

Fate of bulk autografts in uncemented total hip arthroplasty

Evaluation by bone scintigraphy

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ABSTRACT

Objective: To review short term results of uncemented cup implantation and the fate of bulk femoral head autografts in patients with acetabular bone deficiency due to dysplasia of the hip. We used bone scintigraphy to assess the viability of the grafts.

Methods: We treated 19 hip joints of 17 patients with osteoarthritis due to developmental dysplasia of the hip with uncemented total hip arthroplasty between 1997-2003 in the Department of Orthopedics and Traumatology, Gazi University, Ankara, Turkey. The average age was 49.1 (31-72 years), and the average follow up period was 36 months. We used femoral head autografts to reconstruct superolateral segmental deficiencies of the acetabuli. We evaluated the patients clinically and radiologically to assess acetabular loosening, and we used three-phase bone scintigraphy to evaluate the viability of the autograft.

Results: There was no acetabular component revision throughout the follow up period. There was no radiological evidence of graft resorption or graft displacement in any of the patients. In bone scintigraphy, we observed hyperemia in the blood pool phase, and the osteoblastic activity of the bone graft was at the level of the neighboring iliac bone.

Conclusion: The application of a non-cemented acetabular component with femoral autograft in superolateral acetabulum deficiency increases the stability of the implant and increases the bone stock. It is not easy to evaluate the viability of the graft by the use of radiological methods. Bone scintigraphy gives sufficient information about the viability of the graft as a non-invasive method.

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Total hip arthroplasty in patients with developmental dysplasia of the hip (DDH) is a difficult procedure for orthopedic surgeons. A severe deficiency in the anterolateral acetabular bone stock impairs adequate coverage and stable fixation of the acetabular component. Various techniques have been described for reconstruction of the deficient acetabulum, including the method of reconstruction by placing the socket in the true acetabulum and

augmenting the superolateral aspect of the ilium with a bulk femoral head autograft, as advocated by Harris and Crothers.¹⁻⁸ Cemented or cementless acetabular components may be implanted with this technique. Early results of cemented cups augmented with bone grafting of acetabular deficiencies have been encouraging, with high rates of graft incorporation. With longer follow-up, however, increasing rates of graft resorption, collapse and acetabular loosening

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are of concern.⁹⁻¹² We know little about the durability of uncemented cups, and the fate of bulk femoral head autografts used for reconstruction of acetabular deficiencies in patients with DDH. The most common method for assessing the fate of the autografts used in this method has been conventional radiograms. However, they have been unreliable because of the difficulty in accurately visualizing the complex geometry of the pelvis-graft interface. A definite method for proving the vitality of the graft would be obtaining a biopsy, however, its impracticality limits this method.¹³ Radionuclide imaging is a more reliable technique compared with conventional radiology for assessing the graft.^{14,15} The purpose of this study is to review short term results of uncemented cup implantation and the fate of bulk femoral head autografts in patients with acetabular bone deficiency due to DDH. For this purpose, we used bone scintigraphy to assess the viability of the grafts.

Methods. We treated 19 hips of 17 patients with degenerative joint disease secondary to DDH with total hip arthroplasty between 1997-2003 in the Department of Orthopaedics and Traumatology, Gazi University, Ankara, Turkey. We did not include patients with primary osteoarthritis and secondary arthritis due to reasons other than the DDH in this study. Twelve of the 17 patients were female and 5 were male. The average age at the time of the index arthroplasty was 49.1 (range, 31-72). The mean duration of clinical and radiographic follow-up was 36 months (range, 24-96 months). None of the hips had been operated previously. We classified preoperative radiographs according to the classification system of Crowe et al.¹⁶ None of the hips were in group I; 3 (18%) were in group II; 9 (53%) were in group III, and 5 (29%) were in group IV. We used the uncemented technique to fix all the acetabular components (**Figures 1a & 1b**). The implanted hemispherical acetabular components with roughened surfaces (Sulzer Medica, Switzerland) had an average 48 mm (range, 46-52) outside diameter, and were matched with 28 mm femoral heads. Superolateral segmental deficiencies of the acetabuli, which would leave more than 1.5 cm of the socket uncovered, were reconstructed with ipsilateral femoral head autografts, as proposed by Spangehl et al.¹⁷ We screwed the autografts to the pelvis prior to final reaming and filled the interface between the grafts and host bone with morselized grafts to enhance union. We used the press-fit technique to insert the acetabular sockets, and fixed these to the host bone with 2 screws. We clinically evaluated the patients one year after the index procedure, and obtained radiograms to assess the acetabular cups for loosening.

We also used the radiograms to assess visible signs of graft resorption and collapse, according to the criteria of Gerber and Harris.⁹ Again, one year after the arthroplasty, we performed scintigraphic imaging after obtaining informed consents from the patients. We obtained dynamic blood flow, blood pool and delayed static anterior and posterior views of pelvises after intravenous injection of 740 MBq Tc-99m-methylene diphosphonate (MDP). We used a dual-head gamma camera with high-resolution collimators (Maxxus, GE Medical Systems, Milwaukee-USA) to acquire all the images, and obtained delayed static images 3 hours after the injection and in a preset time of 10-minutes. Two experienced nuclear medicine physicians, blinded to the clinical status of the patients, assessed the images visually. We considered the presence of hyperemia on blood pool images and/or radioactivity uptake equal to or greater than the adjacent iliac bone in the acetabular area corresponding to the autograft

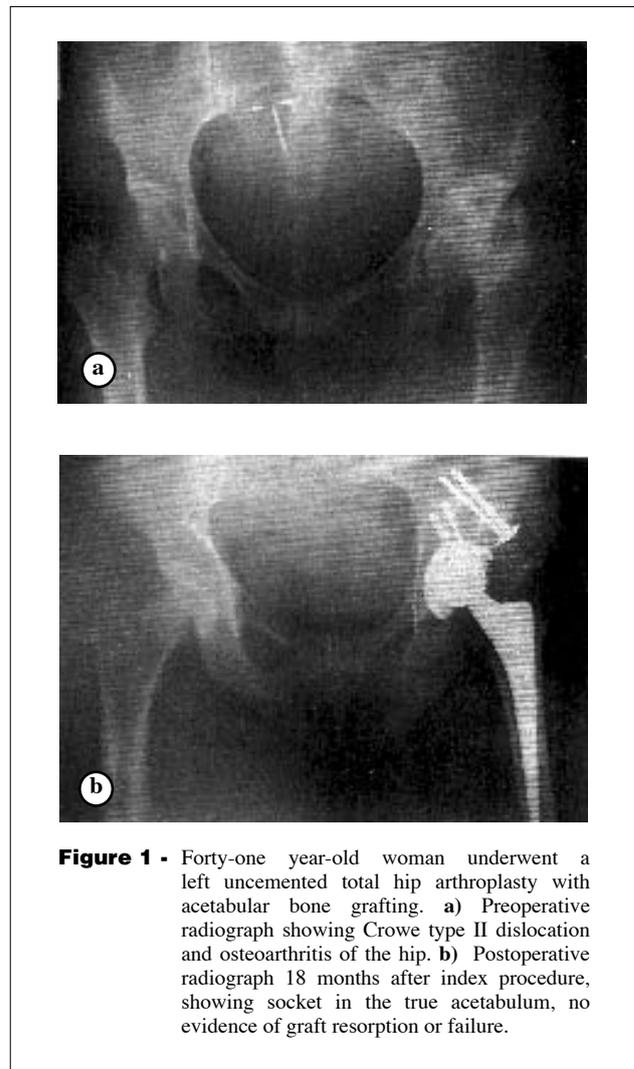


Figure 1 - Forty-one year-old woman underwent a left uncemented total hip arthroplasty with acetabular bone grafting. **a)** Preoperative radiograph showing Crowe type II dislocation and osteoarthritis of the hip. **b)** Postoperative radiograph 18 months after index procedure, showing socket in the true acetabulum, no evidence of graft resorption or failure.

positive for the patency of anastomosis and the viability of the graft.

Results. Clinical evaluation demonstrated a marked decrease in pain and improvement in function following total hip replacement. All patients but one had excellent clinical results without hip pain. One patient suffered from symptomatic deep-vein thrombosis and superficial wound infection and was treated conservatively. Four of the 17 patients had a limb-length discrepancy of more than 15 millimeters. Harris hip score demonstrated a significant change compared with the preoperative status. The average preoperative status was 53 (range 48-66), while the average postoperative score was 87 (range 67-96). At the final radiographic follow-up, none of the cups showed evidence of probable or definite signs of loosening as radiolucent signs ≥ 2 mm in any zones. All of the grafts were seen to be united with the host bone, without collapse or discernible bone resorption. However, 3 patients had minor resorption adjacent to washers and screw heads used to secure the graft to host bone and were considered as inconsequential as they were in the lateral unstressed areas of the grafts. Scintigraphic examination demonstrated that all of the hips presented hyperemia on blood pool images and/or osteoblastic activity on the bone phase images in the acetabular area. We interpreted this as viability of the grafts and progression of angiogenesis into the grafts.

Discussion. Anterolateral acetabular bone deficiency is a technical problem that we must deal with when we use total hip arthroplasty to treat DDH. We can use bulk femoral autografts, or bone deficiencies of varying severity in order to provide additional anterolateral support for the socket and augmentation of bone stock.^{13,18-20} Studies report variable results with cemented sockets with autologous femoral head bone grafts for the treatment of DDH.^{10,21-24} Harris and Crothers advocated this procedure, however, the prevalence of aseptic loosening of the socket in their patients increased substantially with longer follow up. Although early results are favorable, the results deteriorate because of socket loosening and graft collapse in the long term. Gerber and Harris⁹ reported loosening and a revision rate of 21% at 7.1 years follow up; Mulroy and Harris¹¹ reported that failure rate had increased to 46% at 11.8 years follow up. Lee et al¹⁰ found that the rate of mechanical failure increased from 6% at 5 years to 39% at 10 years. However, Inao et al²¹ found that no revision in the 20 cups followed for 5.2 to 12.9 years after reconstruction with a graft. The amount

of resorption of the graft with time also varied in series of cemented sockets.¹³ However, even as they reported high rates of failure with time, most authors agree that autografts contribute valuable pelvic bone stock that facilitates subsequent revision. There are limited reports of uncemented sockets in combination with autogenous bone grafts for the treatment of secondary osteoarthritis due to acetabular deficiency. Uncemented sockets in combination with autogenous femoral head grafts provided good acetabular fixation in developmental hip dysplasia patients in our study at 18.5 months follow-up. Barrack and Newland² noted no failures in 10 hips within 3 years. Anderson and Harris¹ reported that, of the 20 dysplastic hips followed for at least 5 years after reconstruction with use of an uncemented cup, none had mechanical failure. Morsi et al²⁵ had to revise only one in 17 hips at a mean follow up of 6.6 years related with and uncemented cups and autogenous grafts.²⁵ When implanting uncemented cups into acetabuli reconstructed with autogenous grafts, we were concerned for the lack of primary stability provided by the use of cement. This might have caused fixation problems for the cup and have an adverse effect on the graft by exerting large forces on the graft and cause complications. In this study, clinical results in terms of pain and functional status and radiological findings were favorable in the short-term period. The autografts provided good augmentation for the structure of the pelvic bone. This is important as most of these patients are young and active, they may require additional hip operations in the future, and having a bone stock meeting those demands is an advantage. We did not observe graft failure with radiological examination in this study. However, it is difficult to determine graft union and resorption only with anteroposterior radiographs as they only provide a 2-dimensional representation of a 3-dimensional reconstruction. Conventional roentgenograms proved unreliable in evaluating bone graft reconstitution because of overlapping trabecular bone patterns of the graft and iliac wing, making an accurate assessment difficult. Bone scintigraphy offers dynamic physiologic monitoring of the incorporation process; whereas a roentgenogram of a bone graft may appear united even when avascular necrosis or lack of bony union has occurred. In this study, we presented a non-invasive way of addressing the fate of bulk autografts. Bone scintigraphy has been used for diagnosing bone lesions, following new bone formation and metabolic diseases with an incredibly safe margin. The most commonly used agent for these purposes has been ^{99m}Tc-MDP. The diphosphonate agents concentrate in the mineral phase of bone with particular affinity for sites of new bone formation. It is

thought that diphosphonate uptake on bone, primarily reflects osteoblastic activity, but it is also dependent on skeletal vascularity.¹⁴ Thus, bone scintigraphy provides a functional display of skeletal activity, vascularity of bone, and new bone formation.^{15,17} In our study, bone scintigraphy demonstrated a significant amount of radioactivity accumulation, which is an indicator of bone remodeling and revascularization of the autograft. With this knowledge, we judged that bone scintigraphy with ^{99m}Tc-MDP would be a good choice for evaluation of the viability of the femoral head autograft.

In conclusion, we observed good short-term results after use of an uncemented porous-coated socket fixed with screws in conjunction with a bulk femoral head autograft at the true anatomical acetabular level. The autografts used for reconstruction of the acetabuli united with the host bone, as demonstrated by bone scintigraphy, which is a useful and non invasive method for this purpose.

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