THE USE OF REINFORCEMENT RINGS TO RECONSTRUCT DEFICIENT ACETABULA

J. ROSSON, J. SCHATZKER

From Sunnybrook Health Science Centre, Toronto

We reviewed 64 patients in whom 66 acetabula had been reconstructed with either the Müller ring (46) or the Burch–Schneider anti-protrusio cage (20) at a mean follow-up of five years.

Five hips had been revised a second time for loosening, all after a Müller ring had been used for a medial segmental defect (2), ungrafted cavitary defects (2) or after resorption of a block graft (1). The use of bone grafts with the implants reduced the incidence of failure from 13% to 6% and of circumferential radiolucent lines at the bone–implant interface from 39% to 2%.

The Müller ring is indicated for acetabula with isolated peripheral segmental defects or cavitary defects confined to one or two sectors. The Burch–Schneider cage should be used for medial segmental defects, extensive cavitary defects and combined deficiencies. Defects should be reconstituted with bone graft rather than cement.

Deficiency of acetabular bone may prejudice the long-term results of total hip arthroplasty, and this problem is most severe in the increasing number of patients requiring revision arthroplasties. The causes include the initial disease process, bone removal at primary surgery and the subsequent effects of loosening and implant migration (Samuelson et al 1988). At a revision operation the acetabulum may not only be morphologically deficient, but the remaining bone may often be thin and eburnated, providing poor anchorage for bone cement. After revision surgery using conventional cemented components early failure is common (Amstutz et al 1982; Callaghan et al 1985; Kavanagh, Ilstrup and Fitzgerald 1985; Hungerford and Jones 1988).

Several techniques have been devised to compensate for acetabular deficiency. These include the use of additional bone cement (Charnley 1979); the use of autograft or allograft in conjunction with cemented (Mendes, Roffmann and Silbermann 1984; Hirst et al 1987) or uncemented components (Hungerford and Jones 1988); and augmentation of the reconstruction with vitallium mesh (Jasty and Harris 1988) or one of a variety of reinforcement rings used with or without supplementary bone grafts (Schatzker, Glynn and Ritter 1984; Samuelson et al 1988). No single technique is likely to provide the solution to the full spectrum of possible acetabular defects, and in an attempt to encourage a rational approach, the American Academy of Orthopaedic Surgeons (AAOS) Committee on the Hip devised a classification of these defects (D'Antonio et al 1989).

Since 1981, the senior author (JS) has used either the Müller acetabular ring (Fig. 1) or the Burch–Schneider anti-protrusio cage (Fig. 2) in selected primary and revision arthroplasties. Previous reports on the use of these implants have been encouraging (Schatzker et al 1984; Haentjens et al 1986; Mayer and Hartseil 1986), and we have reviewed the longer-term results with the aim of defining the indications in relation to the AAOS classification of acetabular defects.

PATIENTS AND METHODS

We have used the Müller acetabular ring or the Burch–Schneider anti-protrusio cage in 81 patients from 1981 to 1988. In five patients the records did not allow classification of the acetabular defects, four had died of unrelated causes and eight could not be traced. We therefore report on 64 patients with 66 hip reconstructions.

The indications for acetabular reinforcement and the nature and extent of acetabular deficiency were determined from the pre-operative radiographs and the operative reports. Acetabular deficiency was classified

J. Rosson, MS, FRCS, Senior Orthopaedic Registrar
Department of Orthopaedics, St George's Hospital, Blackshaw Road, London SW17 0QT, England.

J. Schatzker, MD, BSc(Med), FRCS C, Chief of Orthopaedic Surgery
Sunnybrook Health Science Centre, 2075 Bayview Avenue, Toronto, Ontario, Canada M4N 3M5.

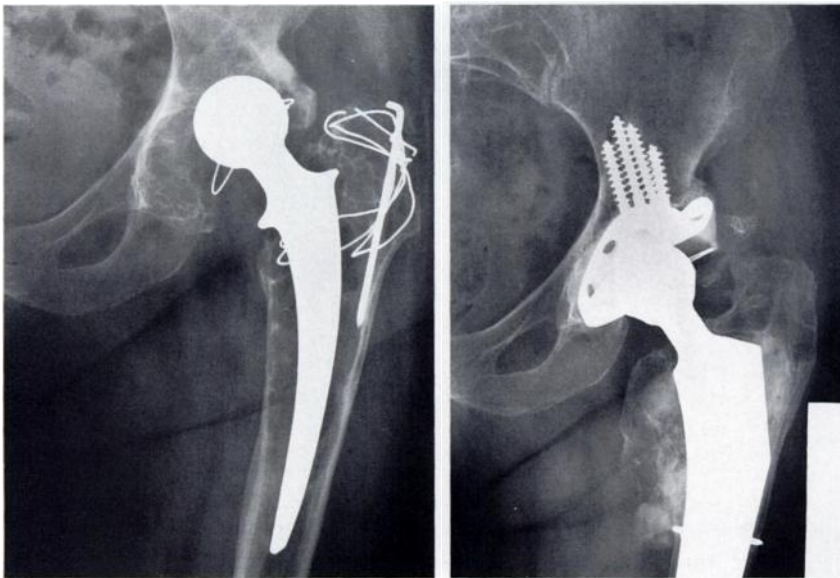Correspondence should be sent to Mr J. Rosson.

Fig. 1a

Fig. 1b

Figure 1a – A failed primary replacement showing superior and medial cavitary deficiencies of the acetabulum due to aseptic loosening. Figure 1b – Five years after reconstruction with a Müller acetabular ring and morsellised allograft.

according to the AAOS classification of D'Antonio et al (1989) as segmental (type I), cavitary (type II), combined (type III) defects, or pelvic discontinuity (type IV). Segmental defects were recorded as medial or peripheral (anterior, superior or posterior) and cavitary defects according to the number of sectors of the acetabulum involved (anterior, superior, posterior or medial). We recorded the type of ring used, the number of screws, the use of bone graft, and the nature of this graft.

Follow-up was from two to ten years (mean five years), and each patient was assigned a score on the

Table I. The use of acetabular reinforcement in hip arthroplasty

	Müller ring	Burch–Schneider cage
Primary arthroplasty	10	2
Revision of resurfacing	18	3
Revision of cemented THR	18	15

Figure 2a – Aseptic loosening with superior and medial cavitary deficiencies and a medial segmental defect. Figure 2b – Three years after reconstruction with a Burch–Schneider cage and morsellised allograft.
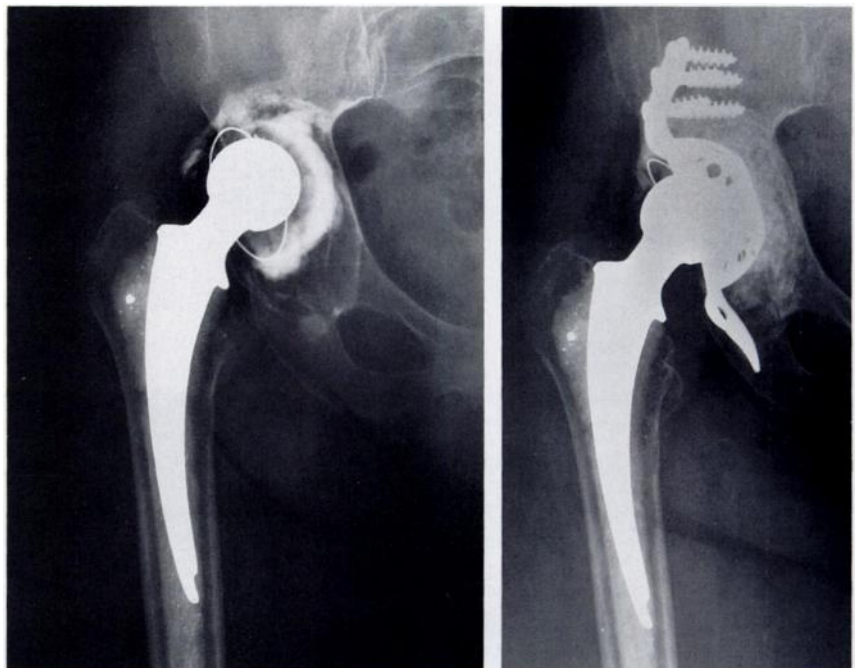

Fig. 2a

Fig. 2b

Table II. Details of 46 acetabular reconstructions using the Müller ring

Deficiency (AAOS type)	Number	Bone graft used		Re-revision for aseptic loosening	Radiolucent lines	
					Non-progressive <2 mm	None
Osteoporotic	3	No		0	3	0
Segmental (I)	8 (2 medial)	Yes		1	0	1
	(6 peripheral)	Yes	5	1	0	4
		No	1	0	1	0
Cavitary (II)	34	Yes	25	0	5	20
		No	9	2	7	0
Combined (III)	1 (medial segmental)	Yes		1	0	0
Total	46	Yes	33	3	5	25
		No	13	2	11	0

Harris hip rating system (Harris 1969). Radiographs were assessed as regards the bone–implant interface, the integrity of the screws and the appearance of any bone-grafted area.

RESULTS

The procedures at which acetabular reinforcement was used are shown in Table I and the methods of reconstruction are related to the outcome in Tables II and III.

Müller ring. The Müller ring was used to reconstruct 46 acetabula in 19 men and 26 women with an average age of 63 years (32 to 79). Three acetabula were osteoporotic, but had no focal bony defects, and in 31 of the 34 with cavitary (type II) defects these were present in only one or two sectors of the acetabulum. Of the remainder, eight had segmental (type I) and one combined (type III) defects.

Table III. Details of 20 acetabular reconstructions using the Burch–Schneider cage

Deficiency (AAOS type)	Number	Bone graft used		Radiolucent lines	
				Non-progressive <2 mm	None
Segmental (I)	1 (medial)	Yes		0	1
Cavitary (II)	4	Yes	3	1	2
		No	1	1	0
Combined (III)	14 (12 medial segmental)	Yes	13	2	11
		No	1	1	0
Pelvic discontinuity (IV)	1	Yes		0	1
Total	20	Yes	18	3	15
		No	2	2	0

Three to five screws were used to secure the implants (mean 3.5) and 33 of the 46 reconstructions were augmented with bone graft. Autogenous block grafts were used in five hips with peripheral segmental defects. Morsellised graft (20 autogenous, eight allogeneic) was used in two hips with medial segmental defects, 25 of the 34 hips with cavitary defects and in the one hip with a combined (type III) deficiency.

None of the nine patients excluded from the study because of death or inadequate records had required revision. At review five arthroplasties had failed due to aseptic loosening, and had been revised at a mean of six years (four to eight). All five showed progressive radiolucency at the bone–implant interface and in four of them broken screws had indicated loosening. There had been failure in two of the three hips with medial segmental defects, including the one with a combined deficiency. Only one of the six hips with peripheral segmental defects had failed: this was due to resorption of the autogenous block graft used to reconstruct a posterosuperior defect. None of the five hips with superior segmental defects due to dysplasia failed. Of the 34 hips with cavitary defects, there were no failures in the 25 which had had bone grafts, but there were two failures in the nine in which cement alone had been used.

Radiolucency at the bone–implant interface was apparent in 16 of the 41 unrevised hips at a mean follow-up of six years. All the lines became apparent within one year of surgery, were less than 2 mm wide, non-progressive and not associated with screw failure. Radiolucency extended to all three zones of DeLee and Charnley (1976) in only five hips. There were lucent lines in all 11 surviving hips that had not been grafted, but in only five of the 30 grafted hips. All 25 hips with no evidence of interface lucency after a mean of 4.5 years had been grafted. The screws were intact in all the surviving hips, and the graft appeared to have incorporated in all 30 surviving hips in which it had been used.

The mean Harris hip score of the 40 unrevised patients was 87 (61 to 100); only seven patients failed to achieve 80 points.

Burch–Schneider cage. The anti-protrusio cage was used to reconstruct 20 acetabula in eight men and 11 women with an average age of 62 years (22 to 73). In the four patients with cavitary deficiency only, the defects extended to three or four sectors of the acetabulum.

Again, three to five screws were used to secure the cage (mean 4). Nine of the 20 reconstructions were augmented with morsellised autograft and nine with morsellised allograft. In two hips cement alone was used.

At review, none of the hips had required revision. In one patient a screw had broken within one year of surgery but after five years the implant remained satisfactory with no evidence of loosening or migration; the patient had a Harris hip score of 90.

Interface radiolucency was seen in five of the 20 hips at a mean of six years, including the two which had not been grafted. It was non-progressive, always less than 2 mm wide and in only one case did it extend to all three zones. In the other 15 hips there was no radiolucency and only one broken screw at a mean of five years. All the grafts appeared to have incorporated. The mean Harris hip score was 81 (56 to 99).

DISCUSSION

Acetabular revision using conventional cemented implants has yielded disappointing results, which have encouraged the use of cementless methods (Hungerford and Jones 1988). Callaghan et al (1985) reported that 34% of acetabular components revised using cement showed circumferential radiolucency immediately post-operatively. At a mean of 3.6 years, 20% showed progressive lucency and 9% had migrated. Similarly, Kavanagh et al (1985) reported a 50% incidence of probable radiographic loosening and a 33% incidence of symptomatic loosening at 4.5 years after revision with cemented acetabular components for aseptic loosening.

In our series, there was a 7.5% incidence of further revision for aseptic loosening, and the incidence of circumferential non-progressive radiolucency was 10%. Such radiolucency raises doubts about long-term survival, but in these reinforced reconstructions it does not appear to indicate impending failure as we have seen no progression and the screws have remained intact.

In the early period of use of these implants, bone grafting was added, as block autografts, only for the reconstruction of peripheral segmental defects secondary to dysplasia. In later cases, grafting was also used to reconstruct cavitary and medial segmental defects. At present, the Müller ring is used for peripheral segmental defects over block grafts secured by screws. Cavitary defects are filled with compacted morsellised graft. The ring is then impacted into the reconstructed acetabulum, where it gains some peripheral support from living bone, and is secured by at least three screws into the dome of the acetabulum. The Burch–Schneider cage is used for more severe cases and is impacted into an acetabulum largely reconstructed with morsellised graft. The implant gains support from the posterior wall and from the iliac wing to which it is secured, again by at least three screws. An intact superior segment is required if a high placement of the centre of rotation of the hip is to be avoided. No attempt was made to secure the inferior flange of the implant to the ischium.

Although a trochanteric osteotomy is not required, use of the Burch–Schneider cage requires a more extensive exposure of the acetabulum and wing of the ilium and, despite the excellent results achieved with this implant, we do not feel that it should be used for all cases of acetabular deficiency. Our results indicate that it is preferable to adopt a selective policy.

The Müller ring failed in two of three acetabula with medial segmental defects, while the Burch–Schneider cage was successful in all 13 acetabula with medial segmental defects, 12 of which were associated with cavitary deficiencies. The Müller ring is inadequately supported on its medial aspect by bone graft alone; the Burch–Schneider cage is to be preferred in this situation.

For osteoporotic acetabula, however, and for those with isolated peripheral segmental defects or cavitary defects confined to one or two sectors, the Müller ring provides excellent support. In our series, its use for these indications resulted in only two failures; in both of these the cavitary defects had been filled with cement.

We used bone grafting more often for acetabula with severe deficiencies. The mean follow-up of the grafted cases was marginally less than that of the ungrafted cases (means: five years versus six years) but there was a marked difference in the incidence of revision.

Only three of the 51 grafted acetabula failed (6%); two after a Müller ring had been used in the presence of medial segmental deficiency and one because of the resorption of a block autograft. Only eight of the 48 surviving grafted hips showed interface radiolucency, and in only one was this circumferential (2%). Of the 15 ungrafted acetabula, two had failed (13%) and the remaining 13 all showed radiolucencies which were circumferential in five (39%). We found no apparent difference in the behaviour of morsellised autograft and morsellised allograft.

It is difficult to evaluate the clinical results of revision hip surgery (Johnston et al 1990), and we have focused on the radiographic appearances, using the Harris hip score to demonstrate that most patients achieved a satisfactory level of pain relief and function. Most of the poor functional scores in unrevised patients related to systemic disease, concomitant disease in other joints or loosening of an unrevised femoral component rather than to an unsatisfactory acetabular reconstruction.

Our results show that the primary indication for the Müller ring is an acetabulum with cavitary defects in only one or two sectors (see Fig. 1). It should not be used in the presence of a medial segmental defect, but is useful for isolated peripheral segmental defects. Anterior segmental defects do not require grafting, but posterior or superior defects should be block grafted.

The Burch–Schneider cage is indicated for acetabula with medial segmental or extensive cavitary defects and

combined deficiencies. With the use of bone graft it is possible to achieve impressive augmentation of bone stock and the restoration of the centre of rotation of the hip to a near-anatomical position (see Fig. 2), which minimises abnormal loading.

The use of these implants for the indications that we have defined can help to provide a cemented reconstruction which is a viable alternative to cementless revision in terms of implant survival.

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