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The Exeter method—acetabular impaction grafting with cemented reimplantation

Introductory remarks

The use of morcelised impacted bone graft in revision hip surgery has been employed successfully for 30 years [1]. In Exeter we favour this technique of acetabular revision in appropriate cases. It enables restoration of bone that has been lost through the loosening of implants, and allows recreation of acetabular anatomy and biomechanics. The technique involves vigorous impaction of bone chips into an acetabular defect, which is either contained, or in the case of segmental defects, is converted to a contained defect by the use of metal reinforcement mesh or porous tantalum augments. The impacted bone provides a stable, porous host bed at the correct centre of rotation into which a polyethylene acetabular component may be cemented. Over time, as the graft incorporates, the patient's bone stock is restored (◘ **Fig. 1**).

Surgical principle and objective

Restoration of acetabular anatomy and biomechanics by replacing lost acetabular bone through impaction bone grafting for acetabular osteolysis in revision hip surgery.

Advantages

- Correction of cavitory and limited segmental defects created by acetabular osteolysis
- Good restoration of acetabular anatomy and biomechanics, with recreation of the correct hip centre of rotation
- With graft incorporation over time, patient's acetabular bone stock is replenished—a particular advantage in the younger patient
- Established technique with good published results
- A technically exacting, but reproducible technique
- May be used in revision of cemented and uncemented implants, for reasons of aseptic loosening from osteolysis, and infection
- May be used in the primary settings of protrusio acetabuli, dysplasia and trauma

Disadvantages

- Technically exacting
- Requires access to fresh frozen allograft cancellous bone, ideally from femoral head harvested at hip replacement operations
- Not suitable for large segmental defects, where the defect cannot be securely contained

Indications

- Aseptic loosening due to osteolysis
- Bone loss due to infection
- Iatrogenic loss during implant removal
- Protrusio acetabuli

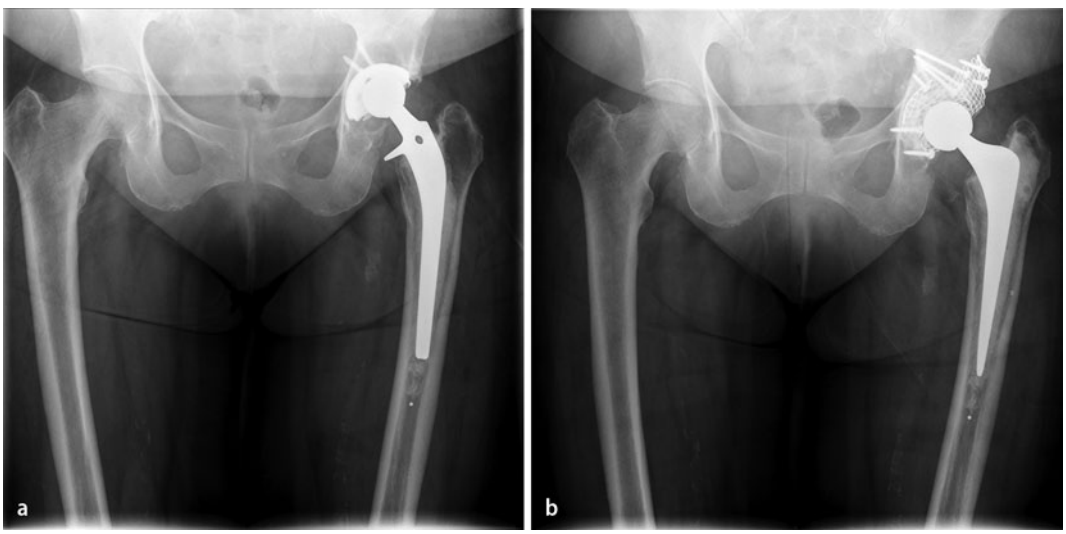

Fig. 1 ◀ Seven year radiograph of a fully impacted socket with a supporting rim mesh

- Dysplasia
- Trauma—healed previous acetabular fracture

Contraindications

- Inability to contain a large segmental defect, peripheral or central [2]
- Unhealed acetabular fracture
- The presence of untreated infection
- Previous radiotherapy to the area of the affected hip

Patient information

- Usual risks of revision total hip replacement (THR)
- Revision for aseptic loosening (survivorship of 91.6% at 5.8 years [3], 87% at 20 years [4])
- Theoretical risk of acetabular fracture—we have not seen this
- Partial weight bearing with crutches for 6–12 weeks post-operatively

Preoperative work up

- Standard workup for revision THR including blood tests, ECG (or EKG; electrocardiography), CXR (chest X-ray)
- Cross match and consider intra-operative cell-salvage
- Radiography—AP and lateral films of the pelvis.
- Occasionally CT to clarify extent of defect, integrity of columns of the acetabulum, or healing in the case of previous acetabular fracture

Instruments and implants

- Standard revision hip sets: including cement splitters, power burrs, occasionally metal cutting burr, acetabular reamers, cup extractors, femoral instruments tailored to type of femoral revision e.g. cement in cement femoral instruments
- Fresh frozen femoral heads: two to three suffice for most defects
- Concave femoral head reamers (**Fig. 8**) to remove cartilage and cortical bone from the femoral heads
- Large rongeurs to produce cancellous bone graft chips of 8–10 mm^3

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Abstract

Objective. Restoration of acetabular anatomy and biomechanics at revision hip surgery by replacing deficient acetabular bone through impaction of allograft and/or autograft bone chips.

Indications. Aseptic loosening of the socket due to osteolysis, bone loss from infection, iatrogenic bone loss due to implant removal, and in the primary setting protrusio acetabuli, dysplasia and previous acetabular fracture.

Contraindications. Large segmental peripheral acetabular defects which cannot be contained, the presence of untreated infection, unstable acetabular fractures, previous radiotherapy to the affected hip area.

Surgical technique. Sound exposure of the acetabulum with delineation of the bony defect. Creation of a host environment suitable for bone graft and containment of segmental defects using rim mesh or porous augments. Impaction grafting using layered allograft or autograft bone chips of 0.8–1 cm^3, packed using hemispherical impactors, followed by cementing of a polyethylene acetabular component with pressurisation.

Postoperative management. Partial weight bearing 6 weeks, modified depending on level of containment and intra-operative findings.

Results. A successful and reproducible technique with survival up to 87% at 20 years for aseptic loosening in the revision setting.

Keywords

Bone grafting · Surgical procedures, operative · Reoperation · Allografting · Autografting

Die Exeter-Methode – azetabulare Graft-Impaktierung mit zementierter Reimplantation

Zusammenfassung

Operationsziel. Wiederherstellung der azetabularen Anatomie und Biomechanik im Rahmen einer Revisionsoperation durch Ersatz des defekten Azetabulumknochens mittels Impaktierung von Allo- und/oder Autograft-Knochenchips.

Indikationen. Aseptische Lockerung der Pfanne durch Osteolyse, Knochenverlust durch Infektion oder iatrogen nach Implantatentfernung; im primären Setting Pfannenprotrusion, Dysplasie und frühere Azetabulumfraktur.

Kontraindikationen. Große segmentale Azetabulumdefekte in der Peripherie, bei denen ein Containment nicht möglich ist, bestehende nichtbehandelte Infektion, instabile Azetabulumfrakturen, frühere Strahlentherapie im betroffenen Hüftbereich.

Operationstechnik. Gründliche Freilegung des Azetabulums mit Darstellung des knöchernen Defekts. Erzeugen einer für das Knochengraft und das Containment segmentaler Defekte geeigneten Host-Umgebung („rim mesh", poröse Augmente). Impaktierung von mit hemisphärischen Impaktoren geschichteten Allo- bzw. Autograft-Knochenchips (0,8–1 cm^3), anschließend unter Druck Einzementierung einer azetabularen Polyethylenkomponente.

Weiterbehandlung . Für 6 Wochen Teilbelastung, Modifikationen je nach bestehendem Containment und intraoperativen Befunden.

Ergebnisse. Erfolgreiche, reproduzierbare Technik bei aseptischer Lockerung im Revisionssetting. Überlebensraten von bis zu 87% 20 Jahre postoperativ.

Schlüsselwörter

Knochengraft · Chirurgische Interventionen · Operative Revision · Allograft · Autograft

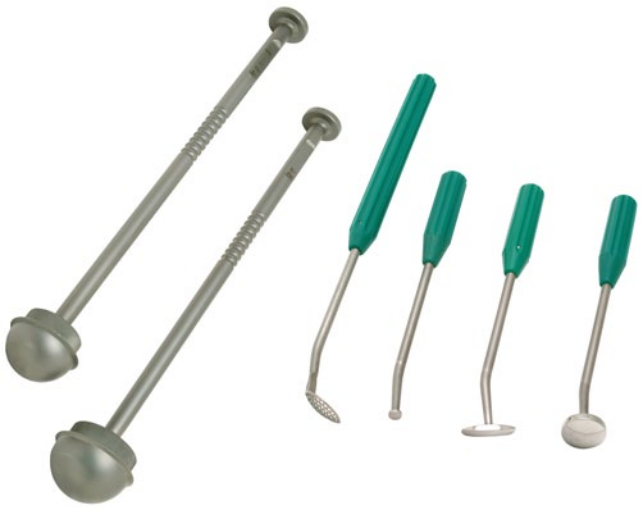

Fig. 2 ◀ Instruments used in impaction grafting including hemispherical impactors of varying diameter, peripheral impactors, and mesh to allow washing of graft

- A selection of sizes of rim and medial wall meshes
- 3.5 mm small fragment screw set with self-tapping screws
- Hemispherical aectabular impactors in a variety of sizes (◘ **Fig. 2**)
- Small peripheral impactors (◘ **Fig. 2**)
- Porous tantalum augments for cases where a larger peripheral segmental defect exists

Anesthesia and positioning

- Spinal and/or general anaesthesia
- Lateral positioning with padded pelvic props
- Perioperative antibiotics (after samples have been taken if suspicion of infection)

Surgical technique

(◘ **Fig. 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14**)

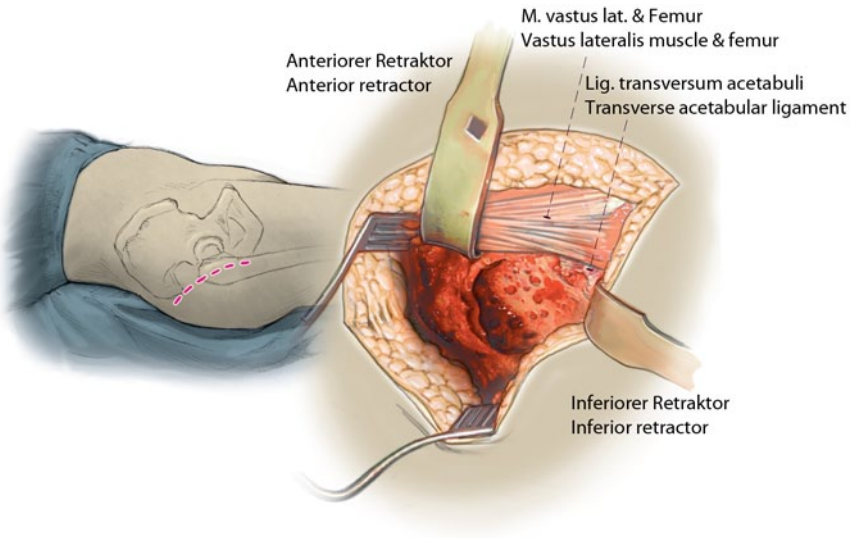

Fig. 3 ▲ The acetabulum is exposed—we prefer an extensile posterior approach. The failed socket and all cement are removed. The transverse acetabular ligament, if still present, is preserved as a guide to the position and orientation of the patient's native acetabulum. All soft tissue membrane is removed from the cavity, and the margins of the acetabulum exposed fully to clarify the limits of any segmental defect. After removal of all membrane the host bone surface should be bleeding, to promote incorporation of the bone graft. If the bone is sclerotic and fails to bleed multiple small drill holes are made in its surface to encourage neovascularisation

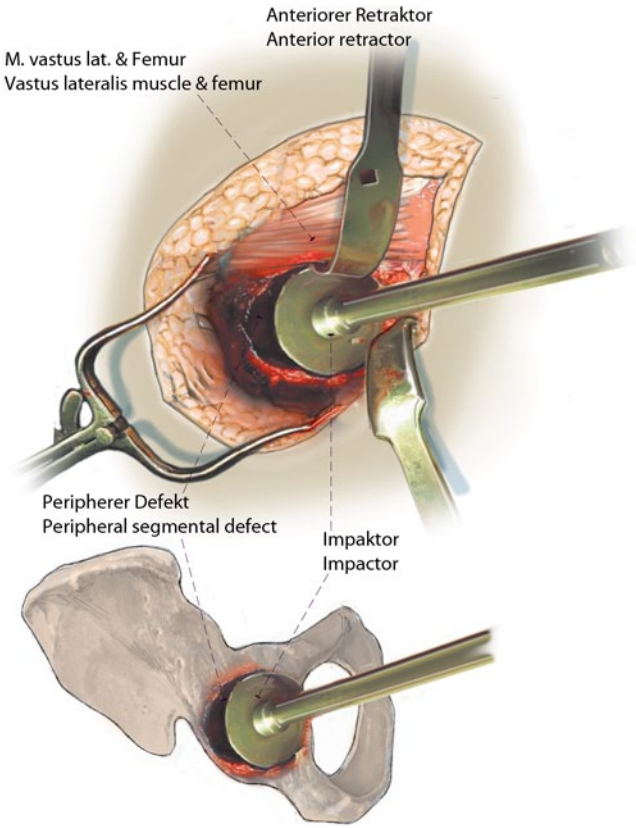

Fig. 4 ▲ An appropriately sized acetabular impactor placed in the correct orientation within the cavity helps delineate the peripheral segmental defect, if present

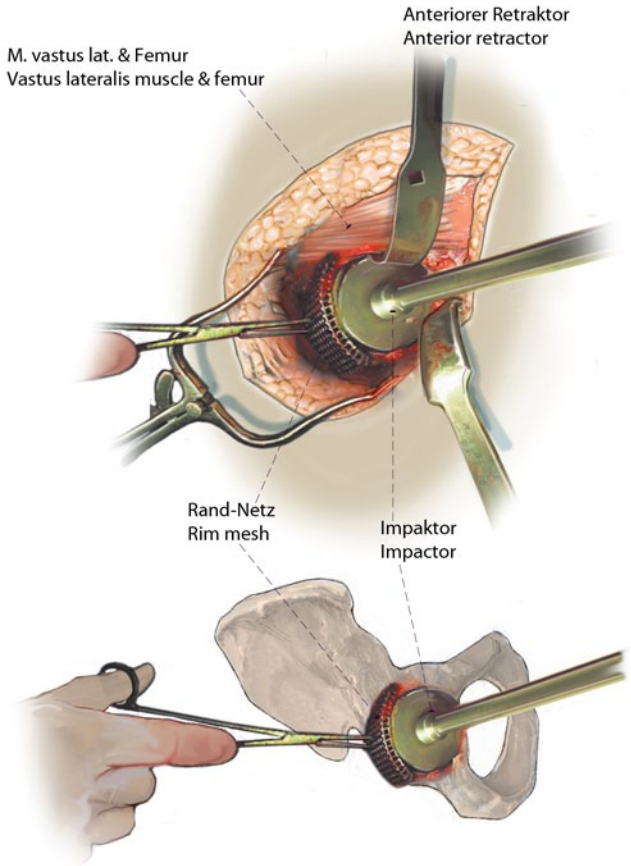

Fig. 5 ▲ Reconstruction of the peripheral segmental defect is then carried out. A rim mesh of the appropriate size is trimmed to fit using an impactor as a guide to its final location and size

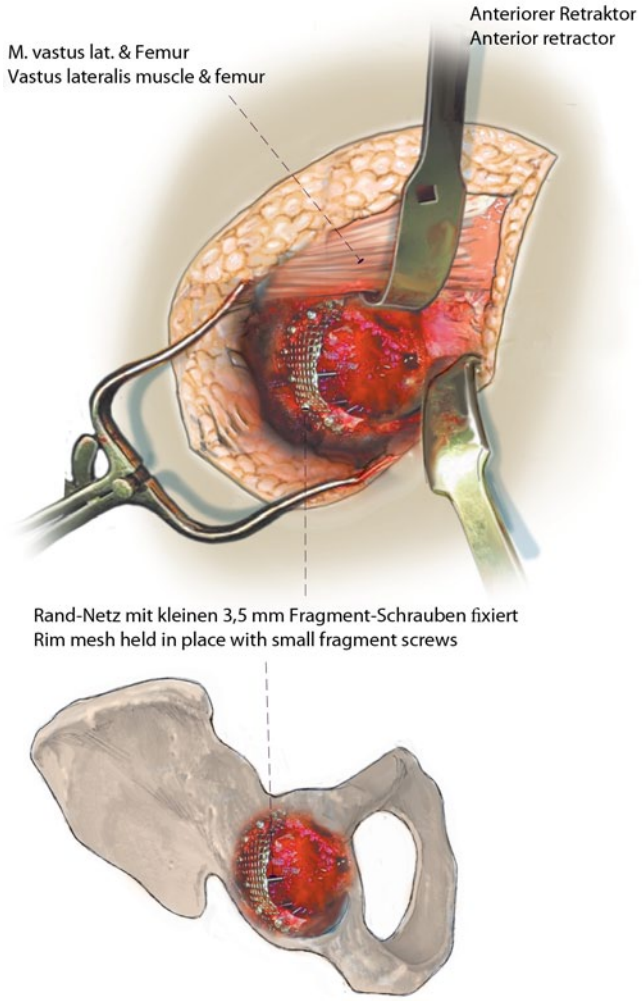

Fig. 6 ▲ With a limited segmental defect a rim mesh is held in place with small fragment screws placed at 1 cm intervals around the margin. The apical screw is placed first, allowing adjustment of the mesh orientation prior to insertion of the anterior and posterior screws, followed by remaining 1 cm interval screws around the margin. Bicortical screws are ideal, and may cross the cavity so long as the cup position is not compromised

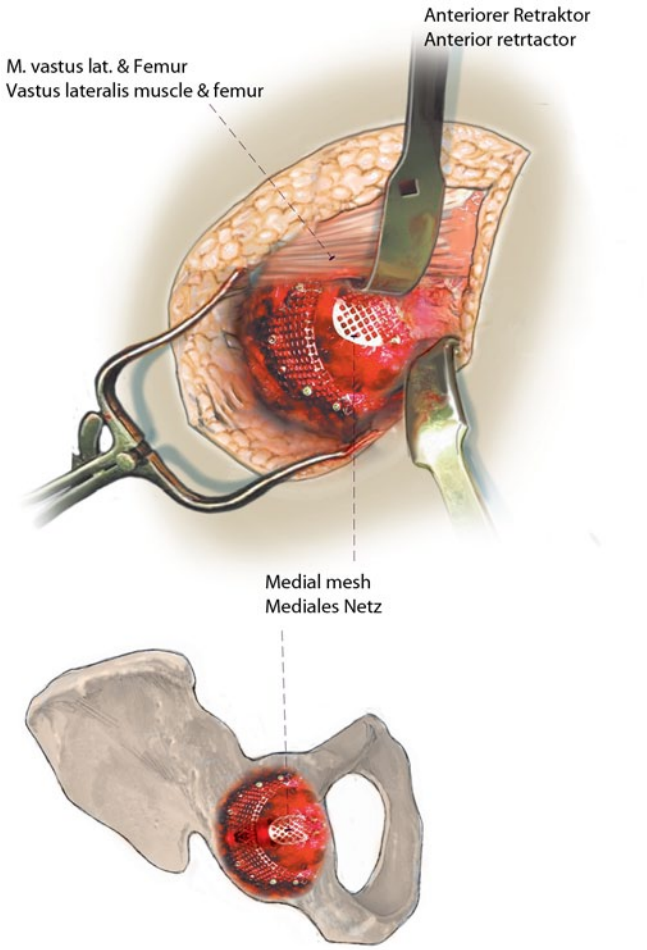

Fig. 7 ▲ An anterior mesh may also be required, and is placed within the acetabulum, often requiring no screws, but sometimes superior and inferior screws are inserted to secure the mesh position, taking care to avoid vascular injury. In a similar way a medial mesh may be placed on the floor of the acetabulum often without screws

Fig. 8 ◀ Graft is now prepared—concave femoral head reamers strip the cartilage from the femoral head

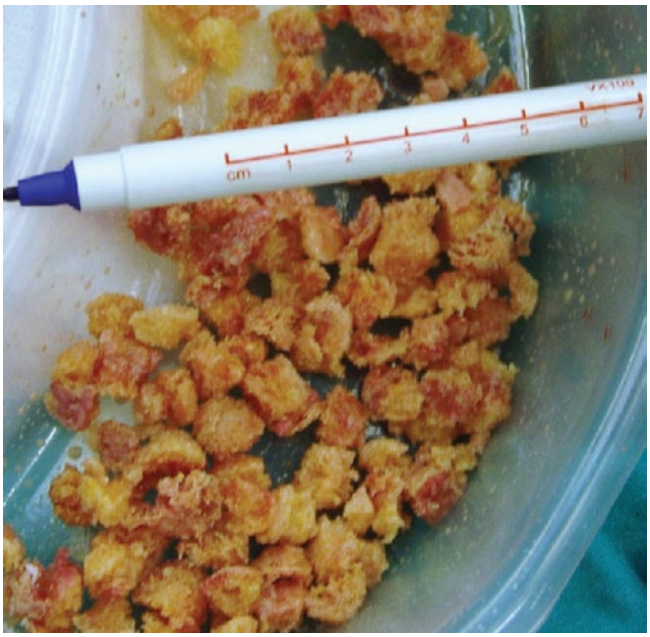

Fig. 9 ▲ The head is sectioned into 2 or 4 using a saw, and large rongeurs are used to produce chips of 0.8–1 cm^3 [5, 6]. Alternatively a bone mill may be used, although the authors preferred method is creation of cancellous bone chips by hand. Bone chips are washed with pulse lavage to improve stability by allowing tighter impaction [5, 6, 7] and washing may also reduce the risk of disease transmission [8]. This process has been shown not to compromise graft incorporation [9]. Finally 1 g of vancomycin antibiotic powder is added to the graft as prophylaxis against infection. In second stage revision for infection alternative or further antibiotic may be added with microbiology advice

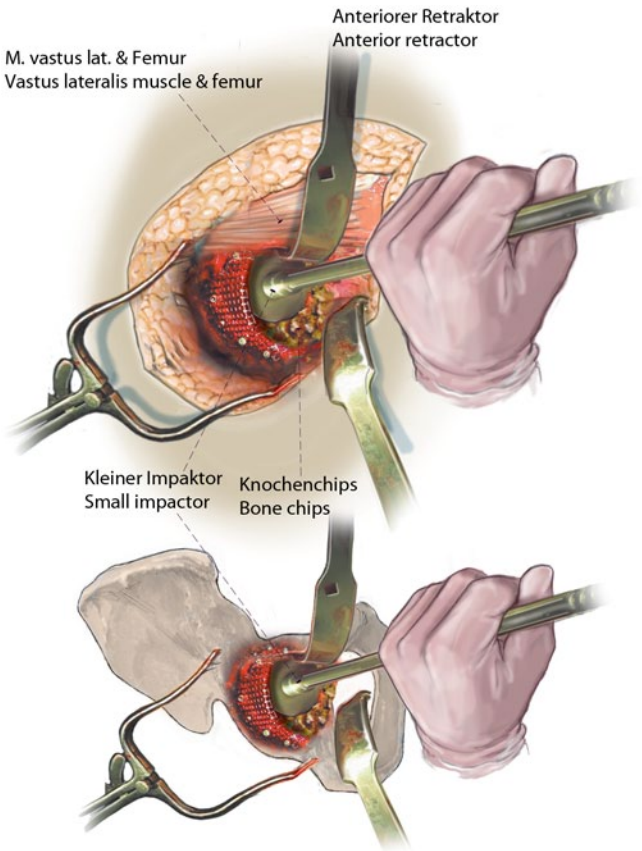

Fig. 10 ▲ Initial packing is performed in the apex of the cavity, into cysts, and around screws using small impactors or hand packing instruments

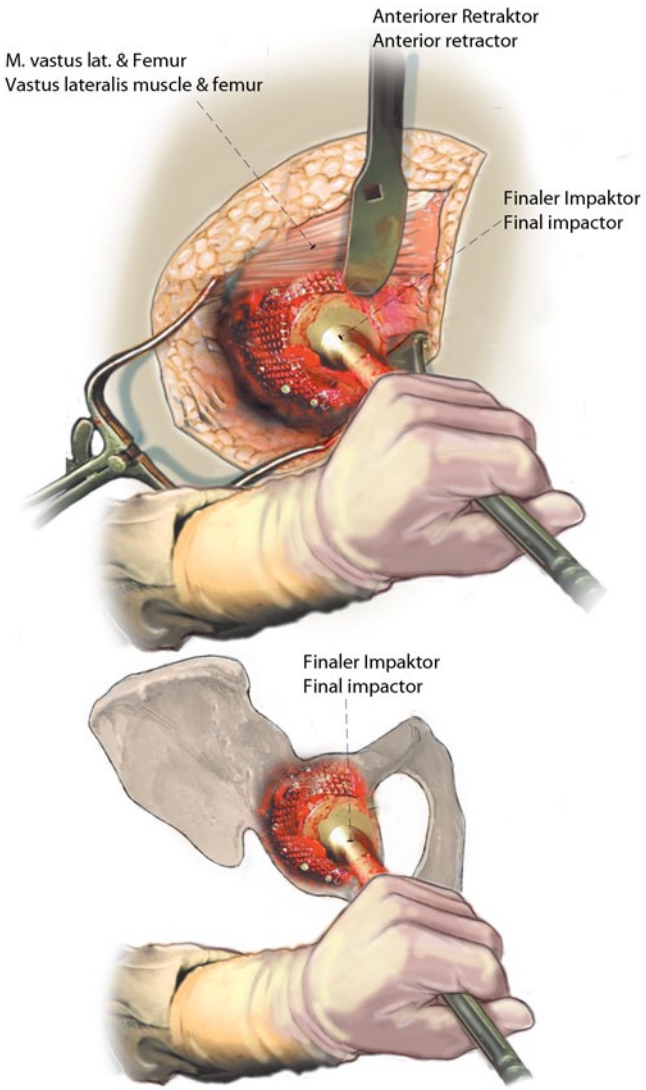

Fig. 11 ▲ Layers of graft are impacted into the cavity, firstly using a small impactor and then progressing to use of the selected, correctly sized hemispherical impactor. Small aliquots of graft are introduced and impacted with vigorous hammering using a metal mallet. Care is taken to ensure that bone is directed and impacted up into the defect and to avoid excessive graft thickness on the medial floor. Whilst impaction must be firm enough to create a solid bed for cementing of the socket, it must not be so great as to fracture the acetabulum. We find multiple moderate blows to be superior to this end compared with fewer heavy hammer blows. After completion of the central impaction, the last hemispherical impactor remains in place whilst further graft is added to the superolateral periphery of the impactor, and sequentially impacted with a narrow punch until this peripheral graft is solid and no further graft can be added. This last step contributes significantly to the final density of bone graft impaction and the stability of the graft and it is key to the success of the technique

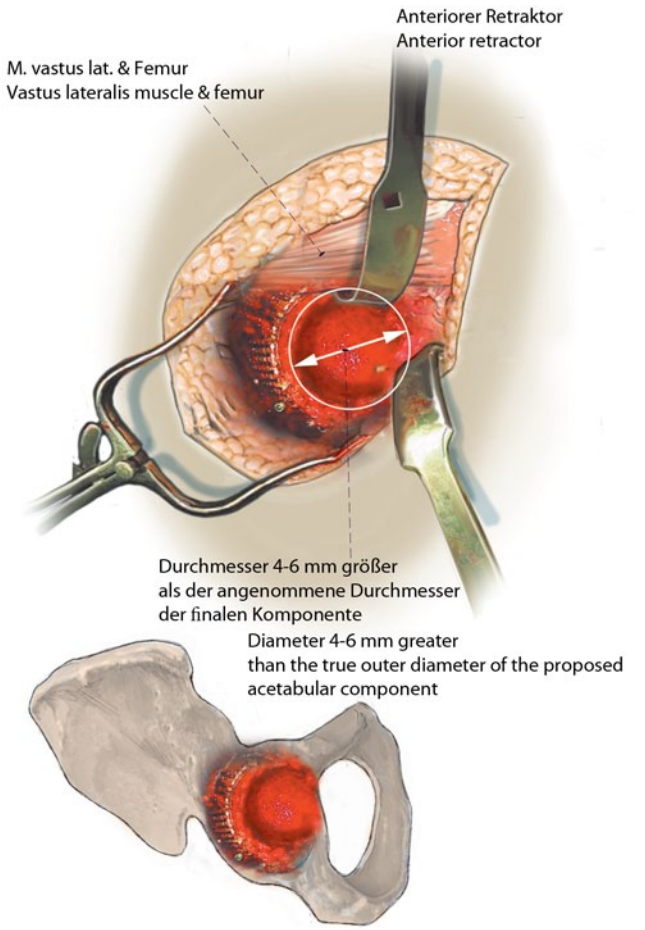

Fig. 12 ▲ The final impacted graft should be at least 5 mm thick circumferentially, and should feel solid, not dissimilar to cortical bone. The final impactor should be 4–6 mm greater diameter than the true outer diameter of the proposed acetabular component to allow for an adequate cement mantle

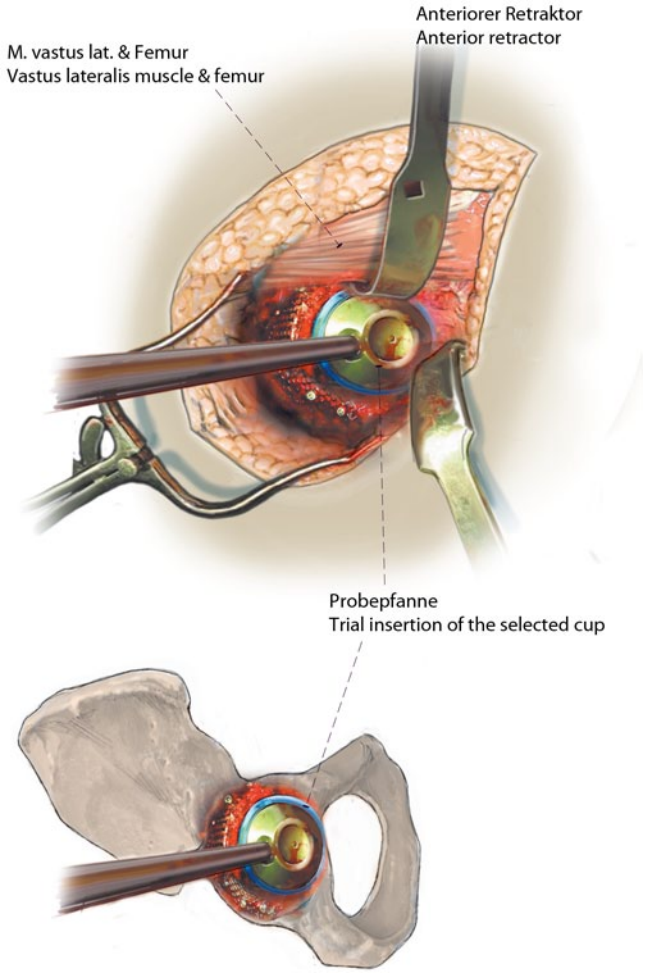

Fig. 13 ▲ A trial insertion of the selected cup is carried out to confirm that accurate reproduction of the desired socket position will be achieved and the graft bed is carefully washed through a specially designed mesh (visible in the centre of ◘ **Fig. 2**) and dried

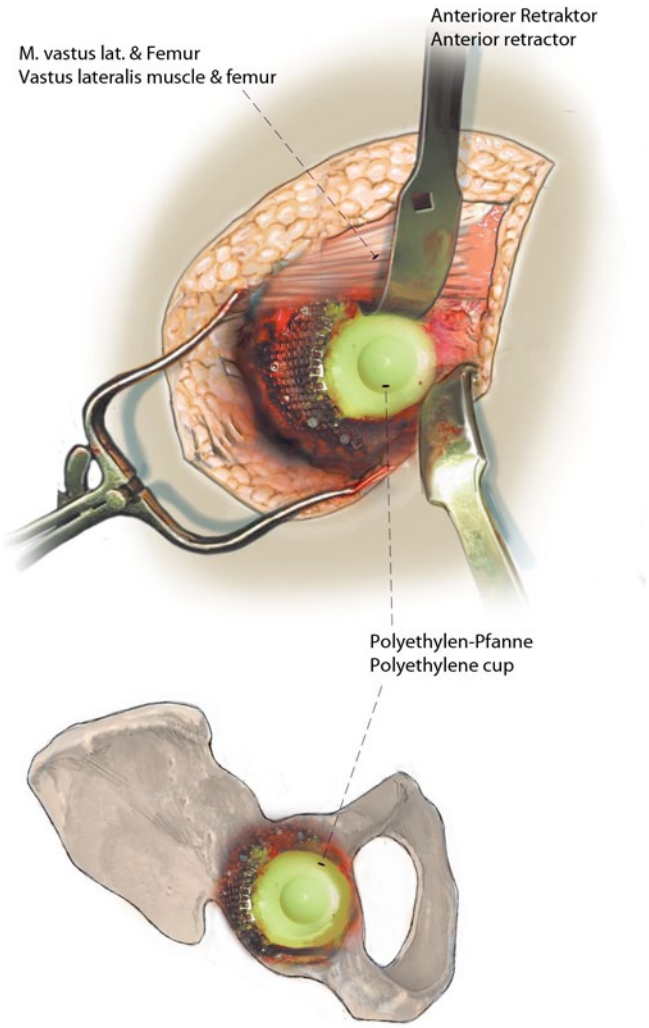

Fig. 14 ▲ Cementing is performed with pressurisation and the polyethylene cup inserted

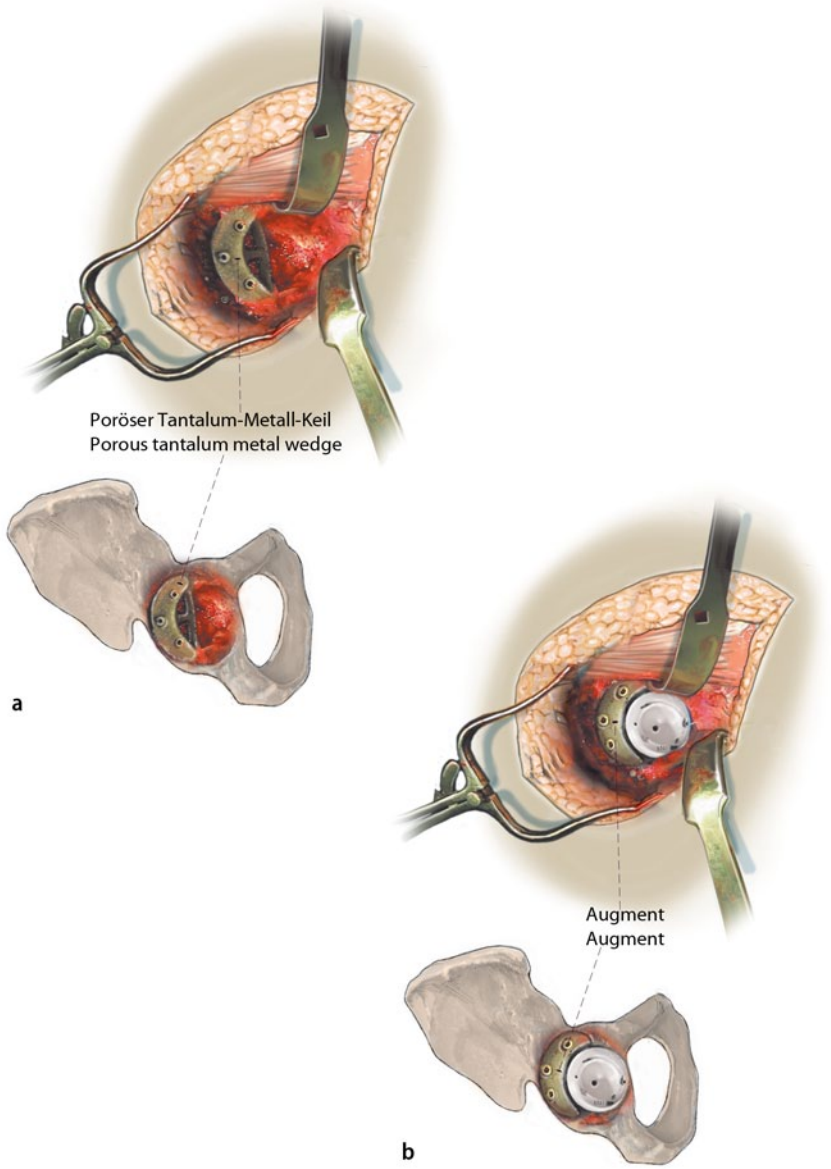

Fig. 15 ▲ **a** In the case of a larger segmental defect, porous tantalum metal wedges may be screwed in place to contain the defect prior to impaction grafting. **b** As for a rim mesh, a trial cup or hemispherical impactor is used to confirm the size and position of the augment, and the orientation of the acetabular component

Special surgical considerations

(◘ **Fig. 15**)

Postoperative management

- Mobilisation day 1 post-op. Partial weight bearing, usually for 6 weeks and occasionally 12 weeks for more extensive segmental defects.
- Routine post-operative bloods and radiographs
- Outpatient review 6 weeks, 3 months, 6 months, 1 year and then 2 yearly, check radiographs

Errors, hazards, complications

- The host cavity for impaction grafting *must* be contained, either primarily by the host walls in the case of a cavitory defect, or by the use of mesh or porous tantalum augments where segmental defects exist.
- Care should be taken during impaction to concentrate on filling the superior defect initially, and to avoid placing excessive graft medially, which can lateralise the acetabular component
- Peripheral impaction after packing of the main cavity is a vital step in producing a densely packed bone bed in which to cement.
- Early limited migration of the cup may be seen. Radiostereometric analysis (RSA) studies confirm that the rate of migration decreases after the initial years as graft incorporates [10].
- Significant cup migration in defects reconstructed using large meshes may result in fatigue failure of the mesh and failure of the overall construct.

Results

We have published favourable results of this technique described in 339 consecutive hip arthroplasties [3]. In all, 202 patients were undergoing their first revision, 46 their second, 9 their third, and 4 their 4th revision. Forty-four patients were undergoing primary total hip arthroplasty (THA) and 34 second-stage revision for infection. The average age at surgery was 71 years (range 23–96 years), and the average follow-up was 6.1 years (range 4.3–8.4 years). No patient was lost to follow-up. The acetabular defects were classified according to Paprosky ([11], ◘ **Tab. 1**); the techniques used to contain the defects varied and are detailed in ◘ **Tab. 2**. Complications included 5 nerve injuries (1 femoral and 4 sciatic), 3 of which made a full recovery. Overall, 15 deep infections were identified; 8 were new infections (8/305; 2.6%), and 7 followed after two-stage revisions for infection (7/34; 20.6%). Of 13 dislocations (3.8%), 4 became recurrent, 2 of which were re-revised. Kaplan Meier survival was 89.1% at 5.8 years with reoperation for any reason as the endpoint. Overall survivorship of the socket, with revision for aseptic loosening as the endpoint, was 91.6%. Importantly analysis of the 15 cases re-revised for aseptic loosening revealed that 9 were large rim mesh constructs for extensive segmental defects, 2 were fractured Kerboull–Postel plates, 2 were migrating cages, 1 was a

Tab. 1 Paprosky classification of acetabular defects

Paprosky classification	Patients (n)
Grade 1	10
Grade 2A	71
Grade 2B	95
Grade 2C	57
Grade 3A	55
Grade 3B	48
Pelvic discontinuity	3

Tab. 2 Methods of graft containment in Exeter series

Method of graft containment	Patients (n)
Impaction only	89
Medial mesh	48
Rim mesh	118
Rim and medial mesh	19
Kerboul–Postel plate	53
Reinforcement ring/cage	12

medial wall mesh failure, and 1 followed impaction grafting for a cavitory defect. Larger segmental defects were therefore a common feature in the group that failed, indicated by the high proportion of failures after use of a large rim mesh. Accordingly we approach large segmental defects with caution, favouring cages or porous augments in combination with impaction grafting in cases of larger defects or sometimes selecting an alternative method of acetabular revision. A further follow up study completed recently in our unit of these patients, as yet unpublished, reveals survivorship at 13.5 years with revision for aseptic loosening as the endpoint was 85.9% (95% confidence interval (CI) 81.0–90.8%). Survivorship with revision for any reason as the endpoint at 13.5 years was 82.8% (95% CI 76.9–88.7%).

The Nijmegen group has published results at 20–25 years follow-up on 62 revisions using impaction grafting with a cemented cup [4]. Patients mean age was 62 years, 38% of defects were classified as cavitatory, 62% combined. Survival was found to be 87% with aseptic loosening as the endpoint. The Nijmegen group also describe results of the technique in a young patient group, in 42 cases patients under 50 years old. Taking revision for aseptic loosening as the endpoint, survival was 85% at 20 years, and 77% at 25 years [12].

This group also report success in a young group (mean age 57 years) of rheumatoid patients, with 85% survival at 12 years for aseptic loosening [13]. Finally a report in patients with "extensive acetabular defects" in 27 hips, and a mean follow-up of 8.8 years (range 3–14.1 years), showed a 10-year survival of 88% with revision for any reason as an endpoint, or 95% taking aseptic socket loosening as the endpoint [14].

Azuma et al. [15] reported on the fate of 30 hips with a variety of cavitary and segmental defects at 5.8 years. Although no cases were revised, 3 were lost to follow-up, and 2 radiographic failures were reported. In this study, segmental defects were closed with block grafts rather than with wire mesh. Of the two cases that migrated, one socket had been reconstructed using a block graft.

Comba et al. [16] reinforce the importance of achieving stable reconstruction of segmental defects in their review of 31 patients at mean 4.3 years follow-up (range 2–13.1 years). Survival for aseptic loosening was reported as 98% although 6 were lost to follow-up (worst case survival 91.3%). A total of 48% of patients had segmental defects but a mesh was used in just 11%, the remainder being "contained" long flange of an Ogee cup. All three mechanical failures were reconstructed with this technique rather than a mesh.

Large peripheral segmental defects have been shown to be less successful with acetabular impaction grafting. van Haaren et al. [17] reported only 72% survival in a group of patients of whom 70% had American Association of Orthopedic Surgeons (AAOS) grade III or IV defects. The authors conclude that failure rates with more severe defects were higher, whilst conceding that the cohort did represent their learning curve, and that results may have been affected by broadening indications beyond the scope of the procedure to, for example, pelvic discontinuity. Twenty-three AAOS grade III defects were reviewed by Buttaro et al. [18] and showed 90.8% survival at only 36 months. Histological examination of the failures showed fibrous tissue and necrotic bone, suggesting instability as the main cause of failure. The authors concluded that mesh did not prevent migration, whilst noting that, despite evidence of migration, many patients remained asymptomatic. The cases of failure presented suggested too few screws had been used, and with less than ideal screw placement. The conclusion from these authors was that mesh and graft are suitable for medium but not severe uncontained defects.

New developments in acetabular impaction grafting include use of porous tantalum augments to contain segmental defects, beneath which impaction grafting may be performed (**Fig. 15a, b**). We have published early results with this technique in 15 hips using Trabecular Metal™ augments and impaction grafting and with mean 39 month follow-up (range 25–83 months) at which stage no constructs had failed clinically or radiologically [19]. Further follow-up is required to judge the medium and longer-term outcome of this technique. Others have also used this technique, the Hamburg group describing 46 patients treated with porous tantalum augments combined with impaction grafting to treat 28 type-2B and 18 type-3A Paprosky defects [20]. At an average of 46 month follow-up, 2 cases had needed further revision because of cup loosening and construct failure, the remaining 44 being radiographically stable and oseointegrated. From the early results available so far this technique shows promise as a successful method of managing more severe uncontained defects.

Histological studies have helped back up the good clinical results seen with impaction grafting. Buma et al. [21] took core biopsies from the grafted acetabula of 8 patients undergoing revision for various reasons, including aseptic loosening and infection. Grafts sampled at greater than 8 months all showed evidence of incorporation, compared with none sampled at less than 4 months. At greater than 15 months, graft remnants were extremely scarce and samples represented normal trabecular bone [21]. Heekin looked at the graft from 3 patients who had died of unrelated cause some time after impaction grafting. At 18 months the graft had vascularised to a depth of 4 mm, at 53 months the graft had incorporated, and

at 85 months the graft had completely remodelled [22].

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Compliance with ethical guidelines

Conflict of interest. T.G. Petheram certifies that there is no current or potential conflict of interest in relation to this article. J.R. Howell is a design surgeon for the Exeter Total Hip Replacement System and receives royalties from Styker Orthopaedics.

The accompanying article does not contain any studies on humans or animals.

References

1. Sloof TJ, Huiskes R, Horn J van, Lemmens AJ (1984) Managing bone loss in acetabular revision. Acta Orthop Scand 55:593–596
2. D'Antonio JA, Capello WN, Borden LS et al (1989) Classification and management of acetabular abnormalities in total hip arthroplasty. Clin Orthop Rel Res 243:126–137
3. Rigby M, Kenny PJ, Sharp R et al (2011) Acetabular impaction grafting in total hip replacement. Hip Int 21:399–408
4. Schreurs BW, Keurentjes JC, Gardeniers JW et al (2009) Acetabular revision with morcellised cancellous bone grafting and a cemented acetabular component: a 20- to 25-year follow-up. J Bone Joint Surg Br 91:1148–1153
5. Arts JJ, Verdonschot N, Buma P, Schreurs BW (2006) Larger bone graft size and washing of bone grafts prior to impaction enhance the initial stability of cemented cups: experiments using a synthetic acetabular model. Acta Orthop 77:227–233
6. Dunlop DG, Brewster NT, Madabhushi SP et al (2003) Techniques to improve the shear strength of impacted bone graft: the effect of particle size adn washing of the graft. J Bone Joint Surg Am 85:639–646
7. Ullmark G, Nilsson O (1999) Impacted corticocancellous allografts: recoil and strength. J Arthroplasty 14:1019–1023
8. Kwong FN, Ibrahim T, Power RA (2005) Incidence of infection with the use of non-irradiated morcellised allograft bone washed at the time of revision arthroplasty of the hip. J Bone Joint Surg Br 87:1524–1526
9. Donk S van der, Weernink T, Buma P et al (2003) Rinsing morselized allografts improves bone and tissue ingroth. Clin Orthop Relat Res 408:302–310
10. Ornstein E, Franzén H, Johnsson R et al (2006) Five-year follow-up of socket movements and loosening after revision with impacted morselized allograft bone and cement: a radiostereometric and radiographic analysis. J Arthroplasty 21:975–984
11. Paprosky WG, Magnus RE (1994) Principles of bone grafting in revision total hip arthroplasty: acetabular technique. Clin Orthop Relat Res 298:147–155
12. Busch VJ, Gardeniers JW, Verdonschot N et al (2011) Acetabular reconstruction with impaction bone-grafting and a cemented cup in patients younger than fifty years old: a concise follow-up at twenty to twenty-eight years, of a previous report. J Bone Joint Surg Am 93:367–371
13. Schreurs BW, Luttjeboer J, Thien TM et al (2009) Acetabular revision with impacted morcelized bone graft and a cemented cup in patients with rheumatoid arthritis. A concise follow-up, at eighteen to nineteen years, of a previous report. J Bone Joint Surg Am 91:646–651
14. Egmond N van, De Kam DCJ, Gradeniers JWM, Schreurs BW (2011) Revisions of extensive acetabular defects with impaction grafting and a cement cup. Clin Orthop Relat Res 469:562–573
15. Azuma T, Yasuda H, Okagaki K, Sakai K (1994) Compressed allograft chips for acetabular reconstruction in revision hip arthroplasty. J Bone Joint Surg Br 76:740–744
16. Comba F, Buttaro M, Pusso R, Piccaluga F (2006) Acetabular reconstruction with impacted bone allografts and cemented acetabular components: a 2- to 13-year follow-up study of 142 aseptic revisions. J Bone Joint Surg Br 88:865–869
17. Haaren EH van, Heyligers IC, Alexander FG, Wuisman PI (2007) High rate of failure of impaction grafting in large acetabular defects. J Bone Joint Surg Br 89:296–300
18. Buttaro MA, Comba F, Pusso R, Piccaluga F (2010) Acetabular revision with metal mesh, impaction bone grafting, and a cemented cup. Clin Orthop Relat Res 466:2482–2490
19. Gill K, Wilson MJ, Whitehouse SL, Timperley AJ (2013) Results using Trabecular Metal™ augments in combination with acetabular impaction bone grafting in deficient acetabula. Hip Int 23:522–528
20. Gehrke T, Bangert Y, Schwantes B et al (2013) Acetabular revision in THA using tantulum augments combined with impaction bone grafting. Hip Int 23:359–365
21. Buma P, Lamerigts N, Schreurs BW et al (1996) Impacted graft incorporation after cemented acetabular revision. Histological evaluation in 8 patients. Acta Orthop Scand 67:536–540
22. Heekin RD, Engh CA, Vinh T (1995) Morcelized allograft in acetabular reconstruction: a postmortem retrieval analysis. Clin Orthop Relat Res 319:184–190

Resorbierbare Implantate aus Biopolyestern

Forscher haben resorbierbare Implantate zur Knochenheilung entwickelt, die vom Körper abgebaut werden können. Das Projekt „BRIC - BioResorbable Implants for Children" soll dazu führen, dass zukünftig Mehrfach-Operationen bei Kindern vermieden werden können.

Die abbaubaren Implantate werden aus von Bakterien produzierten Biopolyestern (Polyhydroxyalkanoate, PHA) hergestellt. Dieser nachwachsende Rohstoff besitzt den Vorteil, dass er biokompatibler ist als die bisher verwendeten Titan- oder Stahl-Werkstoffe, aus denen Implantate wie Nägel, Schrauben oder Platten gefertigt werden. Diese müssen nach der Verheilung des Knochens wieder operativ entfernt werden, während der neue Biopolyester vom menschlichen Körper resorbiert werden kann. Die Abbaugeschwindigkeit kann durch die Zusammensetzung des PHA kontrolliert und an die Heilungszeit des Knochens angepasst werden. Im Unterschied zu diesem Biopolymer führt der alternative technische Biopolyester Polymilchsäure (PLA) zu chronischen Entzündungen und einer Übersäuerung des Organismus.

Die Materialien sind im Entwicklungsstadium und werden derzeit unter anderem auf ihre Materialeigenschaften und Abbaugeschwindigkeiten getestet. Die BRIC sollen in Zukunft bei Kindern eingesetzt werden können, um schmerzhafte zusätzliche Operationen zu vermeiden.

Quelle: Technische Universität Graz, www.tugraz.at