

Radiography versus multidetector computed tomography in assessing graft integration after acetabular reconstruction

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ABSTRACT

Purpose. To compare radiography with multidetector computed tomography (MDCT) in the evaluation of graft integration following acetabular reconstruction for failed total hip arthroplasty (THA).

Methods. Records of 5 men and 6 women aged 60 to 78 (mean, 71.8) years who underwent acetabular reconstruction using structural allografts for severe acetabular deficiency secondary to aseptic loosening (n=9) or septic loosening (n=2) were reviewed. The mean survival time of the THA was 136.4 (range, 12–360) months. Acetabular defects were classified as IIC (n=2), IIIA (n=3), or IIIB (n=6). Structural allografts were fixed with impaction followed by a reinforcement ring (n=10), an antiprotrusio cage (n=2), and/or an oblong cup (n=1) with gentamicine-loaded cement. Cup loosening, graft integration, and graft resorption were evaluated using radiography. In addition, graft integration was evaluated using MDCT.

Results. At a mean follow-up of 4.2 (range, 2–11)

years, the survival of the acetabular reconstruction was 90.9%. No patient had any signs of infection. One patient underwent reoperation 22 months later for dislocation secondary to abductor deficiency caused by nonunion of the trochanteric fracture. According to radiography, all patients had graft integration. One patient had definitive and another had possible cup loosening. Four patients had minor graft resorption. According to MDCT, graft integration was complete in only one patient, partial >50% in 3, partial <50% in 4, and absent in 2.

Conclusion. MDCT is more accurate than radiography in evaluating graft integration following acetabular reconstruction.

Key words: acetabulum; bone transplantation; multidetector computed tomography; reoperation

INTRODUCTION

Revision of the acetabular component in total hip arthroplasty (THA) is challenging when bone stock is severely deficient. The use of a structural allograft

supported by a reinforcement device is a viable option.¹ Graft integration is usually evaluated using radiography.²⁻⁹ This study compared radiography with multidetector computed tomography (MDCT) in the evaluation of graft integration following acetabular reconstruction for failed THA.

MATERIALS AND METHODS

Records of 5 men and 6 women aged 60 to 78 (mean, 71.8) years who underwent acetabular reconstruction using structural allografts for severe acetabular deficiency in failed THA secondary to aseptic loosening (n=9) or septic loosening (n=2) from January 1998 to December 2008 were reviewed. The mean survival time of the THA was 136.4 (range, 12–360) months. According to the Paprosky classification,¹⁰ the acetabular defects were classified as IIC (n=2), IIIA (n=3), or IIIB (n=6). For the 9 aseptic loosening acetabula, 5 were cemented and 4 were uncemented. For the 2 septic loosening acetabula, a cement hip spacer was inserted. Before revision THA, infection was ruled out using blood tests (for the erythrocyte sedimentation rate and C-reactive protein) and technetium scanning.

All patients underwent revision THA through the modified transgluteal approach.¹¹ Culture was obtained during capsule opening. Old implants were removed, and histological samples were obtained from the periprosthetic membrane or surrounding tissue for a frozen-section study using haematoxylin-eosin staining.^{12,13} Infection was considered positive in the presence of >5 polymorphonuclear cells per high-power field in at least 5 separate microscopic fields (x40).¹³ Two patients initially considered to have aseptic loosening had >10 and >20 polymorphonuclear cells per high-power field in at least 5 separate microscopic fields, but the decision for one-stage revision THA was made.

Structural allografts were obtained under strict aseptic conditions, with no sterilisation method applied, and stored at -80°C, according to standards of the Asociación Española de Bancos de Tejidos, European Association of Musculoskeletal Transplantation, and European Association of Tissue Banks.^{14,15} Structural allografts were fixed with impaction followed by a reinforcement ring (n=10), an antiprotrusion cage (n=2), and/or an oblong cup (n=1) with gentamicine-loaded cement.

Intravenous antibiotic prophylaxis (ceftacide 2 g and teicoplanine 800 mg) was administered prior to surgery, and repeat doses (ceftacide 2 g) were administered during surgery and 2 hours

after the start of the procedure. Postoperatively, intravenous antibiotic prophylaxis (vancomycin 1 g every 12 hours and ceftacide 2 g every 8 hours) was administered for 5 days. Low molecular-weight heparin was prescribed for 6 weeks after surgery.

Postoperatively, partial weight bearing was allowed at 4 weeks. Full weight bearing was allowed as tolerated by the patient after a minimum of 12 weeks.

Clinical outcome was evaluated using the Harris Hip Score¹⁶ and the Postel-Merle d'Aubigné score.¹⁷ Radiographic outcome was evaluated by 2 independent observers. Cup loosening was classified as definite loosening (type III: screws broken, migration of ≥ 5 mm, complete progressive radiolucent line medial, superior, and through the screws), probable loosening (type II: progressive radiolucent line medial and cranial), or possible loosening (type I: non-progressive radiolucent line without involvement of the screws).^{4,18} Graft integration was defined as trabecular remodelling crossing the graft-host interface. Graft resorption was classified as minor (<1/3), moderate (1/3–1/2) or severe (>1/2).¹⁹

MDCT was performed by a senior radiologist using helical acquisition (kV=120, mAs=200, slice thickness=3 mm, pitch=1.5, and spacing reconstruction=3 mm). No intravenous contrast material was administered. A bone reconstruction algorithm and a wide window to accentuate the border of bony structures were used to minimise artefacts from metallic prosthesis. Images were also reconstructed with a soft tissue algorithm. Graft integration was classified as complete, partial >50%, partial <50%, or absent based on trabecular remodelling crossing the graft-host interface by semiquantitative evaluation of all 2-dimensional sequential images and supported by 3-dimensional reconstruction. The extent of remaining bone stock was measured as the distance between the medial wall and the metallic implant. Presence of soft-tissue collections surrounding the prosthesis was noted.

RESULTS

At a mean follow-up of 4.2 (range, 2–11) years, the survival of the acetabular reconstruction was 90.9%. The mean Postel-Merle d'Aubigné score improved from 6.5 (range, 5–10) to 14.63 (range, 10–18). The mean postoperative Harris Hip Score was 65.19 (range, 41–94.9). No patient had signs of infection. One patient underwent reoperation (reattachment of the greater trochanter) 22 months later for dislocation

secondary to abductor deficiency caused by nonunion of the trochanteric fracture.

According to radiography, all patients had graft integration. One patient had definitive cup loosening (radiolucencies in zone 2 and breakage of one screw), and one patient had possible cup loosening (radiolucencies in zones 1 and 2). Four patients had minor graft resorption.

According to MDCT, graft integration was complete in only one patient, partial >50% in 3, partial <50% in 4, and absent in 2 (Table and Fig.). The mean distance of bone stock from the medial wall to the metallic implant was 7.5 (range, 1–16) mm. Two patients had collection of liquid in the tissue surrounding the prosthesis.

DISCUSSION

Options for acetabular reconstruction include

the use of impaction bone graft,^{20,21} acetabular reinforcement ring,^{22,23} oblong cup,^{24,25} uncemented cup with high hip centre,²⁶ structural allograft with reinforcement device,²⁷ and trabecular metal cup with augmentation.^{28,29} The use of structural allografts provides adequate support and transforms uncontained acetabular defects to contained ones and achieves satisfactory outcome,^{7,8,20,30} with a revision rate of up to 7% at 10 years.³¹ Nonetheless, poor mid-to-long-term outcome has also been reported, with revision rates ranging from 33 to 60%.^{3,32,33} To improve outcome, adding bone substitute material to the allograft³⁴ and supercharging the structural allografts with mesenchymal stem cells³⁵ have been proposed. The main concern about use of allografts is the risk of disease/infection transmission,³⁶ thus the use of trabecular metal is increasingly popular.

Radiographic evaluation of graft integration is prone to interobserver error³¹ and overestimation.³⁷ Radiography tends to magnify the extent of host-graft

Table
Characteristics of failed total hip arthroplasty (THA) and graft integration outcome based on multidetector computed tomography

Sex/age (years)	Loosening	THA type	Survival of THA (years)	Acetabular defect	Graft integration	Integration site
F/65	Aseptic	Cemented	20	IIIB	Partial <50%	Anterior and posterior columns
F/69	Aseptic	Cemented	30	IIIA	Partial >50%	Roof and anterior and posterior columns
F/75	Septic	Spacer	7	IIIB	Partial >50%	Roof and posterior column
M/60	Aseptic	Uncemented	7	IIIB	Absent	None
M/74	Aseptic	Uncemented	10	IIC	Partial <50%	Roof and posterior column
F/78	Septic	Spacer	1	IIIB	Partial >50%	Roof and posterior column
F/76	Aseptic	Uncemented	9	IIIB	Absent	None
F/70	Aseptic	Uncemented	26	IIC	Complete	Complete
M/77	Aseptic	Cemented	9	IIIA	Partial <50%	Roof
M/71	Aseptic	Cemented	4	IIIA	Absent	None
M/75	Aseptic	Cemented	2	IIIB	Partial <50%	Anterior and posterior columns

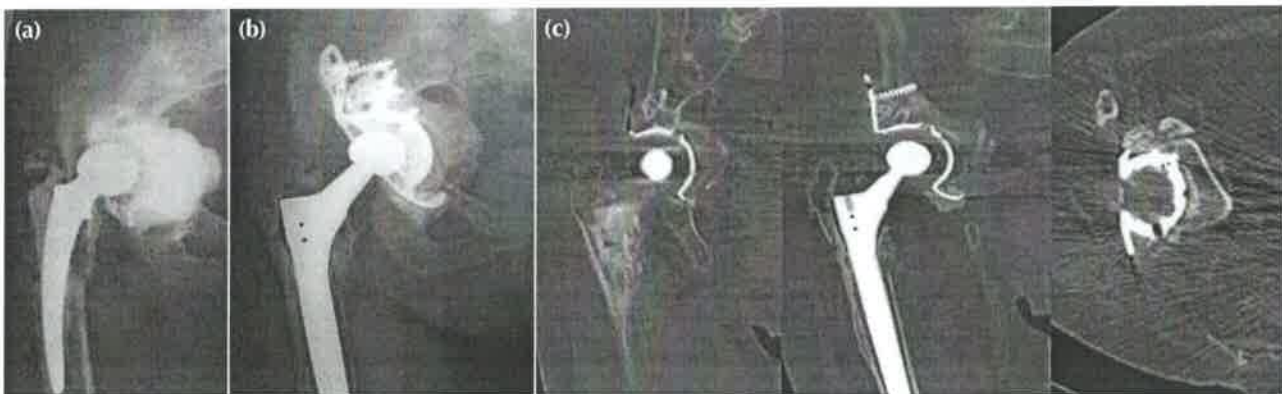


Figure Patient 1: (a) a preoperative radiograph showing a type IIIB acetabular defect, and (b) a postoperative radiograph and (c) multidetector computed tomographic images showing partial <50% graft integration 10 years after revision total hip arthroplasty using a structural allograft.