Factors affecting socket fixation after cemented revision

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Summary. *Factors influencing the radiographic outcome of revised cemented sockets have been investigated in 360 cases; 70 with radiological signs of failure were analysed. The acetabular bone stock at revision and preparation of the acetabular floor were the two factors which had a significant influence on the outcome. The thickness of the cement mantle around the socket also had an influence. Young patients were at a higher risk of failure. The use of a flanged socket and an acetabular cement pressuriser appeared to improve the radiographic result, but this was not statistically significant.*

Résumé. *Nous étudions les facteurs influençant l'évolution radiologique des cupules cimentées après changement. Dans cette étude, 360 cupules cimentées dont 70 présentant un descellement radiologique ont eu à une analyse statistique. Le capital osseux de l'acétabulum et la préparation du fond du cotyle lors du changement de la prothèse se sont révélés être les deux facteurs ayant une influence hautement significative ($p = 0.0001$) sur l'évolution de ces cupules. Nous avons aussi constaté que l'épaisseur du manteau de ciment autour de la cupule influence le pronostic. En outre, les patients jeunes présentent un risque élevé de descellement radiologique. L'utilisation du pressurisateur à ciment et des cupules avec rebord tend à améliorer l'évolution radiologique, mais de façon non significative statistiquement.*

Introduction

The results of cemented revision arthroplasty have been described [5, 10, 11, 12], but good long term fixation of the socket remains a difficult problem.

Ritter et al. presented an analysis of the factors that were associated with loosening of cemented sockets after primary arthroplasty [13]. We have undertaken statistical analysis of the factors which influence the outcome of revised cemented sockets.

Patients and methods

The 360 consecutive revisions of cemented sockets which were carried out by the senior author (BMW) between 1970 and 1990 were the subject of this study.

The acetabular bone stock at revision was assessed with the help of preoperative radiographs and the findings at operation were recorded using Gustilo and Pasternak's classification [7]:

- Type I – Minimal enlargement of the acetabular wall.
- Type II – marked enlargement and thinning of the wall without a defect.
- Type III – local defects of the anterior, posterior, superior or central quadrants.
- Type IV – massive global collapse or a defect involving two or more quadrants.

We further subdivided the last type into:

- Type IVa – where the acetabular rim was intact.
- Type IVb – where the rim was damaged.

Radiographic analysis was carried out by VVR on serial anteroposterior radiographs of the pelvis taken after operation. The socket angle was measured against the line joining the pelvic tear drops. The cement thickness was recorded as the maximum thickness of the mantle around the socket. Demarcation in the surrounding zones was classified according to DeLee and Charnley [3]. Radiographic loosening of the socket was present [8] when there was a complete and progressive zone of demarcation >1 mm, or if there was any degree of migration; these were regarded as failures, irrespective of the

clinical result. Vertical migration was measured by the change in the vertical distance of the socket from the tear drop line and horizontal migration by a perpendicular to the tear drop line drawn through the tear drop.

All the operations were carried out in a Charnley-Howarth enclosure with body exhaust suits. A transtrochanteric approach was used in every case. Charnley components of the Wroblewski angle-bore socket (DePuy, Leeds, UK) were used. Flanged sockets were used from 1977 and an acetabular pressuriser in most cases since 1984. Bone grafts or reinforcement rings were never used. After operation the patients were mobilised at 2 weeks, and continued partial weightbearing with crutches for 3 months.

Statistical analysis

The data was analysed by PK and VVR using the chi-squared test, *t*-test and Kendall's Tau B test. It was then subjected to multivariate regression analysis.

Results

Of the 360 revised sockets studied, 70 were classified as radiographic failures [8]: 35 (9.7%) had a continuous zone of demarcation of >1 mm thickness, and 35 showed migration at the last follow up. The relevant factors involved were studied statistically.

Sex

There were 182 women and 178 men. Revision failed in 44 (24.2%) of the women and 26 (14.6%) of the men. This difference was statistically significant ($P = 0.02$), but this specific finding was not confirmed by a multivariate regression analysis.

Age

The average age at revision for the whole series was 62 years (range 23 to 92 years). The mean age of the failures was 55.5 years, and was 63.6 years among the successes (*t*-test, $P = 0.0001$). In 70 patients who were under 50 years of age, 23 sockets failed (32.9%). In patients over 50 years, the failure rate was 17.2% (chi-squared analysis, $P = 0.0007$), indicating that the older the patient the greater was the chance of success.

Body weight

The average was 69 kg (range 40 to 118 kg). The mean weight of those with radiographically loose sockets was 65 kg, compared with 70 kg in those whose sockets did not fail (*t*-test, $P = 0.02$). Thus, the heavier patients did better than those who were lighter.

Table 1. Acetabular bone stock at revision

Type of acetabular bone stock	Number of cases	% of cases
I	132	36.7
II	49	13.6
III	84	23.3
IVa	68	18.9
IVb	27	7.5

Table 2. Correlation between acetabular bone stock at surgery and radiographic socket loosening at last follow-up

Acetabular bone stock	Incidence of radiographic socket loosening
Type I	9.8%
Type II	14.3%
Type III	20.2%
Type IVa	27.9%
Type IVb	51.9%

Acetabular bone stock

The number of patients with the 5 grades of acetabular bone stock [7] is shown in Table 1 and the incidence of loosening in each grade is shown in Table 2. The increasing incidence of failure with worsening bone stock was statistically significant (Kendall's Tau B test, $P = 0.0001$).

Flanged socket

The unflanged Charnley socket was used at revision in 20 cases, and 5 of these failed (25%). The incidence of failure in flanged sockets was 19.1% (chi-squared analysis, $P = 0.0553$), so the use of the flanged socket did not improve the results.

Preparation of the acetabular floor

The number of anchor holes that could be drilled to improve fixation at revision is shown in Table 3. The incidence of failure associated with an acetabular floor where 4 or more holes were drilled was 15%. Where the quality of bone was less good

Table 3. Number of anchor holes drilled in preparation of the acetabular floor

No. of anchor holes	Number of cases
0	33
1	5
2	15
3	20
4 or more	287

and only 3, or fewer, holes could be drilled, the incidence of failure was 37% (Kendall's Tau B test, $P = 0.0001$). Good bone stock allowing 4 or more holes to be drilled helped to improve the results significantly.

Acetabular cement pressuriser

This was used in 184 cases (51.1%) and the incidence of failure was 17.9% compared with 21% when it was not used (chi-squared analysis, $P = 0.366$). The use of the pressuriser did not improve the results.

Socket angle

The mean socket angle open laterally was 44° (range 25° to 60°) in the whole series. An angle between 40° and 50° was present in 241 hips, and the incidence of failure was 20.3% compared with 17.6% in the remainder (chi-squared analysis, $P = 0.7$). The angle therefore made no difference to the outcome.

Thickness of the cement mantle

The average thickness of cement around the socket was 21 mm (range 2 mm to 48 mm). The mean thickness in the sockets which failed was 23.4 mm compared with 20.2 mm in the stable sockets (t -test, $P = 0.003$). When there was marked enlargement and destruction of the walls of the acetabulum, indicated by a greater thickness of the mantle, the radiographic outcome was worse.

Follow up

The average follow up was 6 years (2 to 17 years); the average for the failures was 5.8 years compared with 6.2 years for the successes (t -test, $P = 0.03$).

Multivariate regression analysis confirmed our results since it showed that the factors which made a statistically significant difference to the outcome were age, body weight, acetabular bone stock, preparation of the acetabular floor, and the thickness of the cement mantle. The sex of the patient did not correlate with failure.

Discussion

Ritter et al. presented a multifactorial analysis of failure in the loosening of cemented sockets after primary arthroplasty and concluded that the patient's age and metal backing of the socket were the only factors which correlated with failure [13].

No previous report has analysed the influence of various factors on failure of the cemented socket following revision.

Our finding that older patients have a lower failure rate than younger patients confirms that of other authors [1, 2, 4].

We are not certain about an explanation for the better results which were found in heavier patients, but this may reflect a tendency for lighter patients to be more active, and Feller et al. have suggested a causal relationship between activity and loosening [6]. Also, obese women have a lesser incidence of postmenopausal osteoporosis.

The importance of the amount of bone stock present at revision cannot be overemphasised. Our findings indicate the predictive value of this factor for failure, and deteriorating bone stock significantly increases the incidence of radiographic failure ($P = 0.0001$). An increase in the cement mantle and a decrease in the number of holes drilled also reflect the quality of the acetabular bone stock at revision. The statistically significant correlation further emphasises the value of good bone stock for fixation.

The use of a flanged socket and the cement pressuriser showed a trend towards better results, but this was not statistically significant. The socket angle open laterally appeared to have no influence on failure.

Our results show that there are no factors under the direct control of the surgeon that help to improve the radiographic results of acetabular revision, apart from operating early when the bone stock is better.

It is therefore important to preserve bone stock by insisting on regular follow up and revising the socket before there is too much radiographic deterioration. Bone grafts should be used whenever possible to strengthen the existing structure.

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References

1. Callaghan J, Salvati E, Pellicci P, Wilson P Jr, Ranawat CS (1985) Results of revision for mechanical failure after cemented total hip replacement, 1979 to 1982. *J Bone Joint Surg [Am]* 67: 1074–1085
2. Chandler H, Reinick T, Wixson R, McCarthy J (1981) Total hip replacement in patients younger than thirty years old. *J Bone Joint Surg [Am]* 63: 1426
3. DeLee JG, Charnley J (1976) Radiological demarcation of cemented sockets in total hip replacement. *Clin Orthop* 121: 20

4. Dorr L, Takei G, Conaty P (1983) Total hip arthroplasties in patients less than forty-five years old. *J Bone Joint Surg [Am]* 65 A: 474
5. Engelbrecht DJ, Weber FA, Sweet MBE, Jakim I (1990) Long term results of revision total hip arthroplasty. *J Bone Joint Surg [Br]* 72: 41–45
6. Feller JA, Kay P, Hodgkinson JP, Wroblewski BM (1994) Activity and socket wear in the Charnley Low-friction Arthroplasty. *J Arthroplasty* 9: 341–345
7. Gustillo RB, Pasternak HS (1988) Revision total hip arthroplasty with titanium ingrowth prosthesis and bone grafting for failed cemented femoral component loosening. *Clin Orthop* 235: 111–119
8. Hodgkinson JP, Shelley P, Wroblewski BM (1988) The correlation between the roentgenographic appearance and operative findings at the bone-cement junction of the socket in Charnley low friction arthroplasties. *Clin Orthop* 228: 105–109
9. Hunter GA, Welsh RP, Cameron HU, Bailey WH (1929) The results of revision of total hip arthroplasty. *J Bone Joint Surg [Br]* 61-B: 419–421
10. Kavanagh BF, Ilstrup DM, Fitzgerald RH Jr (1985) Revision total hip arthroplasty. *J Bone Joint Surg [Am]* 67: 517–526
11. Kershaw CJ, Atkins RM, Dodd CAF, Bulstrode CJK (1991) Revision total hip arthroplasty for aseptic failure – a review of 276 cases. *J Bone Joint Surg [Br]* 73: 564–568
12. Pellicci P, Wilson P Jr, Sledge C et al (1985) Long term results of revision total hip replacement; a follow-up report. *J Bone Joint Surg [Am]* 67: 513–516
13. Ritter MA, Faris PM, Keating M, Brugo G (1992) Influential factors in Cemented acetabular cup loosening. *J Arthroplasty* 7: 365–367