

Fig. 2. Kaplan-Meier survival analysis after Spitzzy shelf operation, with duration of painless period postoperatively (years) as “survival”.

Table 2

Associations between clinical and radiographic factors and painless period postoperatively in 47 hips with follow-up ≥ 10 years and no pain one year postoperatively.

	Univariable analysis		Multivariable linear regression P
	Painless period (years) Mean (SD)	P	
Age at Spitzzy			
< 11 years	24.9 (14.4)	0.629	
≥ 11 "	22.9 (12.9)		
Gender			
Female	23.7 (13.6)	0.348	
Male	33.1 (18.5)		
Preoperative CE angle			
< 10°	18.4 (8.5)	0.023	0.040
10–17°	27.7 (15.2)		
Preoperative hip pain			
No pain	25.2 (13.7)	0.383	
Hip pain	21.4 (13.7)		
Avascular necrosis (AVN)			
No AVN	25.4 (14.5)	0.016	0.398
AVN	17.2 (6.6)		
Unilateral vs. bilateral surgery			
Unilateral	22.7 (12.5)	0.524	
Bilateral	25.3 (14.9)		
Femoral osteotomy			
No osteotomy	24.6 (14.2)	0.441	
Osteotomy	20.5 (11.9)		

coverage and predispose to reduced survival of the procedure. Our patients with graft resorption had lower than 20° postoperative CE angle and their mean age at surgery was lower than that of the remaining patients. This indicates that patient age at Spitzzy procedure should be at least 8 years.

The shelf procedure is a relatively easy and safe procedure and does not harm the hip joint itself since the procedure is extra-articular. Nevertheless, serious complications like postoperative wound infection occurred in 4 of our patients and destroyed the hip joint in 3 of these

hips. The risk of this complication is less today when prophylactic antibiotics are routine procedure. In recent years more demanding and technically complicated periacetabular osteotomies have gained popularity for joint-preserving purposes. Matsui et al¹⁴ reported early deterioration of the dysplastic hip after a modified rotational periacetabular osteotomy and concluded that periacetabular osteotomy is an uncertain procedure since the development of early osteoarthritis may be accelerated by loss of articular cartilage. Thus, the long-term clinical and radiographic outcome of these more complicated procedures should be compared with the results of the present study before the final answer to the question of the optimal surgical procedure for residual acetabular dysplasia can be established.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or non-for-profit sectors.

Conflict of interest

None.

Ethical approval

The study was in accordance with the ethical standards of the institutional research committee, the 1964 Helsinki declaration and its later amendments for this type of study a formal consent is not required.

Acknowledgments

The authors wish to thank Anne Marie Fenstad at the Norwegian arthroplasty register for her assistance in retrieving data from the register.

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