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AUTOGENOUS BULK STRUCTURAL BONE GRAFTING FOR RECONSTRUCTION OF THE ACETABLUM IN PRIMARY TOTAL HIP ARTHROPLASTY: AVERAGE 12-YEAR FOLLOW-UP

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ABSTRACT

The purpose of the present study was to assess the clinical and radiographic results of primary cemented total hip arthroplasty with acetabular bone grafting. Twenty patients (21 hips) were included in the current study: two males and 18 females with a mean age at surgery of 54.5 years (range 40–66 years). The mean duration of follow-up was 12 years (range 8–15 years). The diagnosis for all hips at surgery was secondary osteoarthritis due to developmental dysplasia. The degree of subluxation as categorized according to the classification of Crowe *et al*. was 11 hips in group I, 6 in group II, and 4 in group III. The Harris hip score was used for clinical evaluation. Standard anteroposterior radiographs were used for radiographic evaluation. The mean Harris hip score improved from 45.0 (range 24–60) before surgery to 90.4 (range 77–100) at the final follow-up. The mean proportion of the socket covered by the bone graft was 23.1% (range 9.8–42.3%). At the final follow-up, three sockets showed radiological evidence of loosening. No revision surgery was undertaken during the investigation period since those patients had only mild pain and did not request surgery. Autogenous bulk structural bone grafting for reconstruction of the acetabulum yielded favorable results during a mean follow-up of 12 years, provided that the proportion of coverage of the graft was less than 50%.

Key Words: Total hip arthroplasty, Bone graft, Acetabular reconstruction

INTRODUCTION

Total hip arthroplasty (THA) often requires complex reconstruction for acetabular bone defects in patients with developmental dysplasia. Various techniques to deal with the lack of acetabular bone stock have been described, including the use of a socket with cement to fill the superior defect,[1] an offset bore cup,[2,3] medial wall fracture technique,[3,4] structural bone grafting,[5-9] and impaction bone grafting.[10] We performed autogenous bulk structural bone grafting for reconstruction of the acetabulum in cemented THA until March 2004. The purpose of the present study was to assess the clinical and radiographic results of 20 patients after a mean follow-up of 12 years.

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MATERIALS AND METHODS

Between April 1992 and December 1997 the senior author (T. S.) performed 75 consecutive, primary cemented THA on patients with degenerative osteoarthritis. Autogenous bulk structural bone grafting was performed on 27 joints. Of these, six patients (six hips) did not return to us for follow-up during the most recent period of six years or longer. We tried to contact them by mail but were unsuccessful. These six patients were followed for a mean of 42 months (range 7–76 months), and no revision surgery had been performed before they were lost to follow-up. The remaining 20 patients (21 hips) were our focus in the current study. This study was approved by the institutional review board.

Subjects were comprised of two males and 18 females with a mean age at surgery of 54.5 years (range 40–66 years), a mean height of 1.53 m (range 1.41–1.80 m) and a mean weight of 53.3 kg (range 42–75 kg). The mean duration of follow-up was 12 years (range 8–15 years). The diagnosis for all hips at surgery was secondary osteoarthritis due to developmental dysplasia. The degree of subluxation as categorized according to the classification of Crowe *et al.*[11] was 11 hips in group I, 6 in group II, and 4 in group III.

All operations were performed through a posterolateral approach using the femoral head for the graft. The grafts were screwed to the superolateral aspect of the acetabular roof with single

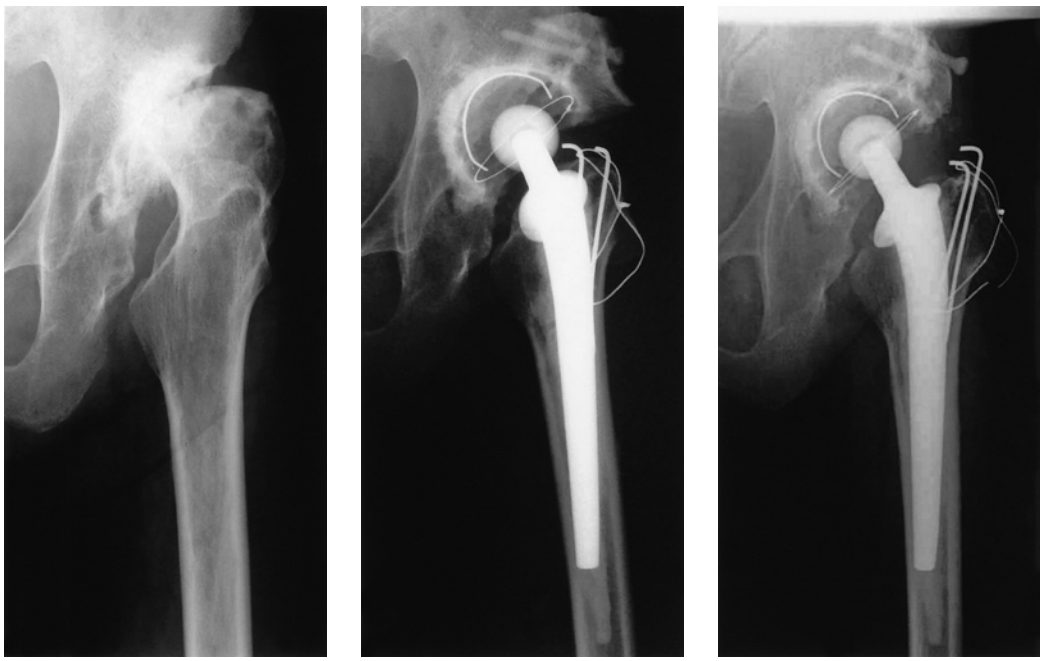

Fig. 1 A 62-year-old male had osteoarthritis secondary to developmental dysplasia of the left hip (Crowe group III).
A) Preoperative radiograph.
B) Radiograph immediately after total hip arthroplasty with acetabular bone graft.
C) At 11 years after surgery, no radiological findings of loosening were recognized in either the acetabular or femoral components. Harris hip score improved from 36 before surgery to 96 at the final follow-up.

crystalline alumina-ceramic screws (Kyocera, Kyoto, Japan). We used the Bioceram implant (Kyocera, Kyoto, Japan) with a 26-mm alumina-ceramic head. A cup supporter[12] was used in one hip for reinforcement of the socket fixation. Both acetabular and femoral components were fixed with cement using a hand-packing cement technique (Fig. 1).

The Harris hip score[13] was used for clinical evaluation. Standard anteroposterior radiographs were used for radiographic evaluation. The presence of a radiolucent line at the cement-bone interface in the three zones of DeLee and Charnley[14] was recorded. Loosening of the acetabular component was classified according to the criteria of Hodgkinson *et al*.[15] The presence of a radiolucent line around the femoral component was recorded for the seven zones described by Gruen *et al*.[16] The criteria of Harris *et al*.[17] were used to assess radiological evidence of any loosening of the stem. The preoperative radiographs were measured to define the centre-edge (CE) angle,[18] sharp angle,[19] and acetabular head index[20] (AHI). The initial postoperative anteroposterior radiographs were measured to determine the degree of initial abduction of the socket and the proportion of the socket covered by the bone graft according to the method described by Inao *et al*.[9] In both the preoperative and initial postoperative radiographs, the position of the center of the hip was measured as to height and horizontal location according to the method described by Russotti *et al*.[21]

Statistical significance was evaluated by a non-parametric method. The Wilcoxon signed-rank test was used to analyze differences between readings of the same subject at different times, while the Mann-Whitney *U* test was used to analyze differences between groups. A *P* value of < 0.05 was considered to indicate statistical significance.

RESULTS

Clinical results

The mean operative time was 153 minutes (range 118–187 minutes), and the mean intraoperative bleeding volume was 520 ml (range 202–980 ml). Early postoperative complications included a dislocation in one hip that required a closed reduction; which was successful with no recurrence. One patient had a transient partial palsy of the peroneal nerve. No patients incurred a surgical site infection or pulmonary embolism. The mean range of motion was improved from 73.1° (range 40–100°) preoperatively to 83.1° (range 60–100°) at the final follow–up for hip flexion, and from 11.9° (range –10–30°) preoperatively to 19.3° (range 5–30°) at the final follow–up for hip abduction. The mean Harris hip score improved from 45.0 (range 24–60) before surgery to 90.4 (range 77–100) at the final follow-up. Three hips were candidates for revision surgery due to aseptic loosening of the socket in two hips and aseptic loosening of both the socket and stem in one. However, no revision surgery was done during the investigation period since those patients had only mild pain and did not request surgery.

Radiological results

At the most recent follow-up, 14 sockets showed the presence of a radiolucent line at the cement-bone interface. Among them, seven sockets showed the radiolucent line in one zone and four sockets in two zones described by DeLee and Charnley.[14] The remaining three sockets showed radiological evidence of loosening. According to the criteria of Hodgkinson *et al*,[15] two sockets were type 3 and one was type 4. One case experienced graft collapse with migration of the socket. The radiolucent line of the femoral component was seen in four hips, with radiological loosening evident in one hip, the socket of which was also loose.

Each parameter was assessed in 18 of 21 joints. Three joints with fixed sockets were excluded

Table 1 Radiological measurements and socket loosening

Parameter	Socket loosening (–)	Socket loosening (+)
Number of joints	15	3
Center-edge angle (°)	2.1 ± 14.1	4.3 ± 3.8
Sharp angle (°)	50.5 ± 4.4	50.0 ± 1.0
Acetabular head index (%)	52.7 ± 9.2	54.1 ± 1.3
Abduction angle of the socket (°)	41.0 ± 5.9	42.3 ± 2.1
Proportion of socket covered by bone graft (%)	24.1 ± 10.2	18.1 ± 7.6

Mean ± standard deviation

due to a use of a cup supporter in one hip and an incomplete series of radiographs in two others. The mean height of the center of the hip was 34.1 mm (range 24.2–46.7 mm) preoperatively and 30.5 mm (range 22.5–45.1 mm) postoperatively. The mean horizontal location of the center of the hip was 43.9 mm (range 36.8–55.5 mm) preoperatively and 32.0 mm (range 26.0–42.5 mm) postoperatively. The differences were statistically significant in both parameters ($p<0.001$). The preoperative CE angle, sharp angle, and AHI were 2.5° (range –15.5–29.5°), 50.4° (range 42.5–58.5°), 53.0% (range 40–72.6%), respectively. The mean initial abduction angle of the socket and the proportion of the socket covered by a bone graft were 41.2° (range 26–49.5°) and 23.1% (range 9.8–42.3%), respectively. A comparison between the three hips with a radiological loose socket and the 15 hips with a radiological fixed socket showed no significant difference in any parameter (Table 1).

DISCUSSION

In the present study, the author reported the clinical and radiological results of patients who had undergone cemented THA with autogenous bulk structural bone grafting after a mean follow-up of 12 years. No socket was revised for any reason, and radiological loosening of the socket was seen in three hips (14.3%). Several studies have followed patients with cemented arthroplasty and a bone graft for more than ten years.[5-9] Mulroy and Harris[5] reported a series of 46 dysplastic hips that had been treated by grafting of the femoral head in conjunction with THA. Follow-up studies showed that the rates of loosening and revision of the socket were 40% and 20%, respectively, after a mean of 11.8 years. They concluded that they could no longer recommend the use of bulk autogenous grafts even if the acetabular bone stock were extremely deficient. Others[8,9] have obtained more favorable results. Iida *et al*.[8] reported a series of 133 dysplastic hips which had been treated using cemented THA with grafting of the femoral head. Follow-up studies revealed rates of loosening and revision of 19.5% and 4.5%, respectively, after a mean of 12.3 years. Inao *et al*.[9] also reported that the rates of loosening and revision of a socket in cemented THA with bulk bone graft were 15% and 0%, respectively, after a mean of 12.9 years. Our results were comparable to those in the literature described by Iida *et al*.[8] and Inao *et al*.[9]

The mean proportion of the sockets covered by bone graft was 23.1% (range 9.8–42.3%). This was lower than the 49% (range 15–100%) reported by Shinar *et al*,[7] or the 37% (range 16–63%) reported by Inao *et al*.[9] who aimed to place the socket at the level of the true acetabulum. In the current study, the mean position of the center of the hip was postoperatively moved a trifle distally. Therefore, the high hip center of the socket was considered to be the reason for the lower proportion of coverage of the bulk bone graft in our series.

Good results have been reported in patients in whom the socket was covered by only a small amount of graft. The larger the extent of the cover, the greater has been the rate of late failure.[7,8] Shinar *et al*.[7] reported a series of 70 dysplastic hips that had been treated by THA with acetabular bulk bone grafts after a mean of 16.5 years. The average coverage of the socket by the bulk graft was 49%, and the rate of sockets that were either revised or loose was 61.4%, whereas none of the nine sockets with 30% of the contact area or less covered by the graft were revised. Rodriguez *et al*.[6] followed 29 hips treated by THA with a bulk bone graft for a mean of 11 years. They reported that the average coverage of the socket by the bulk graft was 27% (range 15–45%) and the rate of sockets that were either revised or loose was 37%. They recommended the amount of coverage of the graft to be limited to less than 40%. In our study, the rate of revised or loosed sockets was 14.3%, which was less than that reported by Shinar *et al*.[7] One of the reasons was considered to be the low amount of mean coverage of the bulk bone graft.

Our study showed that autogenous bulk structural bone grafting for reconstruction of the acetabulum yielded favorable results during a mean follow-up of 12 years, provided that the proportion of coverage of the graft was less than 50%.

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