

Revision Surgery in High Grade Acetabular Defects with Thermodisinfectected Allografts

Authors

R. Volkmann¹, K. Bretschneider¹, E. Erlempf¹, S. Weller²

Affiliations

¹ Department for Trauma Surgery and Orthopaedics, Hospital Bad Hersfeld, Germany

² Tübingen, Germany

Key words

- aseptic acetabular loosening
- biological acetabular revision
- reinforcement ring
- allogenic thermodisinfectected and cryoconserved bone substitute

Abstract



Aim: Due to new medical knowledge and legal restrictions, it is increasingly difficult to run a traditional allogenic bone bank so that alternative bone substitutes and methods of processing are being sought worldwide.

Method: In a prospective clinical study, the biological efficacy of thermodisinfectected and then cryopreserved allogenic bank bone was investigated in 19 acetabular revisions in 18 patients. Simultaneously a newly developed titanium reconstruction ring was used. Any revision was regarded as an end point and the follow-up with radiological and clinical results were recorded.

Results: The mean follow-up period was 8.1 (7.9–9.8) years. The patients were 73.5 years old (46–91) at the time of the revision surgery. One case had a septic course necessitating revision surgery. The other cases showed increasing ho-

mogeneity compared to the opposite side and gradual adaptation to the radiological structures found there beforehand. Screw breakage was observed in 3 cases but no implant failure, migration tendency or change in the position of the reconstruction ring or PE-cup.

Conclusion: Despite the low case numbers and different baseline situations, it can be concluded that thermodisinfectected cancellous bone chips enable similarly good acetabular reconstruction as the routinely tried and tested cryoconserved, non-processed bone bank allograft, which is becoming increasingly difficult to obtain because of altered guidelines and legislation. The newly developed reconstruction ring has proven itself because of the improved range of sizes and the possibility of adjustment to the anatomical circumstances together with its outstanding material characteristics in clinical use.

Introduction



Despite innumerable modifications and improvements of joint replacements, fixation philosophies and implantation techniques with the aim of fixing “dead implant material” permanently in the “living body” remain a hitherto unachieved vision.

Patients growing ever older and generous indications in young patients mean that more and more patients are experiencing the thus far unavoidable implant loosening. The insidious loosening process, which is often only noticed late, leads to sometimes grotesque bone substance defects, which in the past were often filled with solid plugs of cement, though only for a short time [1, 2, 9].

Acetabular cup loosening predominates, which can cause problems with regard to lasting re-fixation as a result of marked defects in the fixation

region. Undoubtedly, operative strategies that fill the resulting defect with potentially revitalisable material and ensure loading capacity and bone remodeling with the use of bridging reinforcement rings are desirable. The efficacy of these measures was already demonstrated for the use of allogenic, cryopreserved bone and the tried and tested Burch-Schneider ring in 41 patients [10].

In contrast, biologically based revisions have become more and more desirable, where the acetabular defects are filled with homogeneous – ideally autologous – bone chips, which are remodeled to an autologous bearing acetabular floor in a highly grafted bed utilising so-called “creeping substitution”.

It is well-known that there is often not sufficient autologous material available in the usually elderly and frequently polymorbid patients. The efficacy of allogenic, cryopreserved bank bone has

Bibliography

DOI 10.1055/s-2007-965660

Z Orthop Unfall 2007; 145:

S44 – S48 © Georg Thieme

Verlag KG Stuttgart · New York ·

ISSN 1864-6697

Correspondence

PD Dr. Rüdiger Volkmann, MD

Klinik für Unfallchirurgie und

Orthopädie

Klinikum Bad Hersfeld GmbH

Seilerweg 29

36251 Bad Hersfeld

Germany

Phone: +49 62 21 88 15 71

Fax: +49 62 21 88 15 60

ruediger.volkmann@klinikum-hsf.de

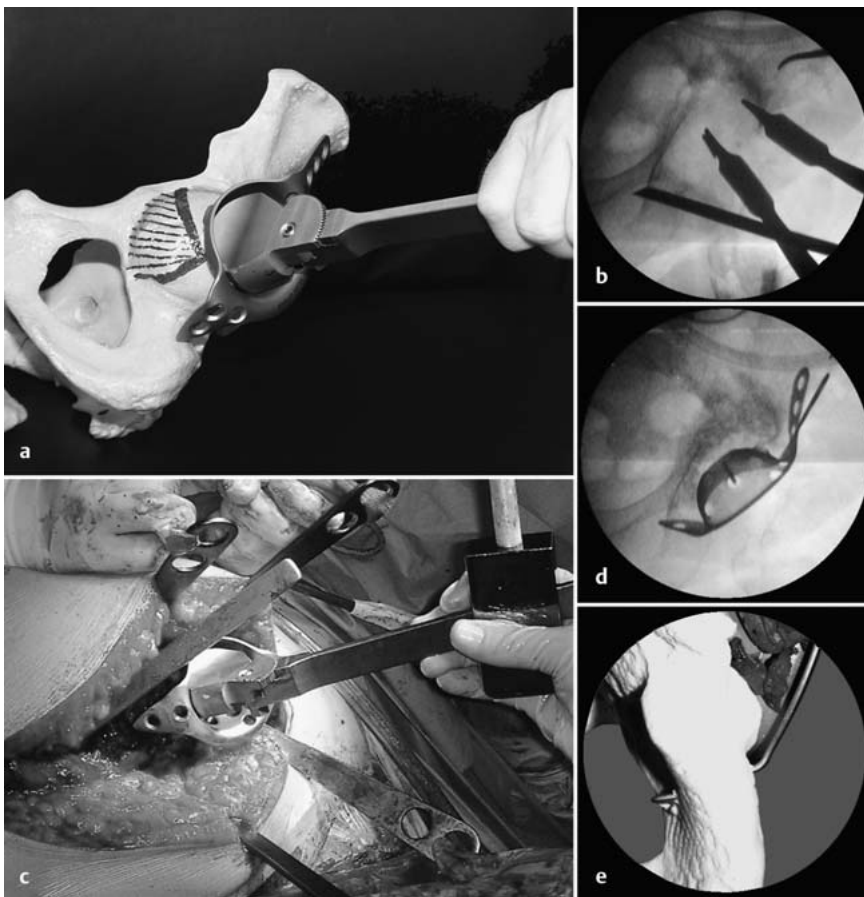


Fig. 1 a to e Method of implant and bone graft fixation: **a** Implantation of the reconstruction ring in a model using the positioning instrument after fitting the cranial flanges and ischium fixation. **b** Intraoperative marking of the ascending ramus of the ischium with a chisel under image intensifier control. **c** Insertion of the reconstruction ring. **d** Check of correct implant position with multi-directional image intensifier. **e** The horizontal perforation of the ischium improves primary stability and avoids neurovascular complications.

been proven [6] but is difficult to obtain because of incalculable disease transmission risks. Many hospitals also had to give up their banks because of logistical and financial problems. In this situation, unlimitedly available bone substitutes are becoming more and more the desired target material of users and industry. However, the biological value of filler material, which is vitalisable in principle, for use in advanced defect situations has not yet been adequately validated in the literature.

In an ongoing clinical study, the practicability of native allogenic thermoisinfected and immediately cryopreserved bone (femoral heads obtained at primary arthroplasty) was investigated at acetabular revision. Compared to the already tried and tested but only cryopreserved bone, this has the advantage of immediate availability as it can be rendered sterile by a recognised treatment [4] and can be used immediately without time-consuming investigations. Its biological value should be preserved with this method, even if perhaps with lower quality compared to autologous bone. Without changing the operation technique, the survival rate of allogenic thermoisinfected acetabular reconstruction in combination with a *newly developed* titanium reconstruction ring was investigated and their stability *in vivo* was tested. The aim of this study was to establish whether allogenic cancellous bone processed by thermoisinfection gives follow-up results that are at least as good as cryopreserved bone alone and also to investigate the altered new reinforcement ring with regard to possible preshaping and stability compared to a clinically proven reinforcement ring.

Material and Method



In the period August 1997 to April 2000 nineteen cases of acetabular revision operations were performed in 18 patients (1 bilateral) in a defect reconstruction technique [8,10]. The acetabular defect classification [2] was grade 2 in 5 cases, grade 3 in 6 cases, grade 4 in 5 cases and grade 5 in 3 cases. A newly developed malleable titanium reinforcement ring (B.Braun-Aesculap, Tuttlingen, Germany) was used as stabilising implant with screw fixation at the ilium (two malleable fixation flanges) and caudal fixation to the ascending ramus of the ischium (● Fig. 1 a – e).

The defect is filled with allogenic, thermoisinfected and cryopreserved cancellous bone chips (“Marburg System”, Telos, Marburg, Germany), less for mechanical reinforcement but rather to fill the cavity and reconstruct the bone. The acetabular reconstruction rings, which are available in three different sizes (52, 58 and 64 mm external diameter), are placed depending on the initial anatomical situation as a bridge from the ascending ischium to the wing of the ilium. The resulting bony defect is filled with cancellous bone graft and after checking the position with the image intensifier, a polyethylene cup (internal diameter 32 mm) is “glued in” with bone cement (Refobacin-Palacos) used sparingly.

Follow-up (clinical and radiological) took place in our arthroplasty outpatient clinic after 3, 6 and 12 months and then at annual intervals. The failure rate, i.e. the time to repeat cup revision or removal of the acetabular reinforcement ring because of loosening or infection as provisional end point of treatment is shown in the following bar chart (● Fig. 2).

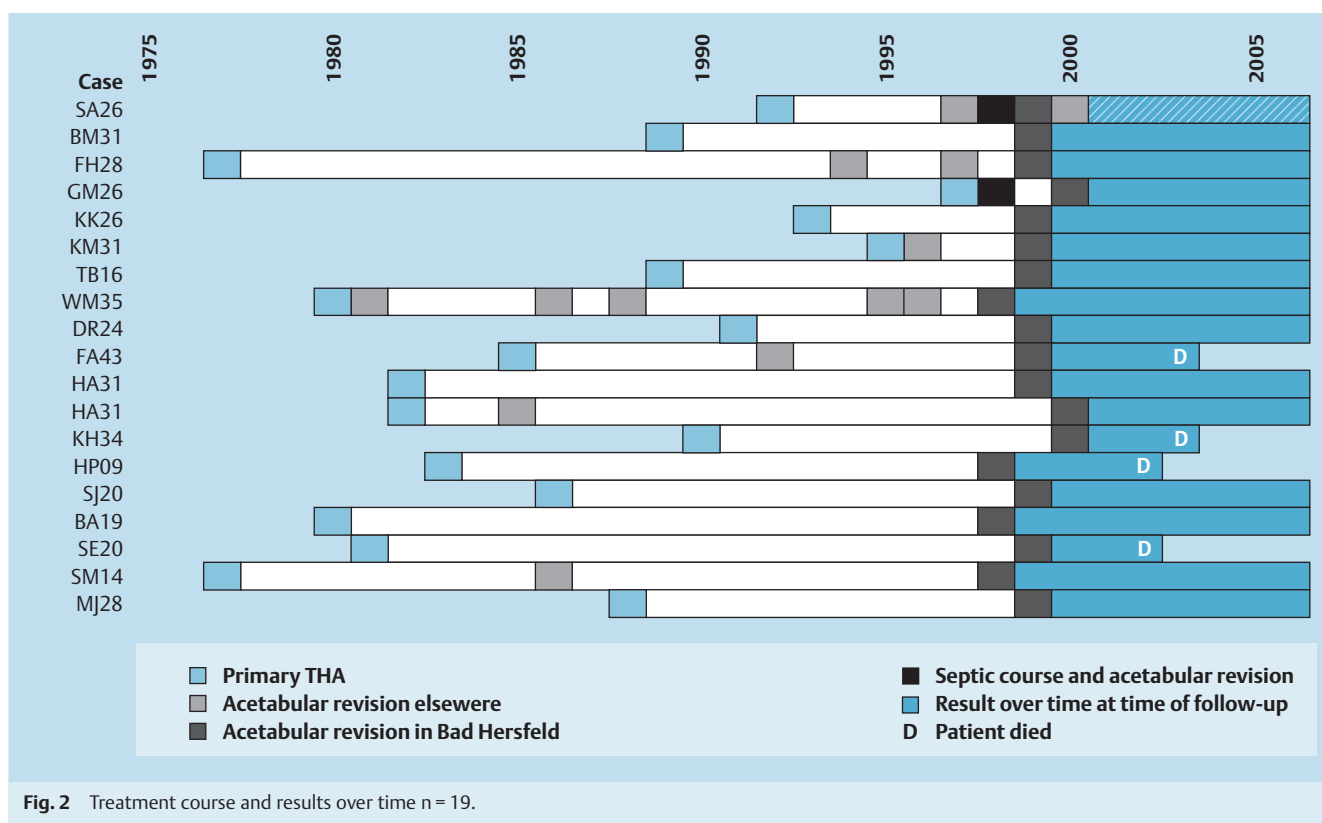


Fig. 2 Treatment course and results over time n = 19.

The average follow-up was 8.1 years (7.9–9.8 years). All patients who were mobile and had transport were examined clinically according to the criteria of the Harris Hip Score and radiographically with a standardised a.p. pelvis including the affected hip with the adjacent thigh in 2 planes to assess bone changes in the region of the acetabulum.

In the case of three patients with senile dementia, the family doctor was asked about the hip situation and confirmed that there are no problems in this regard.

Results

Up to the time of the last follow-up in April 2007, 4 patients with intact hips died of diseases not specific to the prosthesis or because of age. One patient (SA 26) who had already had revision and early infection elsewhere had a septic course postoperatively and was revised again in a different hospital. According to telephone information, the cup was exchanged and the stem was left in place. No further operation has been necessary so far. All other patients were recorded clinically and radiologically as described above so that there is practically a 100% follow-up rate for analysis.

The average age of the patients (12 female) at the time of operation was 73.5 (46–91) years; the right side required revision in 11 cases and the left side in 8.

With regard to the subjective clinical information and the examination findings, the preoperative Harris Hip Score improved by 23 points at the follow-up times, initially increasing slowly. The preoperative score could not be recorded in full in three cases, because of the particular baseline situation (periprosthetic shaft fracture, persistent infection).

When radiographs of the pelvis were compared, there were no measurable changes; in particular, no tendency to migration was found. Isolated screw fractures were evident in 3 cases but did not lead to instability.

There were no fatigue fractures of the titanium ring, fixation fingers and caudal fixation part; there was also no loosening of the polyethylene cup glued in with small amounts of bone cement. Radiological assessment (2 independent investigators) of the bone reconstruction shows increasing homogenisation especially in the main loading zones; compared to the acetabulum on the opposite side there was gradual adaptation of the radiological structures found there previously. In no case was re-operation necessary in the study period because of a loosened revision cup (● Fig. 3 a–e).

Discussion

The aim of treatment in revision operations of loosened arthroplasties consists on the one hand of regaining lost quality of life and on the other hand in preventing future threats of further implant loosening by rational treatment concepts. There is more and more a switch from primary stable cement filling of the defect zones to “biological” methods aimed at reconstructing the bone and protection with so-called acetabular reconstruction rings [1, 8, 10].

Vitalisation of the firmly impacted allogenic cancellous bone filling the cavity with subsequent remodeling of the acetabular defects was demonstrated clinically, radiologically and with the aid of positron emission tomography (PET) [10]. A requirement for the successful achievement of a highly grafted bone bed capable of load-bearing is primary stable bridging of the defect by a suit-

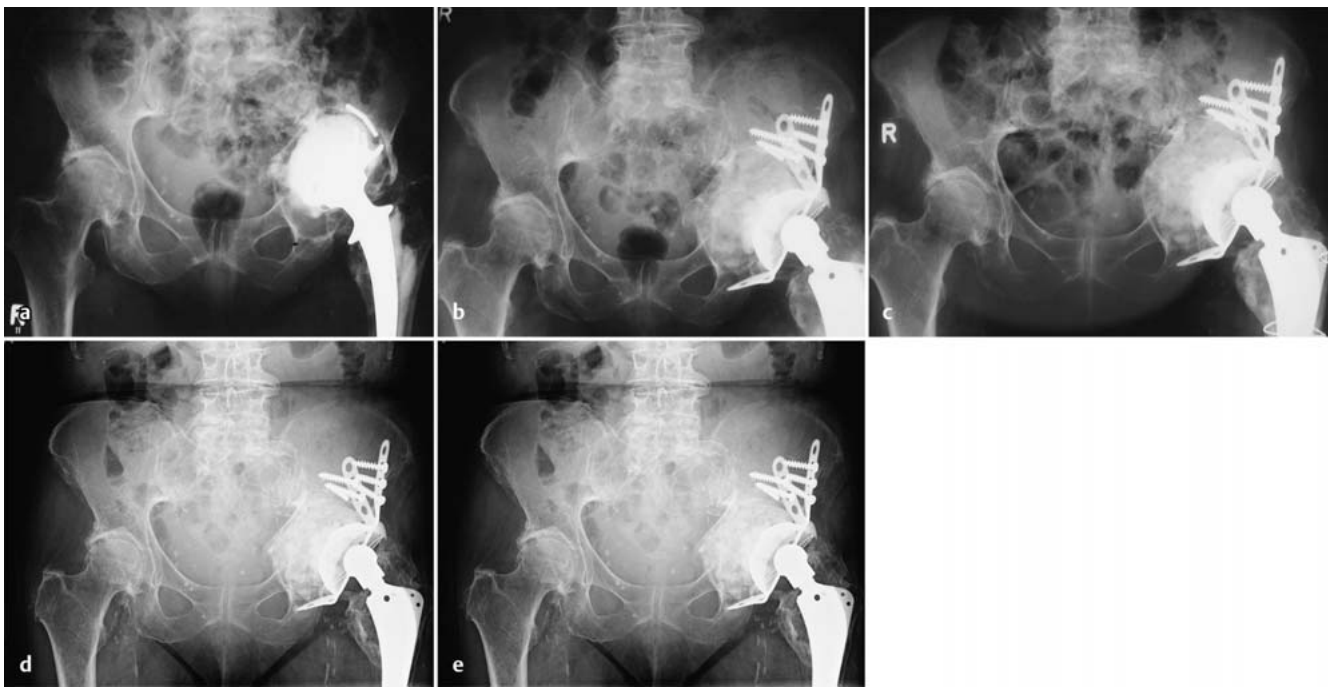


Fig. 3 a to e Radiographic course of acetabular reconstruction with thermoisinfected, allogenic cancellous bone filling the defect and bridging with a reconstruction ring with an external diameter of 64 mm. **a** Preoperative radiograph of an 85-year old patient with intolerable pain due to further aseptic loosening (first implantation in 1977, cup revision in 1986) with pelvic discontinuity (Katthagen grade 5). **b** Repeat radiograph 3 months after acetabular reconstruction (operation on 26.06.1998) in the described technique; patient mobile with full loading and without pain in the operated joint (note: broken screw remnant is from the first implantation). **c** Radiographic

course (09/99) over the first postoperative year with stabilisation of gait and marked regression of the initial gluteal insufficiency. Slightly loosened screw at the proximal fixation tab, no migration of the reinforcement ring, increasing structuring of the cancellous bone. **d** After 7 years (02/05) unaltered position of the reconstruction ring; the bone graft in the floor of the acetabulum is consolidated. **e** At the last follow-up (03/07), the still sprightly 94-year old is safely mobile with a walking stick. Still no signs of loosening, homogeneous structure of the acetabular floor, which is fully vitalised, “creeping substitution” of the bank bone.

able acetabular reconstruction ring that is supported on the ascending ramus of the ischium with a stability advantage and that is also secured to the wing of the ilium. This ensures that “... an implant never has to be fixed to a graft” [9].

The high rates of loosening published with the use of reinforcement rings [5–7] were not found in our study. One reason may be that we devoted great attention to distal implant fixation (see above [Fig. 1](#)). Another reason might be the graft preparation. Increased rates of loosening were reported particularly when defects were filled with structured solid allografts (e.g. whole femoral head or femoral condyles) or xenogeneic material [3, 5, 7]. Similarly good medium-term results should be achievable with the thermoisinfected homogeneous bank cancellous bone according to the Marburg principle (Telos) even if there are no known direct references in the literature so far. The advantage of the Telos method is that the time-consuming and expensive tests of the grafts for safety, as stipulated in the guidelines on operating a bone bank, are not necessary to the full extent because of the heating of the removed femoral heads.

The carefully analysed disease course of the patients who were treated with this modification in our clinic since 1997 allow the conclusion that the bone structures, which are undoubtedly further denatured by the preservation process, obviously continue to have an adequate osteoconductive effect during the follow-up period. All of the revision operations performed (apart from the above-mentioned septic exchange in a different hospital) have been successful up to today and with a radiologically appa-

rent gain of vital acetabular bone. This is an important prospective and prognostic aspect.

In the patients in this study we found no differences from the encouraging earlier results of the study published by Winter [10] of purely cryopreserved allogenic bank bone used with a reinforcement ring of the Burch-Schneider type. With relatively similar results, the provision of biologically high-quality bank bone can accordingly be simplified logistically.

Moreover, the newly developed reinforcement ring which was tested for its technical use and durability has also passed the test. We use it because of the improved variation in sizes and the altered construction with “malleability” in the ever more complex acetabular defect situations. Even if the working life of the respective primary operations has not yet been reached in the present follow-up period of nearly 10 years, the unaltered fixed position of the reinforcement rings and simultaneous biological structuring of the entire acetabulum show that lasting results can be expected from biological reconstruction, even when there is sepsis initially.

References

- 1 Bader R, Mittelmeier W, Zeiler G, Trokar I, Steinhäuser E, Schuh A. Pitfalls in the use of acetabular reinforcement rings in total hip revision. *Arch Orthop Trauma Surg* 2005; 125: 553–563
- 2 Bettin D, Katthagen B-D. [The German Society of Orthopedics and Traumatology classification of bone defects in total hip endoprostheses revision operations] Die DGOT-Klassifikation von Knochendefekten bei Hüft-Totalendoprothesen-Revisionsoperationen. *Z Orthop* 1997; 135: 281–284

- 3 *Bolder SB, Verdonschot N, Schreurs BW.* Technical factors affecting cup stability in bone impaction grafting. *Proc Inst Mech Eng* 2007; 221: 81–86
- 4 *Knaepler H, v Garrel T, Seipp HM, Ascherl R, Gotzen L.* Autoklavierung von allogenen Knochentransplantaten als Alternative zur konventionellen Knochenbank? *Orthop Praxis* 1992; 28: 18–22
- 5 *Lie SA, Havelin LI, Engesaeter LB et al.* Failure rates for 4762 revision total hip arthroplasties in the Norwegian Arthroplasty Register. *J Bone Joint Surg [Br]* 2004; 86: 504–509
- 6 *Piriou P, Sagnet F, Norton MR, de Loubress CG, Judet T.* Acetabular component revision with frozen massive structural pelvic allograft: average 5-year follow-up. *J Arthroplasty* 2003; 18: 562–569
- 7 *Schlegel UJ, Bitsch RG, Pritsch M, Mau H, Breusch SJ.* Mueller reinforcement rings in acetabular revision: outcome in 164 hips for 2–17 ears. *Acta Orthop* 2006; 77: 234–241
- 8 *Volkman R, Maurer F, Eingartner C, Weller S.* [Primary total endoprosthetic hip joint replacement in acetabulum fractures] Primärer totalendoprothetischer Hüftgelenkersatz bei Acetabulumfrakturen. *Unfallchirurgie* 1995; 21: 292–297
- 9 *Wagner H.* [A revision prosthesis for the hip joint] Revisionsprothese für das Hüftgelenk. *Orthopäde* 1989; 18: 438–453
- 10 *Winter E, Piert S, Volkman R, Maurer F, Eingartner C, Weise K, Weller S.* Allogenic cancellous bone graft and a Burch-Schneider ring for acetabular reconstruction in revision hip arthroplasty. *J Bone Joint Surg [Am]* 2001; 83: 862–867