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Socket loosening in arthroplasty for congenital dislocation of the hip

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Mechanical risk factors in loosening of the socket were radiographically analyzed in 123 Charnley arthroplasties performed during the period 1969–1982 for coxarthrosis secondary to congenital dislocation. The socket was placed as near the true acetabulum as possible without extensive soft-tissue release and without reinforcement of the acetabular roof by bone grafting. The rate of socket loosening was 19 percent using progression of a radiolucent line at the bone-cement interface to a width of > 1 mm as the criterion for loosening. Different predictors of loosening were analyzed by stepwise logistic regression analysis. Lack of lateral bony support for the socket was the prime predictor. The next most important predictors were the preoperative degree of hip dislocation and the position of the socket in relation to the true acetabulum.

Socket position in relation to the true acetabulum and bony coverage of the socket are probably critical factors for loosening in arthroplasty for arthrosis secondary to congenital dislocation of the hip (CDH). However, publications of various techniques and levels for socket position have not documented different results, possibly because most of the materials were small with short follow-up (Table 1).

The present analysis was performed to predict the risk of socket loosening in coxarthrosis secondary to CDH.

Material and methods

We analyzed a series of 129 consecutive Charnley arthroplasties performed between 1969 and 1982 for arthrosis secondary to CDH. Criteria for inclusion were preoperative dislocation of Eftekhar (1978) Stage B or worse (Figure 1). Six cases were excluded – 3 because of infection and 3 because of inadequate fixation with a radiolucent line > 1 mm in width seen immediately after the operation. This left 123 hips for analysis. All the patients except 4 were reexamined, with a median of 9 (3–16) years after the operation. Three patients (3 hips) had died, and 1 patient (2 hips) had just had a severe traffic accident.

The standard Charnley technique with trochanteric osteotomy was used. The socket was placed as far distally as possible, usually between the false and the original acetabulum without extensive muscle release. Neither bone grafting nor controlled medial wall fracturing were performed.

Frontal routine radiographs 1 month postoperatively were used for the predictive analysis. Sequences of radiographs taken from the first postoperative day until reexamination were used for detection of socket loosening.

The following predictors were analyzed:

A. Preoperative degree of dislocation (Eftekhar 1978; Figure 1).
B. Socket type: 1) large or flanged; 2) small; 3) extra small; 4) offset bore.
C. Socket position in relation to the true acetabulum (Figure 2).
D. Socket inclination in relation to a horizontal line through the pelvic tear-drops (Figure 3).
E. Lack of lateral bony support of the socket determined by the horizontal distance between the lateral edge of the acetabular roof and the lateral edge of the socket (Figure 3).

Radiographic socket loosening was defined as having occurred if a radiolucent line at the bone-cement interface progressed to a width of > 1 mm.

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Table 1. A survey of published series of hip arthroplasty for congenital dislocation.

Authors	No. of patients/ graftings	Position of the socket	Follow-up: mean (range) (years)	No. of aseptic loosenings: revisions/radiographic loosenings[1]
Charnley & Feagin (1973)	27/?	Neoacetabulum	? (> 1)	1/–
Tronzo & Okin (1975)	27/0	True acetabulum	? (0.7–2.0)	1/–
Coventry (1976)	33/0	True acetabulum	3.3 (1.0–5)	0/1
Dunn & Hess (1976)[2]	22/0	Protrusio socket	1.8 (0.8–3.3)	0/–
Harris et al. (1977)[3]	13/13[4]	True acetabulum	2.1 (1.1–3.3)	0/0
Hess & Umber (1978)[2]	22/0	Protrusio socket technique	3.1 (1.4–4.1)	0/–
Fredin & Unander-Scharin (1980)[5]	20/11[4]	True acetabulum	1.5 (0.5–3.0)	0/–
Fredin (1982)[5]	44/?[4]	True acetabulum	4.3 (0.5–14)	8/–
Giunti et al (1984)	34/0	Neoacetabulum	5.0 (3.0–10)	0/1
Lund & Termansen (1985)	21/8[6]	Neoacetabulum	4.3 (3.8–8)	0/–
Kolmert et al. (1986)	25/8[4]	True acetabulum	4.2 1,3–8)	1/1
Gerber & Harris (1986)[3]	47/47[4]	True acetabulum	7.1 (5–11)	4/6

[1] Radiographic loosening was defined by a continous line of radiolucency of more than two millimeters. – no evaluation.
[2] Same series.
[3, 5] Includes same patients.
[4] Harris' type of graft.
[6] Cancellous bone graft to lateral acetabular edge.

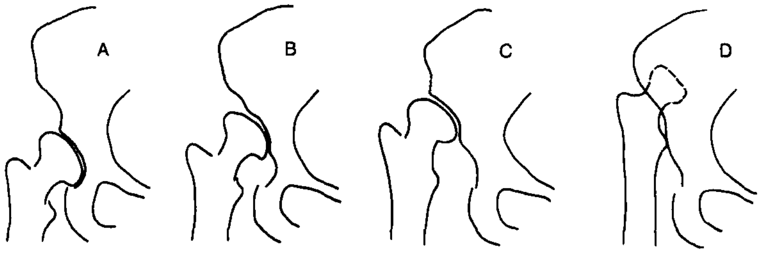

Figure 1. Classification of preoperative hip dislocation according to Eftekhar (1978).

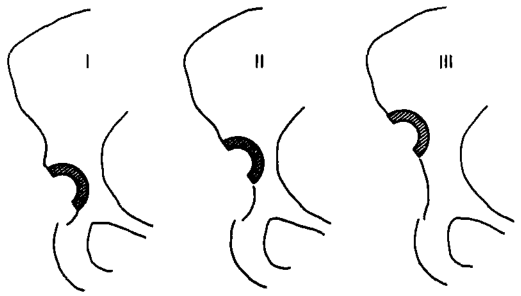

Figure 2. Classification of socket position. I: In the true acetabulum, II: In the roof level of the true acetabulum, III: Proximal to the roof of the true acetabulum.

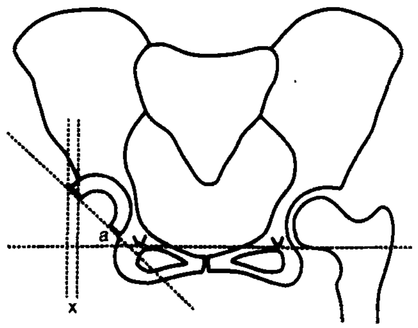

Figure 3. Technique for determination of socket inclination (a) and lack of lateral bony support of the socket (x)

Statistical analysis. Stepwise logistic regression analysis (Biomedical Computer Programs' [BMDP] software package; Dixon 1983) was used to fit a model with different predictors as independent variables and radiographic loosening as a dependent variable. The predictors were analyzed stepwise in relation to their significance at the actual level of the analysis. The significance of the predictors was recorded according to the improvement of the fit (improvement of chi-square) compared with the previous step of the analysis. Correlation analysis between the preoperative degree of dislocation and the postoperative position of the socket was made by the Spearman's rank test. A 5 percent level of significance was chosen.

Results

Radiographic socket loosening occurred in 23 cases (Tables 2–4); socket position was correlated with preoperative degree of hip dislocation (Spearman's rho: 0.70, $P < 0.001$). Small, large, or flanged sockets were loose in 9/65 cases, extra small sockets in 13/56 cases, and a socket with offset bore in 1 of 2 cases.

Lack of lateral bony support (Table 3) was the primary determinant of radiographic loosening (improvement of chi-square: 16.1, $P = 0.001$), and preoperative degree of hip dislocation the second most important factor (improvement of chi-square: 8.9, $P = 0.012$). The postoperative position did not improve the fit of the model because of its positive correlation with the preoperative degree of hip dislocation. If the preoperative dislocation was not included in the analysis, the postoperative position became the second most important factor (improvement of chi-square: 5.6, $P = 0.018$). Socket size and inclination of the socket did not improve the fit of the model. The goodness of the fit of the model increased from a pfi-value of 0.58 to 0.90 when lack of lateral bony support was included in the model, and to 0.94 when either the preoperative hip dislocation or the postoperative position of the socket was included. Inclusion of the remaining factors only improved the goodness of the fit to 0.96.

Table 2. Preoperative dislocation (Figure 1) and postoperative socket position (Figure 2). Number of radiographic loose sockets in brackets

Preoperative degree of dislocation:	Position of the socket			
	I	II	III	Total
B	27 (2)	49 (6)		76 (8)
C	3 (0)	12 (4)	31 (11)	46 (15)
D	1 (0)			1 (0)
Total	31 (2)	61 (10)	31 (11)	

Table 3. Lack of lateral bony support of the socket and radiographic loosening

Loosening	Lack of lateral bony support (mm)						
	0	1–5	6–10	11–15	16–20	21–25	26–30
No	63	14	8	9	4	1	1
Yes	5	2	4	4	5	3	0
Total	68	16	12	13	9	4	1

Table 4. Socket inclination and radiographic loosening

Loosening	Inclination of the socket (degrees)				
	< 30	31–40	41–50	51–60	> 60
No	1	19	33	37	10
Yes	0	3	7	10	3
Total	1	22	40	47	13

Discussion

Radiographic assessment of loosening is controversial. In choosing the definition of loosening in this study, we focused on progressional width of the radiolucent line, as it probably reflects true mechanical loosening better than the > 2 mm zone usually applied. We find such a definition in accordance with recent work on mechanical loosening using roentgen stereophotogrammetric technique (Mjöberg et al. 1986).

From a mechanical point of view, the socket ought to be placed at the site of the true acetabulum to provide bony cover and leg lengthening. However, placing the socket in the true acetabulum may be very difficult, and excessive leg lengthening increases the risk of overstraining the sciatic nerve. Nerve affection has actually been reported in several studies (Coventry 1976, Dunn and Hess 1976, Crowe et al. 1979, Fredin 1982, Gerber and Harris 1986). Furthermore, leg length is not only dependent on socket position, but also on the neck length of the femoral prosthesis and the femoral resection.

Our study shows that socket position proximal to the true acetabulum (position III) increases the risk of socket loosening considerably compared with positions I and II, but even socket position II showed a higher rate of loosening than position I. This does not necessarily mean that positions II and III should be avoided in every case, but the rate of loosening after positioning of the socket proximal to the true acetabulum is so high that this position should be chosen only when the technical difficulties in attaining a more distal position are insurmountable.

Among the various factors analyzed, the size of the lateral bony support for the socket was of greatest importance. Consequently, lateral bone grafting (Harris et al. 1977) seems logical. However, the clinical course of patients receiving bone grafts (Harris et al. 1977, Crowe et al. 1979, Fredin and Unander-Scharin 1980, Fredin 1982, Kolmert et al. 1986, Gerber and Harris 1986) is not better than that of patients not operated on with bone grafts (Tronzo and Okin 1975, Coventry 1976, Giunti et al. 1984, Linde and Jensen 1988). That the results are not improved by bone grafting procedures may be explained by the fact that even the slightest resorption or plastic deformation of such a graft will minimize the load transmission through the graft. The stress on the pelvic bone-cement interface may be as high as if the graft were absent.

The resultant force acting on the hip joint during walking decreases the closer the socket is placed to the center of gravity of the body. It is therefore important that the acetabulum is sufficiently deepened to provide adequate lateral bony support. Much more attention should be paid to this aspect than to lateral grafting procedures. An even more medial position as proposed by Hess (Dunn and Hess 1976, Hess and Umber 1978), achieved by a controlled fracture of the medial wall of the acetabulum, should be avoided because of its unpredictable consequences for the stress on the bone cement interface; it causes a lack of bony support quite near the axis of the resultant force (Inman 1947, Elson and Charnley 1968).

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