The Use of the Resected Femoral Head as a Bond Graft during Total Hip Replacement

Wolfgang Küsswetter, Carl-Heinz Hartwig
Orthopaedic University Clinic Tübingen, Germany

Introduction
Specially prepared bone grafts harvested from the resected femoral head and fixed to the wing of the ilium are used to reconstruct a lateral acetabular bone defect thus providing a solid anchorage of the acetabular component [5, 6, 7, 9, 12, 14, 16].

Primary stability of the autogenous bone graft will be obtained through an exact adaptation using the tongue and groove principle and through the simultaneous fixation with two spongiosa screws.

Shear forces which are transmitted to the acetabular component through the newly formed bony reinforcement will be eliminated.

Even in instances of marked proximal femoral head displacement a reconstruction at the site of the primary acetabulum is possible.

Surgical Principles
Augmentation and enlargement of the lateral wall of the acetabulum through an autogenous specially tailored bone transplant using the resected femoral head. Fixation of the bone graft to the outer wall of the ilium employing the tongue and groove principle and two additional spongiosa screws.

Advantages
Reconstruction of a weight bearing lateral acetabular wall in instances of absent anterior and posteroslateral support for an acetabular implant.

Stable fixation of the acetabular implant in autogenous bone.

In instances of the high dislocation: possibility of a reconstruction of the primary acetabulum without need to use a large metal cup.

Reestablishment of a normal biomechanical situation through a reconstruction at the site of the original acetabulum or slightly cranial to it.

Creation of a stable bony bed necessary for a possible revision: physiological storage of a bone which is normally discarded.

Disadvantages
If the quality of the femoral head is poor or if it had been broken up an allogenic bone graft has to be used.

Difficult surgical technique.

Indications
Total hip replacement in instances of hip dysplasia with painful secondary osteoarthritis when the acetab-
bular implant is covered by the acetabular roof by less than 70%.

Subluxations and long standing high dislocations.

Destructive coxofemoral processes with loss of the normal acetabular roof.

Loosening of the acetabular component with bone loss in the area of the acetabular roof.

**Contraindications**

Absolute:
- Severe osteoporosis.

Relative:
- Impossibility of postoperative nonweight bearing as in patients with contralateral severe osteoarthritis.

**Patient Information**

All usual risks of total hip replacement such as dislocation, infection, injury to nerves and vessels, leg length discrepancy, fractures and danger of thromboembolis.

Damage due to traction of the femoral and/or sciatic nerve, particularly in instances of high dislocation.

Delayed union or resorption of the bone graft.

Loosening or breakage of screws necessitating a revision.

Periarticular ossification causing a reduction in the range of motion.

**Pre-Operative Work-Up**

Radiograph of pelvis and of the hip using the Lauenstein technique.

Drawing of the proposed plane of resection, of the femoral component to be implanted, and the position of the properly sized acetabular component (implanta
tion at the site of the original acetabulum should be attempted). Perioperative prophylaxis for thrombosis with 5000 units of Heparin three times daily. If a cementless implant will be used, perioperative antibiotic therapy with 2 gm cephalosporin, three times daily i. v. for three days.

**Instruments**

- Total hip replacement set.
- Bone files.
- Oscillating saw with various blades.
- Lexer chisel, 5 to 20 mm large.
- Rongeurs.
- Drill bits, 1.7, 3.2, and 4.5 mm diameter.
- Tap 6.5 mm.
- Kirschner wire, 1.4 mm in diameter.
- 6.5 mm spongiosa lag screws between 40 and 60 mm in length with washers.
- Instrument with spherical tip to hold bone in place (Figure 1).

**Positioning**

- Supine.
- The hip to be operated exceeds the lateral border of the table to permit soft tissues to fall back. The lateral position is preferred by many hip surgeons since it eases the access to the joint as the soft tissues will fall back.
- Free draping.
- Draping up to the lower ribs.

![Fig. 1 Instrument with spherical head to hold bone graft in place.](image)
Surgical Technique

Fig. 2 to 14

• Fig. 2 Longitudinal skin incision, 20 cm in length and centred over the greater trochanter (10 cm distal and 10 cm proximal to it).

• Fig. 3 Transgluteal approach to the hip joint according to Bauer et al. [2] and Hardinger [8]: division of the subcutaneous tissue and the fascia lata parallel to the skin incision, separation of the glutaeus medius and minimus in line with their fibres as well as of the vastus lateralis in its anterior third. Sharp detachment of the tendons of the glutaeal muscles and the vastus lateralis from the greater trochanter. Retraction of the soft tissues anteriorly and posteriorly with Hohmann retractor.

Fig. 4 Position of the Hohmann retractors in relation to the femoral vessels and to the joint capsule [3].

Fig. 5 T-like incision of the joint capsule, of which the anterior part will be resected. Neck osteotomy according to the pre-operative drawing. Extraction of the femoral head and division of the posterior joint capsule. Exposure of the original acetabulum with the help of femur retractor inserted posterior to the acetabulum. Additional insertion of three pointed Hohmann retractors, anterior, medial and lateral. In instances of high dislocation release of the iliopsoas and rectus femoris through a tenotomy [10].
Fig. 6  Splitting of the glutæus medius and minimus in line with their fibres in a cranial direction avoiding the superior glutæal nerve. Subperiosteal exposure of the ilium, pointed Hoehmann retractors help to retract the glutæal muscles. Gradual reaming of the primary acetabulum, first in a medial and then in a cranial direction until subchondral vessels start to bleed. A trial acetabulum component allows the visualization of the acetabulum and the determination of the extent of the lateral defect.

Fig. 7  With the help of the oscillating saw a 3 cm large, oval round bony disk will be removed from the resected femoral head. It is important that the outer cortex remains intact and that it is not weakened by subchondral bone cysts.

Fig. 8  A triangular cut will be made in the bone disk at its caudal aspect and rounded off. From the underside (spongiosa) a 0.5 cm large disk will be removed leaving an edge 0.5 cm large and 0.5 high (tongue). The tongue will be rounded off with a rongeur.

Fig. 9  A 0.5 cm large and 0.5 cm deep groove will be made in the cranio-lateral part of the dysplastic acetabulum using the Lexer chisel. The tongue of the bone graft should fit exactly into the groove. Decortication of the ilium at the site of contact to ensure a bleeding surface.
**Fig. 10** View of the acetabulum and the implanted component from anterior.

**Fig. 11** Reaming of the acetabulum and the bone graft until the acetabular component fits.

**Fig. 12** If a cementless implantation (Galante acetabulum II) is planned, press fitting of the component. Stabilization in rotation will be obtained by two to three spongiosa screws. If cement is used, the usual technique of insertion is performed. In both instances care should be taken to assure proper inclination and anteverision of the cup.

**Fig. 14** Insertion of deep suction drains. Drilling of two holes into the greater trochanter (2.7 mm, flexible drive shaft). Transosseous fixation of the anterior tendon-muscle layer while keeping the leg in internal rotation (internal rotation plaster according to Chandler and Pennenberg [4]). Wound closure in layers, subfascial suction drain. Compressive dressing. Radiographic control in the operating room.
Postoperative Management

Low dose heparin (heparin sodium) 5000 units three times daily subcutaneously for the prevention of thrombophlebitis.

Positioning of the leg on a foam splint in slight abduction-internal rotation.

Removal of drains on the second postoperative day.

Thereafter mobilisation of the patient with partial weight bearing (20 kg).

Isometric exercises of the operated limb.

Assisted active exercises in flexion/extension, abduction and internal rotation starting distally.

From the second week on strengthening of the gluteal muscles as well as the extensors against gravity in prone position.

After wound healing hydrotherapy is added as well as gait training.

Starting with the sixth postoperative week partial weight bearing is increased every week by 10 kg.

In order to avoid overloading of the bone graft, patients should sit in high chairs and use a raised toilet seat.

First radiographic control after 6 weeks.

Intra- and Post-Operative Complications

The opening up of cancellous bone surfaces of the pelvis can lead to increased bleeding intraoperatively. As in every total hip replacement we recommend the use of a cell saver, of autotransfusions and of plasmapheresis.

Pressure by retractors may stretch the superior gluteal and/or the femoral nerve. Neuapraxia may result with a temporary paralysis of the gluteal medius and minimus and/or the psoas as well as the quadriceps. Only in occasional instances will the muscle weakness persist.

An elongation of the limb may also cause a damage to the sciatic nerve with weakness of the foot extensors and flexors. In order to remove the tension from the soft tissues, particularly from the sciatic nerve secondary to the elongation we recommend positioning with the hip and knee at 30° of flexion.

In the presence of an early infection and depending on its spread we perform a generous revision and insertion of drains for continuous suction-irrigation. The components are left in place. Systemic administration of specific antibiotics.

In the presence of late infections a revision of the periarticular soft tissues and of the tissues surrounding the implants is indicated. This necessitates the removal of the components in most instances and occasionally of the bone graft (Girdlestone condition). Additional drains for suction-irrigation and specific antibiotics are necessary. At the earliest after 9 to 12 months and in the absence of clinical, laboratory and scintigraphic evidence of infection a replacement can be attempted as long as the bone stock is sufficient.

Postoperative ossification may cause limitation of motion of the operated hip. For prevention we use in elderly patients radiation (5 sittings, 2 Gy each) or we administer in younger patients (<60 years) non-steroidal antiinflammatories during the first 3 weeks [15].

In patients with high dislocations leg discrepancies may remain and will be corrected by shoe lifts.

Errors and Potential Hazards

If the bone graft is too small and too thin it may break during drilling: allogenic bone graft from the bone bank should be used.

Lack of interdigitation between transplant and acetabulum will not allow dissipation of shear forces acting on the bone graft: danger of bone graft resorption or fracture. Revision may become necessary.

Too early weight bearing: the bone graft will not consolidate, may even be resorbed. Loosening of the acetabular component may result and necessitate revision surgery.
Results

The femoral head – as a bone graft operation – in combination with a total hip replacement has been done 94 times for a dysplastic acetabulum between January 1980 and December 1991 (Figure 15).

87 hips (92%) were followed up at the earliest 6 months after the operation. The assessment was based on a completely documented clinical and radiological evaluation (Table 1).

The indication for our technique in association with a total hip replacement is a painful dysplasia with osteoarthritis.

In 7 patients the hip was subluxated pre-operatively or a high dislocation with a secondary painful osteoarthritis of the secondary acetabulum was present. Allogenic bone was used 5 times during an exchange of a loosened component (3 acetabuli, 2 hemiarthroplasties).

The pre-operative angle , used to measure the lateral coverage of the femoral head was less than 10° in 55 hips (63%).

66 cups and 49 femoral components were implanted without cement. In earlier years we performed our operation with cement (22 cups and 38 femoral components).

The assessment of our radiographs showed at the time of follow-up a bony consolidation in 84 patients (96%). The exchange of one acetabular component became necessary due to a complete resorption of the bone graft. Another bone transplant had undergone a partial resorption (8 mm) and had to be considered clinically and radiologically as being loose.

In addition 2 complete and 29 partial instances of resorption of the lateral part of the bone graft had to be attributed to insufficient compressive forces during the phase of consolidation.

They remained without influence on the secondary stability of the implant. Autogenous and allogenic bone grafts showed the same radiologic incidence of incorporation (Figure 16).

For the assessment of results we used the Merle-d'Aubigné score [13 ] (Figure 17). This score takes into account function and pain. 83 of the 87 followed

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**Table 1. Patient population.**

<table>
<thead>
<tr>
<th>Hips followed-up</th>
<th>87</th>
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<tr>
<td>Female/male ratio</td>
<td>55/32</td>
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<tr>
<td>Mean follow-up period</td>
<td>22 months (6 to 75 months)</td>
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<tr>
<td>Mean age at surgery</td>
<td>56 years</td>
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**Fig. 15** Bone grafts (1/1980 to 12/1991).

**Fig. 16** Resorption of bone grafts (n = 33).

**Fig. 17** Merle-d'Aubigné score.
up hips showed a good functional result as evidenced by a high score. Only 4 patients had to be classified as poor. This was due to a loosened acetabular component in 2 patients and due to a loosened femoral component in two other patients.

During the time of observation one acetabular and one femoral component had to be exchanged.

We saw the following perioperative complications in our 87 patients: 3 deep thrombophlebitis documented by a venogram; in 1 patient a long-lasting embolism occurred in addition.

One haematoma, apparent on the 5th postoperative day. It was revised under antibiotic coverage. Uneventful healing.

Two damages to the sciatic nerve, one after an elongation of 4 cm in a patient with remote hip dislocation, showed a partial recovery at the time of follow-up.

An avulsion of a trochanteric fragment occurred intraoperatively and was treated successfully by tension band wiring.

Periarticular ossification occurred 8 times, an incidence comparable to that of simple total hip replacement.

The modified biologic plasty of the lateral part of the acetabulum allows a primary stable anchorage of the acetabular cup in dysplastic acetabuli.

We expect similar results after a long-term observation given the high percentage of consolidation of the bone grafts (see also Figures 18 and 19).

References


Key Words
Total hip replacement • Congenital dysplasia of the hip • Congenital dislocation of the hip • Femoral head bone graft • Acetabular deficiency

Address all correspondence to:
Prof. Dr. W. Küswetter
Orthopädische Universitätsklinik
Hoppe-Seyler-Straße 3
D-72076 Tübingen
Germany

Comment

to the publication of W. Küswetter, C.-H. Hartwig:
The Use of the Resected Femoral Head as a Bone Graft during Total Hip Replacement

The reconstruction of the lateral wall of the acetabulum is often necessary in instances of severe osteoarthritis secondary to dysplasia. A well-established method employed during total hip replacement is the use of an autogenous corticocancellous bone graft removed from the femoral head. The special feature of the technique described by the authors is the exact fit as obtained by the tongue and groove principle which provides a perfect primary stability. It is interesting to note that none of the previously published papers insisted on the need for a sufficient stability for the bone graft and that most of the studies reported a complete and secure consolidation of the graft with the ilium.

When performing an augmentation plasty it is important to retain as much bone from the ilium as possible; this is not the case in the reported technique. I estimate that the groove reduces the coverage by 10 to 15%. The tendency to retain as much contact area of the ilium, particularly in cement-free implantations, is of greatest importance. The greater the load transmitted through the bone graft the greater the danger of graft failure with displacement and eventual loosening of the cup. Important for a good result for a total hip replacement in patients with dysplasia is the fact that physiologic and mechanic conditions are created placing the centre of the hip in its normal position; this can be obtained with this described
The technique of tongue and groove anchorage is a further refinement in the reconstruction of lateral acetabular defects. It attempts to remedy the shortcomings of currently used techniques.

Already in 1990 Mulroy and Harris [2] explained the unsatisfactory results of the Harris acetabuloplasty by the insufficient consolidation between host bone and transplant anterolaterally. They stated that a secure stabilization between the corticocancellous graft and host bone is an absolute prerequisite for a successful outcome. Other authors are also of the opinion that graft resorption accounts for the often reported poor late results.

Our technique addresses the problem of solid anchorage of the cortico-cancellous graft and the principle is based on a solid biologic foundation of bone healing. The coaptation allows an evenly distributed load sharing between graft and acetabulum for better consolidation. It is well known that resorption and subsidence are always the consequence of uneven load transmission.

There is no documented proof that 0.5 cm a deep groove in a dysplastic acetabulum sacrifices 10 to 15% of host bone. We remove only a thin layer of bone, enough to assure good seating of the graft. We fully agree that as much host bone as possible must be preserved.

A definite advantage of our technique for the reconstruction of the dysplastic acetabulum is the fact that no large metal acetabular cup is needed; we give preference to a biologic reconstruction. We were successful in reconstructing supero-lateral acetabular defects.
with allografts during revision surgery. We prefer, however, autologous bone as long as the resected femoral head is of good quality. The incorporation of the transplant largely depends on vessel ingrowth from the host bone which necessitates fitting of the graft into a bleeding, accurately fashioned bed and fixation using the tongue and groove principle.

In summary we are in full agreement with Morscher who as recently as 1993 stated: "... for hip dysplasia we consider the combined of cementless cup and solid autologous graft as the procedure of choice. And we continue to use it, since there is not an alternative method with comparable results" [1].

References


Author:
Prof. Dr. W. Küsswetter
Orthopädische Universitätsklinik und Poliklinik
Hoppe-Seyler-Straße 3
D-72076 Tübingen
Germany