Overview of different Bionik System components

- Metal Head Silver "BS"
- Metal Head Biosurf Silver "BS"
- Femoral Head Shell, cem. Biosurf Silver "BS"
- Hip Surf.Repl., cem. Biosurf Silver "BS"
- Hip Surf.Repl., cem. Silver "BS"

- Nail "BS"
- Profi "BS"
Confirmation

- Your application has been submitted for the Scientific Program of the Annual Meeting of the AAOS 2009.
- **Your Application Number:** 2969
- Notification of acceptance or rejection and all future correspondence will be mailed to the presenter from the Academy office by the end of August 2008.
- All presenters and co-authors will be emailed in August 2008 as to the status of this application. Please make sure all co-authors' email addresses are valid.
- To eliminate duplication of this abstract and possible disqualification, do not mail a hard copy of this abstract to the AAOS office.
- An option to modify your abstract is available at Revise Poster/Podium Submission. Enter your application number above and your last name to access this abstract.
- Below is the information you submitted. Please print this page for your records.

Type of Presentation: Podium

First Abstract Category: Hip/Knee

Second Abstract Category: Sports Medicine/Arthroscopy

Third Abstract Category: Rehabilitation Medicine

Has this information been presented or published at the national level? No

1. Was there an intervention or interaction with a living person that would not have occurred or would have occurred in some other fashion if not for this research? Yes
2. Was identifiable private information/data obtained for this research in a form associable with an individual? Yes
3. Does this research involve existing data or specimens that are publicly available? No
4. Was this research approved by an Institutional Review Board (IRB) or Ethics Committee? Yes
5. Number of subjects 208
6. Type of Investigation Prospective
7. Randomization non Randomized
8. Control Group Yes

FDA Status: NOT Approved

Title:
The onlay hip resurfacing – a controlled prospective study – mid term results

**Presenter/Corresponding Author:**
Gerdesmeyer Ludger

**Address:**
Office
Mare Clinic, Department of Orthopedic Surgery and Sportstraumatology, Kiel,
Eckernförder Strasse 219, 24119 Kiel

**Degree:**
M.D.
City, State, Zip, Country:
Kiel 24119, Germany

AAOS ID No.: Phone: FAX:

E-Mail Address:

Is this a new mailing address: Yes

Author 1:
Address:
Office
Department of Orthopedic Surgery and Sportstrauumatology, Technical Uni
Ismaninger Strasse 22

City, State, Zip, Country:
Munich 81675 Germany

AAOS ID No.: Phone: FAX:

E-Mail Address:

Is this a new mailing address: No

Author 2:
Address:
Office
IDV Data Analysis & Study Planning, Wessobrunner Str. 6, 82131 Gauting

City, State, Zip, Country:
Gauting 82131 Germany

AAOS ID No.: Phone: FAX:

E-Mail Address:

Is this a new mailing address: No

Author 3:
Address:
Office
Department of Orthopedic Surgery and Sportstrauumatology, Technical Uni
Ismaninger Strasse 22

City, State, Zip, Country:
Munich 81675 Germany

Degree: M.D.
104 patient with primary osteoarthritis underwent hip onlay resurfacing. Men aged 51 yr, BMI 27.2. An onlay resurfacing system was used for resurfacing with a cemented femoral and a modular cementless acetabular component was used. The control group (n:104) got a standard cementless THA. All procedures were performed by one surgeon, minimal invasive antero lateral approach was used, same post Op treatment in both groups

Results:

In the Onlay Resurfacing group the HHS improved 6 weeks, 6 month and 3 years after surgery from 46 to 89, to 98 and 98 after 3 years. Compared to resurfacing the THA improved
from 42 to 85, to 92 and 93 after 3 years. At 6 month and 3 years the SF12 score (mental and physical) improved to normal in both groups. One neck fracture occurred in the Onlay resurfacing group, one DVT an 1 dislocation in the standard group. No implant failure in both groups. Blood loss was significant less after Onlay Resurfacing.

Discussion and Conclusion:

Hip onlay resurfacing preserves maximal bone stock and provides excellent functional outcome. The outcome was better in the Onlay resurfacing group compared to standard THA. Combined with minimal invasive surgery patients will be able to shorten the rehab phase significantly. Side effects as luxation, instability, length differences were expected to appear less frequently.
Dorsaler Zugang zur Osteosynthese posteromederer Tibiapfaffrakturen

oben beschriebenen erweiterten dorsalen Zugang stabilisiert, oder wir verwendeten zusätzlich zur dorsalen medizinischen Inzision einen separaten posterolateralen Zugang.

In unserem Patientenkollektiv trat postoperativ eine tiefe Beckenvenenthrombose auf, welche zunächst mit Heparin therapiert wurde. Nach 14 Tagen wurde auf eine orale Marcumar-Medikation umgestellt.

Literatur

The Minimally Invasive Anterolateral Approach Combined with Hip Onlay Resurfacing

Ludger Gerdesmeyer1,2, Hans Gollwitzer2, Peter Diehl3, Björn Buttgereit4, Maximilian Rudert1

Abstract
Objective
Minimally invasive anterolateral approach in hip resurfacing with complete preservation of muscular integrity.

Indications
Primary or secondary osteoarthritis of the hip.

Contraindications
Approach:
- None.
Onlay Implant:
- Females > 55 years with osteoporosis.
- Males > 60 years with osteoporosis.
- Severe varus deformity (CCD [collodiaphyseal] angle < 100°).
- History of metal allergy.
- Clinically relevant renal insufficiency.
- Radiologic appearance of avascular necrosis stage 3 and 4 according to Ficat.
- Femoral head cysts > 1 cm in diameter.

Surgical Technique
Supine position with possible overextension of the hip, longitudinal incision along the intermuscular septum and blunt intermuscular dissection between gluteus medius and tensor fasciae latae, partial resection of the anterior capsule and anterior dislocation of the hip with complete proximal release of the capsule. Dislocation of the femoral head and dorsal positioning, reaming of the acetabulum to implant the cementless acetabular component, exposition and reaming of the femoral head in extension/adduction and external rotation, implantation of the cement onlay endoprosthesis.

Postoperative Management
Prophylaxis of thromboembolism and periarticular ossification. Rehabilitation with weight bearing as tolerated starting on the day of surgery, ergometer training from day 4 after surgery.

Results
31 patients with osteoarthritis underwent onlay resurfacing via a minimally invasive approach. The Harris Hip Score improved from 43.9 to 97.1 at 12 months after surgery. Adverse events such as fracture, dislocation, nerve or muscle lesions did not occur, and clinically significant thromboembolism or infection was not observed.

Key Words
Minimally invasive · Hip · Approach · Onlay · Prosthesis · Osteoarthritis · Resurfacing
Der minimalinvasive anterolaterale Zugang zur Implantation einer Hüftoberflächenprothese

Zusammenfassung
Operationsziel
Implantation einer Hüftonlay-Femurkappenendoprothese über einen minimalinvasiven anterolateralen Zugang mit komplettem Erhalt der muskulären Integrität.

Indikationen
Primäre und sekundäre Koxarthrose.

Kontraindikationen
Zugang:
- Keine.
Onlay-Femurkappenendoprothese:
- Frauen > 55 Jahre mit Osteoporose.
- Männer > 60 Jahre mit Osteoporose.
- Schwere Coxa vara (CCD-Winkel < 100°).
- Metallallergie.
- Klinisch relevante Niereninsuffizienz.
- Hüftkopfnekrose Stadium 3 und 4 nach Ficat.
- Femurkopfzysten > 1 cm im Durchmesser.

Operationstechnik
Rückenlagerung mit der Möglichkeit, durch Aufklappen des Operationstischs das Hüftgelenk zu extendieren, gerader Hautschnitt entlang dem Septum intermusculare und stumpfe digitale Präparation der Muskellücke zwischen Musculus gluteus medius und Musculus tensor fasciae la-
tae, partielle Resektion der vorderen Gelenkkapsel, Luxation des Femurkopfes nach ventral und komplettes Kapselrelease am Azetabulum. Luxation des Kopfes in die dorsale Luxationsstellung, Fräsen des Azetabulums für die zementlose Implantation der modularen azetabulären Komponente t.e. In Extension/Adduktion und Außenrotation Darstellung des Femurkopfes und Formfräsen des Kopfes, Implantation der zementierten femoralen Komponenten.

Weiterbehandlung

Ergebnisse

Schlüsselwörter
Minimalinvasiv · Hüfte · Zugang · Onlay · Prothese · Arthrose · Oberflächenersatz

Introductory Remarks
Resurfacing in total hip arthroplasty experiences a revival in modern orthopedics and becomes more and more popular. The concept itself has first been established in the 1980s [7]. Wagner described a bone-preserving technique already in the mid 1970s, which is still well known as the Wagner cup arthroplasty [8]. The approach was excellent, but poor tribological properties and failures of the polyethylene (PE) used as monoblock acetabular component resulted in a high early failure rate. Furthermore, small cement particles were generated due to significant deformation of the very thin PE acetabular components during weight bearing, and these cement particles initiated third body wear and consecutive failure [3, 4]. Improved technical knowledge and usage of advanced materials with better tribological properties have significantly increased survival rates and initiated a revival of hip resurfacing. All current implants used for resurfacing commonly require substantial bone resection at the femoral head, with loss of subchondral sclerotic bone [1, 2, 7]. Resection of subchondral bone – which shows the best biomechanical properties – is contradictory to the original concept of resurfacing. By contrast, the onlay resurfacing technique avoids bone resection, enables improved biomechanical properties, more anatomic relations of the femoral head, and an improved head/neck ratio. With the Biosurf surface topography of the femoral implant, a significant reduction of wear and metal debris can be achieved as well. High modularity of the component guarantees better options in the case of revision. However, complete preservation of the femoral head is automatically followed by a minimized intraoperative site. An appropriate surgical approach is therefore mandatory. By using guidance systems such as Kirschner wir or templates, the approach has to be increased in size. Therefore, the dorsal approach has been used most frequently, which is associated with a high risk of avascular

Oper Orthop Traumatol 2009 · Nr. 1 © URBAN & VOGEL
necrosis as a result of cutting the perfusing vessels of the medial femoral circumflex artery [1, 7]. On the other hand, if the standard anterolateral approach, first described by Watson Jones, is used, the preserved femoral head prevents adequate exposure and preparation of the acetabulum and correct insertion of the acetabular component [5]. Suboptimal placement is often due to increased anteversion and inclination, leading to a significant increase of metal wear [6]. To prevent these approach-related side effects, we have developed a modified anterolateral approach to be described in this study. This new approach is characterized by excellent exposure of femoral head and acetabulum, prevention of avascular necrosis caused by vessel damages and complete preservation of bone and muscle, which makes fast-track rehabilitation feasible.

Surgical Principles and Objective
Resurfacing of the femoral head by using a modified anterolateral approach with minimally invasive surgical technique. Excellent exposure of the acetabulum and femoral head with complete preservation of surrounding muscles. Resurfacing without bone resection, but with reconstruction of the individual anatomic structures and relations.

Advantages
- Surgery is possible in supine position.
- Excellent exposure of the acetabulum and femoral head.
- No guidance system (Kirschner wire, navigation, X-ray) required.
- Protection and preservation of muscle insertions to the femur.
- Preservation of the anatomic head/neck ratio.
- Extension of surgical approach easy to perform.
- Preservation of the individual anatomy.

Disadvantages
- Extensive soft-tissue preparation.
- High learning curve compared to standard approach.
- No long-term follow-up data.
- Extended duration of surgery.
- Technically demanding in muscular patients.

Indications
- Primary and secondary osteoarthritis of the hip.

Contraindications
Modified Approach
- Obesity 3° according to the WHO classification.
- Previous surgery via anterolateral approach.

Onlay Resurfacing
- Females > 55 years with osteoporosis proven by bone mass measurement.
- Males > 60 years with osteoporosis proven by bone mass measurement.
- Severe varus deformity (CCD [collodiaphyseal] angle < 100°).
- Severe coxa vara epiphysaria so that roundness cannot be restored by reaming the head and the femoral component is seated without full bony contact.
- History of metal allergy.
- Clinically relevant renal insufficiency because of increased metal ion concentration due to wear.
- Avascular necrosis of the femoral head stage 3 and 4 (Ficat).
- Femoral cyst > 1 cm in diameter.

Patient Information
- General surgical risks, e.g., thromboembolism, infection, bleeding, delayed/complicated wound healing, dislocation, nerve lesions.
- Loosening of the implants.
- Implant without long-term follow-up data.
- Ectopic ossifications.
- Intraoperative change of the surgical strategy to another implant, if indicated.
- Metal wear.
- Induction of metal allergy possible.
- Fracture of femoral neck.
- Painful hematoma.

Preoperative Work Up
- Physiotherapy to improve range of motion and reduce contracture which facilitates the surgical procedure.
- Physical exercising.
- Reduction of weight.
- X-ray: anteroposterior and lateral according to Lauenstein.
- Presurgical peripheral catheter nerve block.
- Perioperative antibiotic prophylaxis with second- or third-generation cephalosporin i.v., single dose; in case of surgery duration > 2 h, second application of antibiotics is recommended.
Surgical Instruments and Implants

- Standard instruments for hip replacement.
- Specific instruments and implants for onlay hip resurfacing (ESKA Implants, Grapengießerstraße 34, 23556 Lübeck, Germany).
- Specific retractor set (MIOS, provided by Aesculap, Am-Aesculap-Platz, 78532 Tuttlingen, Germany) used for minimally invasive procedures in total hip arthroplasty with smooth and broad design, and curvatures from 30° to 90° to protect muscles.
- Minimized acetabular reaming system (optional).
- Jet-lavage system.
- Largely curved insertion instrument, minimally invasive socket impactor (ESKA Implants).

Anesthesia and Positioning

- Combination of general anesthesia with femoral nerve block is recommended.
- Patient-controlled analgesia [9].
- Supine position on operating table allowing 30° hip extension by bending the operating table.
- Contralateral stabilization of the patient with operating table fixation tools.
- Fixation of the contralateral leg.
- Disinfection and draping of the leg allowing full range of motion.

Surgical Technique

Figures 1 to 21

Figure 1
Patient placed in supine position allowing to hyperextend the hip up to 30° on the operating table. 10 cm skin incision between the tip of the greater trochanter and the anterior superior iliac spine, just above the intermuscular septum between the gluteus medius and the tensor fasciae latae.

Figure 2
Incision of the fascia within the anterior aspect of the iliobibial band.

Figure 3
Dorsal retraction of the gluteus medius and gluteus minimus by a 60° curved Hohmann retractor. A blunt and broad retractor is placed medially of the femoral neck to retract the tensor fasciae latae anteriorly. A 90° retractor is placed close to the anterior rim of the acetabulum providing good exposure of the capsule.

Figure 4
Incision of the capsule is performed in longitudinal direction of the femoral neck. Another incision is placed perpendicular along the anterior rim of the acetabulum to release the capsule as much as possible. Complete capsulotomy is essential for adequate exposure and to continue resurfacing.

Figure 5
The gluteus medius and gluteus minimus are gently released from the lateral aspect of the pelvis. Abduction facilitates the detachment to create a dorsal muscular pouch for dislocation of the femoral head from anterior dislocation position to dorsal. This important step should be done digitally and gently to avoid muscle lesions.
Figures 6a and 6b
Dislocation of the femoral head to an anterior position is achieved by adduction and external rotation (a). Resection of surrounding osteophytes is required, if luxation is not possible (b).

Figure 7
The transfer of the femoral head between gluteus medius, gluteus minimus and the ilium from anterior to the dorsal dislocation position has to be done very gently by flexion and simultaneous rotations until the final dorsal dislocation position is reached. Then, the release of the capsule has to be completed to provide better mobilization of the femoral head. The release should be done very close to acetabular bone, completing a circumferential capsular release of 360°. If release is done within a wider distance to the bone, bleeding can occur.

Figures 8a and 8b
After capsular release has been finished, the femoral head is dislocated into the dorsal muscular pouch (a) allowing excellent exposure of the acetabulum (b).
After complete exposure of the acetabulum has been achieved, reaming is started with the smallest size until the teardrop position is reached. Further reaming is done with size increasing in 2-mm steps until the size of the smallest possible implant is reached. The first reaming phase of the acetabulum ends with this step.

Repositioning of the femoral head into anterior dislocation by gentle abduction and external rotation. Extension of the hip is achieved; if the operation table is bent up to 30°, exposure of the head is much easier now due to relaxation of the gluteus medius and gluteus minimus in this position. Two 30° retractors are placed around the neck for complete exposure of the femoral head.

The reamer that fits the femoral head loosely has to be chosen first to start reaming until the osteophytes are removed and the head appears round. After all osteophytes have been removed and the head is rounded, the next smaller reamer should be used to start final head reaming by 2-mm steps until all cartilage is removed. The last measured reamer corresponds to the largest size that can be implanted. Weakening of the subchondral bone stock occurs after extended or asymmetric reaming of the femoral head. If the femoral reamer is used in very close bone contact and reaming load is light, the subchondral bone is kept in excellent and unaffected condition.
Figure 12
A trial implant is placed on the femoral head in press-fit technique to verify the reaming size. The trial implant is left in place while the femoral head is transferred back to the dorsal dislocation position for final reaming of the acetabulum.

Figure 13
The second reaming phase starts with the reamer used before until the correct acetabular size is reamed (6 mm larger in diameter than the femur). The correct size is determined by the femoral size (femoral head reamer + 6 mm = correct acetabular reamer).
At the end of acetabular reaming, the subchondral cancellous structure is reached and subchondral sclerosis is opened to allow osseous integration of the implant.
If the acetabulum was overreamed while femoral head was decreased in size, a mismatch of the components could result because a specific femoral component needs to fit a specific corresponding socket and inlay. To avoid mismatch, we recommend to start reaming of the acetabulum first until the smallest socket which could be implanted is determined, followed by reaming of the femoral head to the largest size that fits the head. Then, the surgeon can easily continue reaming the acetabulum to the appropriated size.

Figure 14
The acetabular implant is fixed on the curved impactor. Acetabular implant size = femoral implant size + 8 mm. The acetabulum has to be underreamed with the implant being oversized by 2 mm compared to the final acetabular reamer (socket size = femoral size + 8 mm). Malpositioning of the implants occurs, if exposition of the acetabulum is not completed. Large soft-tissue layers prevent exact positioning of the socket. Inadequate position commonly appears as increased inclination or anteversion or even both. A complete release of the capsule decreases the risk of malpositioning. Specific navigation systems could be an option to reduce the malpositioning risk.
Figures 15a and 15b
A disposable PE inserter has to be used to impact the acetabular implant (a) until correct positioning and depth of the socket are achieved (b). Eccentric impact leads to nonvisible deformities that induce peak load and increased debris rate and, thus, has to be avoided. If the final acetabular implant is seated (b) and correction of the implant is needed, an asymmetric impaction on the rim of the socket is not allowed. If any correction is needed, the socket-inserting instrument has to be used. Asymmetric impaction leads to a relevant deformation of the implant and the cone junction between inlay and socket is not possible anymore. If the inlay has been inserted in a deformed socket, the fixation of the inlay is no longer cone-based. Therefore, the specific impactor tools have to be used.

Figure 16
The insert should be inserted manually to avoid tilting followed by impacting the insert with the single-use PE impactor. Tilting of the insert must be avoided to guarantee an easy removal of the insert in case of revision.

Figure 17
Repositioning of the femoral head into anterior dislocation for final reaming. To finalize reaming, the soft reamer is recommended. The size is determined by the acetabular implant (size of acetabular implant - 8 mm = reamer size to finalize the head).

Figure 18
The trial implant is placed again in anatomically correct position guided by the individual neck-head junction. Then, the guiding hole is drilled and widened to facilitate and guarantee fast and reproducible implantation of the femoral component.

Figure 19
Jet lavage of the femoral head and preparation of the low-viscosity bone cement (Heraeus LV cement, Philipp-Reis-Straße 8/13, 61273 Wehrheim/Taunus, Germany). The cup has to be filled until 2 mm of the guiding pin are still visible. When the cement starts to be pasty, the onlay implant has to be placed on the femoral head.

Figures 20a and 20b
The implant has to be seated with permanent pressure and gentle hammer impaction (a), cleaning of the head, jet lavage, and repositioning followed by examination of the range of motion (b). Femoroacetabular impingement must be avoided. Check for impingement by flexion and internal rotation of the hip. Femoroacetabular impingement is caused by osteophytes, located at the anterior aspect of the head-neck junction or the corresponding aspect of the acetabulum. If the osteophytes are removed, recheck for impingement before wound closure.
Postoperative Management

- Continuous passive motion starts on the 1st day after surgery and is continued until full range of motion is achieved and soft-tissue swelling has disappeared marking the start of the outpatient phase.
- Nonsteroidal anti-inflammatory drugs and metamizole as basic analgesics.
- Vital parameters observed continuously on the day of surgery.
- Mobilization with two crutches from the day of surgery with weight bearing as tolerated, increase of weight bearing up to full weight bearing as tolerated.
- We remove the drain on day 2 after surgery.
- Prophylaxis of thromboembolism until full weight bearing is achieved.
- Initiation of early rehabilitation on day 4 after surgery with 3 x 15 min of cycling on an ergometer (maximum 50 W, 80 rpm).
- Suture removal 12 days after surgery.

Errors, Hazards, Complications

- Bony defects of the acetabulum can occur, if reaming is not performed precisely in the central part of the acetabulum. Primary instability of the components results, if bony integrity of the acetabulum is lost: additional screw fixation is recommended.
- Transient disturbance of the femoral nerve, if retractors are placed at the anterior aspect of the acetabular rim: the retractors should be placed with bony contact to the anterior acetabulum.
- Lesions of small vessels of the gluteal region cause minor hematoma because the femoral head has to pass the interval between the dorsolateral aspect of the acetabulum and the gluteal muscles. These minor bleedings are difficult to coagulate because of the minimally invasive approach: the resulting hematomas is clinically of no relevance and resorbed spontaneously without any specific treatment. If preparation and luxation of the femoral head are done gently, bleeding risk can be reduced.
- Mismatch of the components, if the acetabulum was overreamed while femoral head was decreased in size: start reaming of the acetabulum first until the smallest socket which could be implanted is determined, followed by reaming of the femoral head to the largest size that fits the head. The femoral size determines the size of the socket. If both components cannot be adapted, the onlay procedure cannot be performed and surgery has to be changed to a standard resurfacing.
- Femoroacetabular impingement: resection of the osteophytes located at the anterior aspect of the head-neck junction or the corresponding aspect of the acetabulum.
- Neck fracture after surgery; resurfacing implants are associated with neck fractures known as peripros-
Howie OW, Gerdesmeyer L, et al. Minimally Invasive Anterolateral Approach In Hip Resurfacing

From December 2005 to June 2006, 31 patients (19 males, twelve females; mean age at the time of surgery was 66 years [29–66 years]; mean body mass index 29.2 kg/m² [26.9–30.3 kg/m²]) underwent hip onlay resurfacing via a minimally invasive anterolateral approach using the ESKA onlay implant in all cases. 17 operations were performed on the right and 14 on the left side. Resurfacing was indicated because of primary or secondary osteoarthritis of the hip. Patients with ongoing osteoporosis were excluded. The primary outcome criterion was defined as a change at follow-up compared to baseline in regard of the Harris hip scoring system 12 months after surgery. The change in pain perception measured on a 10-scale visual analog rating system (VAS), the percentage of fractures and loosening were used as secondary criteria. 18 out of the 31 patients suffered from primary and 13 from secondary osteoarthritis (eight cases of dysplasia, three cases of posttraumatic osteoarthritis, and two cases of systemic rheumatoid arthritis). Mean duration of surgery was 81 min (54–145 min). Operating time was significantly longer (up to 145 min) in the first ten cases; mean blood loss was measured at 280 cm³ (140–510 cm³). Cell saving was performed in all cases. Autologous blood sampling was not required prior to surgery. To prevent heterotopic ossification, ibuprofen 600 mg was administered three times a day over a period of 10 days and standard thromboembolism prophylaxis was done until full weight bearing was achieved. Patients stayed in hospital for a mean of 7 (± 3) days, followed by 3 weeks of rehabilitation. Rehabilitation consisted of pain-adapted weight bearing within the full range of motion and ergometer training at a load of up to 50 W and a frequency of 80 rpm. Cycling was allowed from postoperative day 4, if no secretion was noted. The ergometer training done three times a day to a total of 45 min and hi accepted by the patients.

12 months after resurfacing, functional outcome was excellent. The Harris Hip Score improved to 97.1 points at baseline and subjective sensation was scored at 0.6 points on the VAS compared to 8.5 points at baseline. Severe side effects such as fracture or musculoskeletal lesions, thromboembolism, infection and approach-related side effects like del wound healing, limping or muscle insufficiency were observed. Two patients showed relevant herniectomy load-related pain while cycling and walking without need for revision or another specific treatment followed spontaneous resorption.

Implant-related adverse events such as loosening, lengthening or dislocation were not found. All X-ray examinations 3, 6, and 12 months after surgery showed change regarding positioning and loosening. Neith anterior dysfunction nor metal-related allergic reactions were seen within 12 months after surgery.

Results
From December 2005 to June 2006, 31 patients (19 males, twelve females; mean age at the time of surgery was 66 years [29–66 years]; mean body mass index 29.2 kg/m² [26.9–30.3 kg/m²]) underwent hip onlay resurfacing via a minimally invasive anterolateral approach using the ESKA onlay implant in all cases. 17 operations were performed on the right and 14 on the left side. Resurfacing was indicated because of primary or secondary osteoarthritis of the hip. Patients with ongoing osteoporosis were excluded. The primary outcome criterion was defined as a change at follow-up compared to baseline in regard of the Harris hip scoring system 12 months after surgery. The change in pain perception measured on a 10-scale visual analog rating system (VAS), the percentage of fractures and loosening were used as secondary criteria. 18 out of the 31 patients suffered from primary and 13 from secondary osteoarthritis (eight cases of dysplasia, three cases of posttraumatic osteoarthritis, and two cases of systemic rheumatoid arthritis). Mean duration of surgery was 81 min (54–145 min). Operating time was significantly longer (up to 145 min) in the first ten cases; mean blood loss was measured at 280 cm³ (140–510 cm³). Cell saving was performed in all cases. Autologous blood sampling was not required prior to surgery. To prevent heterotopic ossification, ibuprofen 600 mg was administered three times a day over a period of 10 days and standard thromboembolism prophylaxis was done until full weight bearing was achieved. Patients stayed in hospital for a mean of 7 (± 3) days, followed by 3 weeks of rehabilitation. Rehabilitation consisted of pain-adapted weight bearing within the full range of motion and ergometer training at a load of up to 50 W and a frequency of 80 rpm. Cycling was allowed from postoperative day 4, if no secretion was noted. The ergometer training done three times a day to a total of 45 min and accepted by the patients.

12 months after resurfacing, functional outcome was excellent. The Harris Hip Score improved to 97.1 points at baseline and subjective sensation was scored at 0.6 points on the VAS compared to 8.5 points at baseline. Severe side effects such as fracture or musculoskeletal lesions, thromboembolism, infection and approach-related side effects like del wound healing, limping or muscle insufficiency were observed. Two patients showed relevant herniectomy load-related pain while cycling and walking without need for revision or another specific treatment followed spontaneous resorption.

Implant-related adverse events such as loosening, lengthening or dislocation were not found. All X-ray examinations 3, 6, and 12 months after surgery showed change regarding positioning and loosening. Neither anterior dysfunction nor metal-related allergic reactions were seen within 12 months after surgery.

References

Address for Correspondence
PD Dr. Ludger Gerdesmeyer
Department Endoprothetik und Wirbelsäulenchirurgie
Marienkleinklinik
Ernst-Abbe-Straße 219
24119 Kiel-Kronshagen
Germany
Phone (+49/431) 667-4731, Fax -4713
e-mail: Gerdesmeyer@aol.com
Osteoporose erkennen – Frakturen vermeiden

Wolfgang Pollähne, Michael Pfeifer, Helmut W. Münte

Osteoporose: Fehlermöglichkeiten bei der bildgebenden Diagnostik und Therapieempfehlungen
12 Seiten Broschur
€ 37,95 / sFr. 57,50

Ja, hiermit bestelle ich ______ Exemplar(e) des Titels
Wolfgang Pollähne, Michael Pfeifer, Helmut W. Münte

Osteoporose
€ 37,95 (zzgl. € 3,50 Versand im Inland); sFr. 57,50
ISBN 978-3-89935-188-0

Coupon bitte ausschneiden und an Ihren Buchhändler senden oder an Urban & Vogel, c/o Springer Customer Service Center, Haberstr. 7, 69126 Heidelberg, oder per Fax an 06221/345-4229, oder per E-Mail: Leserservice@springer.com

keine Knochenresektion
optimale Gleitfähigkeit
dermodulares System

Femurkopfschale ONLAY®

Wie schützt man Knochen? Mit einem patenten Vorteil!

Ein spezielles Implantat, das von der gesamten Knochenoberfläche der Femurkopfschale ONLAY® der firmeninhaber EMKA entwickelt wurde, ermöglicht es, das Knochenwachstum zu fördern ohne die Knochensubstanz zu beeinträchtigen. Einem erheblichen Vorteil kommt der neue ONLAY®-Femurkopfschale, der es ermöglicht, die natürliche Osteogenese der Knochen zu unterstützen.

Für den Patienten bedeutet das, dass die Femurkopfschale ONLAY® eine optimale funktionelle und ästhetische Lösung für die Behandlung von Frakturen bietet. Die ONLAY®-Kopfschale trägt dazu bei, die Bewegungsfähigkeit des Körpers zu erhalten und somit die Lebensqualität der Patienten zu verbessern.

Wir bitten Sie, diese Information zu beachten, und wünschen Ihnen eine gesunde Osteoporoseverhütung und ein sicheres Leben!

Knochenprophylaxe

Urban & Vogel
Ateneo und Medicine Verlagstätigkeit

Historische Entwicklung


Aktueller Stand der Entwicklung


Die Verwendung von großen Komponenten senken dennoch die Luxationsneigung des Gelenks deutlich. Auch soll die Verwendung von großen Komponenten eher zu einer Kinematik führen, die dem gesunden Hüftgelenk vergleichbar ist. Die Autoren der Studie befürchten, dass größere Durchmesser der Komponenten auch zu einem größeren Bewegungsausmaß führen kann, was jedoch nicht korrekt ist. Das Bewegungsausmaß ist entscheidend von dem im Verhältnis zwischen Femurkopf- und Halsdurchmesser geprägt [3]. Die großen femoralen Komponenten senken dennoch die Luxationsneigung des Gelenks deutlich. Auch soll die Verwendung von großen Komponenten eher zu einer Kinematik führen, die dem gesunden Hüftgelenk vergleichbar ist. Die Autoren der Studie befürchten, dass größere Durchmesser der Komponenten auch zu einem größeren Bewegungsausmaß führen kann, was jedoch nicht korrekt ist. Das Bewegungsausmaß ist entscheidend von dem im Verhältnis zwischen Femurkopf- und Halsdurchmesser geprägt [3].

Um die Schmierung der Komponenten durch einen Flüssigkeitsfilm zu erhöhen, sind große Komponenten mit mög-
Je größer die femorale Komponente, umso größer wird der Knochenverlust bei der Implantation der passenden Pfanne. Dieser Sachverhalt erscheint logisch. Er trifft v. a. im Vergleich zur konventionellen totalen Hüftendoprothetik zu [16].


Femoralseitig spielen der Zugang zum Hüftgelenk, die Drehung des Hüftkopfes respektive Platzierung der Komponente und die Verankerung eine besondere Rolle. Für die Durchblutung des Hüftkopfes ist der Zugang zur halsfraktur und ein femorozetabuläres Impingement erweisen sich als mögliche Frühkomplikationen. Die Implantation dieser Systeme ist technisch anspruchsvoll und erfordert ein hohes Maß an Erfahrung vom Operateur. Eine zugängliche Traumatisierung der Muskulatur und der Haut zuverlässig vorzubeugen, stellt die im Primären die Voraussetzung für den langfristigen Erfolg der konventionellen totalen Hüftendoprothetik dar. Der Implantationspunkt der Kugeln soll für die Traumatisierung der Muskulatur und der Haut zuverlässig vorzubeugen, stellt die im Primären die Voraussetzung für den langfristigen Erfolg der konventionellen Hüftendoprothetik dar.

Zusammenfassung
Der Oberflächenersatz am Hüftgelenk

© Springer Medizin Verlag 2007
M. Rudert, L. Gerdesmeyer, H. Reck, P. Juhnke, R. Gredinger

Resurfacing arthroplasty of the hip

Abstract
Resurfacing arthroplasty is regarded as an attractive method, especially for the young patient who needs a hip replacement. However, the high expectations regarding this new technique in THA must first be met. Earlier experiences with similar forms of surface replacement have led to high revision rates with early subsidence. Induced component loosening and neck fractures. Technical progress in production techniques for metal-on-metal articulations with minimized wear have enabled the introduction of new surface replacements for the hip joint. Long-term results of these resurfacing arthroplasties are still unknown. Femoral neck fractures and femoral acetabular impingement are possible early complications which require revision. The implantation of these systems requires a high degree of operative skill and experience on the part of the surgeon. Also dependent on the stress trauma to the musculature and endangering the blood supply to the femoral head is balanced with the positive effect of the preservation of femoral bone stock and better options in case of revision. Whether the younger patient with a higher activity profile and an increased chance of implant loosening actually profits from the resurfacing arthroplasty will be determined in the future.

Keywords
Hip arthritis · Endoprosthesis · Resurfacing arthroplasty · Metal-on-metal bearing


Abb. 4 a Hüftkopf, bei dem lediglich die Knorpeloberfläche bis auf die Kortikalis entfernt wurde, um eine möglichst physiologische Kraftleitungsverbindung zu einer zementierten Kappe zu erreichen. b Röntgenbild eines rechten Hüftgelenkimplantats mit zementfreier Verankerung in der unter Abb. 4a beschriebenen Technik. Die Pfanne ist zementfrei verankert, die Kappe mit einem niedrigviskösen Zement fixiert (Onlay-Femurkopfschale)

Abb. 5 Konventioneller Oberflächenersatz in zementfreier Verankerungstechnik im Röntgenbild
Ergebnisse


Schlussfolgerungen


Die neuen Generationen des Metall-Metall-Gleitpaarungs mit großen

| Tab. 1 Vor- und Nachteile des Oberflächenersatzes am Hüftgelenk |
|-----------------|-----------------|
| Vorteile | Nachteile |
| Knochenanliegende Technik am Femur | Leicht erhöhte Knochenverlust am Azetabulum |
| Geringe Luxationsgefahr | Gefahr der Schenkelhalsfraktur |
| Bessere Revisionsmöglichkeit am Femur | Fehlende Langzeitergebnisse und Erfahrungen |
| Gleitversatz auch bei exsudativen oder diagnostisch Deformitäten des Femurs möglich | Metallbruch und Materialien im Organismus |
| Seltene Beifallgradienten | Keine Rekonstruktion des Offsets |
Durchmesser weisen äußerst gute Ver- schleißegenschaften auf. Diese Ver- schleißegenschaften kommen aber nur dann zum Tragen, wenn die Komponen- ten optimal implantiert wurden und keine Randbelastungen auftreten, was den Ver- schleiß um das bis zu 50fache erhöhen kann [21]. Je größer der Kopfdurchmesser wird, desto größer wird jedoch auch die Pfannendurchmesser [16], was wiederum dem Ziel eines möglichst knochenspa- renden Eingriffs entgegensteht. Ist eine Revision aufgrund des Versagens auf der femoralen Seite notwendig, wird die Pfan- ne gerade bei großen Dimensionen natür- lich nicht gewechselt werden. Die meisten Systeme zum Oberflächenersatz am Hüftgelenk weisen eine Monoblockpfanne auf, deren Oberfläche z. B. aufgrund eines er- höhten Verschleißes nicht ausgetauscht werden kann. In Simulatorenversuchen hat sich dies zwar als wenig problematisch erwiesen [12], es soll aber zu einer Erhöhung der Lonenkonzentration kommen, die indirekt auf einen erhöhten Abrieb hinweist. Wir geben deshalb einem modularen Sys- tem den Vorzug, das auch im Revisions- fall die Möglichkeit bietet, die Pfanne mit einem neuen Inlay zu versorgen.

Fazit für die Praxis

Der Oberflächenersatz am Hüftgelenk bleibt weiterhin eine reizvolle Alterna- tive zur sehr erfolgreichen Standarden- doprothetik. Zunehmende Erfahrungen und Informationen über die Fehlermechanismen, die bei diesen Systemen eine Rolle spielen, werden helfen, die Implantate weiter zu optimieren und die Implantationstechnik zu verbessern.

Correspondierender Autor
PD Dr. M. Rudert
Klinik für Orthopädie und Sportorthopädie der Technischen Universität München
Ismaninger Str. 22, 81675 München
rudert@lrz.tum.de


Literatur
Modes of Implant Failure After Hip Resurfacing: Morphological and Wear Analysis of 267 Retrieval Specimens

By Michael M. Morlock, PhD, Nick Bishop, Dipl-Ing, Jozef Zustin, MD, Michael Hahn, Dipl-Ing, Wolfgang Rüther, MD, and Michael Amling, MD

Background: Resurfacing of the hip joint is experiencing a revival due to improvements in materials, design, and manufacturing techniques. Despite good midterm outcomes, the high early rate of failure and concerns about metal debris require a detailed morphological and wear analysis of retrieved resurfacing implants in order to understand failure mechanisms.

Methods: A worldwide collection of hip resurfacing revision devices was initiated, and 267 components were received. Devices were analyzed by patient demographics, radiographic positioning, and wear, as well as morphologically and histologically. Specimens were grouped into four different failure types. They were also stratified into rim-loaded or non-rim-loaded groups. Failures were also assessed by surgeon learning-curve effects.

Results: Time to failure was significantly different between the four revision-type groups: Specimens with fractures involving the implant rim were most common (46%) and failed earliest after surgery (mean of ninety-nine days), followed by fractures inside the femoral head (20%, 262 days) and loose cups (9%, 423 days). Revisions not due to fractures or cup loosening (25%) occurred at a mean of 722 days after surgery. Rim-loaded implants exhibited an average twenty-one to twenty-sevenfold higher wear rate than implants without rim-loading. Rim-loaded implants also showed a steeper mean cup inclination than their non-rim-loaded counterparts (59° compared with 50°). Most failures occurred during the learning curve of the surgeon (the first fifty to 100 implantations).

Conclusions: Failures on the femoral side usually occur within the first nine months after surgery and appear to be most directly related to the implantation technique or patient selection. Later failures are observed mainly due to acetabular problems, either due to dramatically increased wear or poor cup anchorage. Improper cup anteversion may be similar to or more important than cup inclination in producing excessive wear.

Clinical Relevance: Femoral neck fractures are the main reason for early hip resurfacing failure. Insufficient cup fixation and positioning can cause later failure and thus, patients at risk of increased wear should be carefully monitored in order to prevent excessive exposure to metal ions. Appropriate education is required to reduce the length of the surgeon learning curve.

The short-term and midterm outcomes of metal-on-metal hip resurfacing are encouraging, particularly in younger and more active patients. This has resulted in rapid acceptance of the technique, which is demonstrated by a 7.8% rate of resurfacing among all Australian total hip arthroplasties in 2007. However, the Australian hip registry also clearly demonstrates an increased risk of revision within the first six to twelve months for hip resurfacing. After this initial period, the number of revisions does not differ from that associated with conventional total hip arthroplasties. The high early revision rates are speculated to be related to the difficult implantation technique, which requires careful sizing of implants as well as reaming, positioning, and cementation of the femoral head. Positioning of the joint components, with an emphasis on the cup, has been shown to be crucial for decreasing wear. Patient selection and surgeon operative expe-

Disclosure: In support of their research for or preparation of this work, one or more of the authors received, in any one year, outside funding or grants of less than $10,000 from DePuy, Zimmer, Smith and Nephew, Biomet, and Corin. Neither they nor a member of their immediate families received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, division, center, clinical practice, or other charitable or nonprofit organization with which the authors, or a member of their immediate families, are affiliated or associated.
The previous study focused on the biomechanical, morphological, and, in particular, tribological aspects related to failure. With respect to the effect of wear debris, it is accepted that a reduction in metal ion concentration by a reduction in joint wear is highly desirable to avoid ion side effects. The purpose of the present study was to identify the main reasons for revision surgery and to analyze the influence of component alignment on total joint wear by investigating complete revisions (head and cup couples of the same joint).

**Materials and Methods**

The implants in this study were obtained from an international retrieval program, which was initiated in 2004. This study gives surgeons the opportunity to submit implants retrieved at revision for a detailed biomechanical, morpho-

---

*Fig. 1*

Left: Determination of the surface geometry of the retrievals with use of a coordinate measurement system. The measured area is highlighted in red. Middle: Wear pattern of a rim-loaded resurfacing head (radial deviation from a perfect sphere). Right: Wear pattern of the respective acetabular cup (radial deviation from a perfect spherical cup).

---

*Fig. 2*

Schematics of the preparation of a retrieval head for the biomechanical, morphological, and histological analysis. This study concentrates on the results of the surface and morphology analysis.
logical, and histological analysis, thereby permitting a better understanding of the reasons for failure. The analysis of the combined individual reports should yield a realistic cross section of the present situation in hip resurfacing. It could give a reasonable estimate of the situation for an arbitrary patient outside a controlled clinical study. Implants from sixteen different countries were included in this study. We did not distinguish between implants from different manufacturers, since almost identical early failure patterns were observed for all implant designs analyzed.

**Patient Data**

Attempts were made to obtain complete sets of patient data and medical records, including radiographic documentation and descriptions of the implantation and cementing technique. Due to the nature of the study, the availability of complete data sets could not be guaranteed. The number of available cases used in each analysis will be described.

**Wear Measurement**

The surface geometry of each retrieved implant was determined with use of a coordinate measurement machine (Mitutoyo BHN 805, Tokyo, Japan). For the heads, sixteen sets of planar data were collected from the equator to the equator through the pole, rotated consecutively by 11.25° around the polar axis, with a coordinate measured every 5 mm using a 1-mm diameter ruby probe. The same method was applied to the acetabular cups but starting 2 mm below the cup rim.

A sphere was fitted to the point data in a manner that excluded the worn regions and included only the assumed original unworn implant surface. The distance of each area of the triangulated points to the unworn spherical surface was calculated as radial deviation and used for the estimation of wear volume. Only deviations greater than the 3 μm accuracy of the measurement machine were considered for the wear estimation (Fig. 1). This method has been described in detail previously.

**Morphological Analysis**

After determination of the surface geometry, implants were analyzed morphologically and histologically. A 4-mm slice was cut from the polar section of the head using a diamond saw (EXAKT 310, Oklahoma City, Oklahoma), and then radiographed and photographed (Fig. 2). We attempted to orient sections to be in the plane of the femoral neck, although this was sometimes difficult to assess in cases of fracture within the head or when the neck had been cut high. Some variation in the cutting plane occurred.

**Cup Inclination, Edge Wear, and Reason for Revision**

The cup inclination angle was determined from the anteroposterior radiograph. The antetorsion angle of the cup could not be determined with confidence since no standardized lateral radiographs were available. The cup inclination alone, however, gives no reliable indication of the loading situation of the implant in situ; therefore, edge-wear pattern, as determined from the surface topography measurements was chosen as an indicator for the rim-loading situation in the patient. This categorization was not based on the magnitude of wear (which is highly dependent on the implantation period), but rather on the wear pattern itself. Patterns demonstrating a clear demarcation between regions of low and high wear of the implant were considered a clear indication of edge wear (Fig. 1).

On the basis of the images of the central slices of the femoral head and the information sent by the surgeon, the implants were allocated to four revision failure-mode groups (Fig. 3). Implantsations with no indication of an acute fracture as a
Modes of Implant Failure After Hip Resurfacing

TABLE I Wear Rate and Implant Inclination for the Two Components of the Implant Pairs with and without Rim-Loading∗

<table>
<thead>
<tr>
<th>Wear Rate</th>
<th>Number of Implants</th>
<th>Mean*</th>
<th>Median*</th>
<th>Standard Deviation*</th>
<th>Minimum*</th>
<th>Maximum*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rim-Loading†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Cup</td>
<td>17</td>
<td>0.0016</td>
<td>0.0001</td>
<td>0.0038</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>Head</td>
<td>12</td>
<td>0.0011</td>
<td>0.0000</td>
<td>0.0016</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>0.0030</td>
<td>0.0009</td>
<td>0.0046</td>
<td>0.0000</td>
</tr>
<tr>
<td>Yes</td>
<td>Cup</td>
<td>15</td>
<td>0.0435</td>
<td>0.0335</td>
<td>0.0441</td>
<td>0.0019</td>
</tr>
<tr>
<td></td>
<td>Head</td>
<td>14</td>
<td>0.0238</td>
<td>0.0256</td>
<td>0.0148</td>
<td>0.0038</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>14</td>
<td>0.0716</td>
<td>0.0768</td>
<td>0.0526</td>
<td>0.0057</td>
</tr>
<tr>
<td>Inclination†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rim-Loading</td>
<td>No</td>
<td>Cup</td>
<td>17</td>
<td>49.8</td>
<td>50.5</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>Head</td>
<td>12</td>
<td>50.8</td>
<td>50.5</td>
<td>5.6</td>
<td>45.0</td>
</tr>
<tr>
<td>Yes</td>
<td>Cup</td>
<td>15</td>
<td>58.5</td>
<td>57.8</td>
<td>10.3</td>
<td>45.0</td>
</tr>
<tr>
<td></td>
<td>Head</td>
<td>14</td>
<td>58.1</td>
<td>63.0</td>
<td>11.2</td>
<td>41.0</td>
</tr>
</tbody>
</table>

*The values for the wear rate are given in mm³/day, and the values for inclination are given in degrees. †The difference in wear rates between the implants with and without rim-loading was significant for the cup (p = 0.003), the head (p < 0.001), and the total joint (p = 0.001) (power = 0.99).

The inclination angle specified for the head represents the inclination angle for the respective cup. The difference in cup inclination angle between the implants with and without rim-loading was significant (p = 0.011) (power = 0.56).

Revision reason were Type 0. If there was cup loosening, they were categorized as Type 3. Implants demonstrating an acute fracture were allocated, depending on the fracture morphology, to Type 1 (fracture entirely within the head) or Type 2 (fracture outside the edge of the implant). Other fracture modes were not identified. These groups are redefinitions of the five groups defined in an earlier paper and reflect the further information gained from the analysis of 200 additional retrievals.

Statistical Analysis

Statistical analyses were performed with use of one-way analysis of variance (fracture type), two-way analysis of variance (edge loading, implant type), and linear regression (inclination angle compared with wear rate). The Tukey B (equal variance) and Tamhane T2 (unequal variance) post hoc comparison tests were used. The probability of a type-I error was set at 5% (α = 0.05) for all analyses. The standard deviation was used throughout to describe the spread around average values. Test power was reported, where applicable.

Results

A total of 267 specimens were available for analysis. Of these, the femoral head component was the most common (84%). The main indication for surface replacement was primary osteoarthritis (75%), followed by hip dysplasia (11%), osteonecrosis (6%), posttraumatic arthritis (5%), and rheumatoid arthritis (4%). The proportion of implants from female patients was 49.5%.

A total of thirty-seven implant couples (head and cup of the same joint) were received. Wear results are presented only for the implant pairs in order to address the wear rate of the total joint. Rim-loading with edge wear was observed in 54% of the pairs (Table I). The daily volumetric wear rate was significantly higher for edge-loaded implants by a factor of twenty to twenty-seven (Table I). The cup wear rate showed a trend to be larger than the head wear rate (p = 0.160, Table I). There was also a trend for rim-loading to affect cup wear more than head wear (p = 0.183). The cup inclination angle was higher for implants with edge wear by a mean of 8.7° (Table I). The variation in cup inclination was about two times greater for implants with edge wear. A significant correlation between cup inclination angle and volumetric wear rate across all implant pairs was found (r² = 0.28, p = 0.019).

Approximately two-thirds of the implants were revised due to fracture (66.5%, Table II). A large variation in implantation period was observed, with a peak in the first fifty days postoperatively. Rim fractures occurred at a mean of ninety-nine days after implantation, and head fractures occurred at a mean of 262 days (Table II). Revisions for cup loosening occurred in 9% of the implants at a mean of 423 days, and revisions without fracture or cup loosening occurred in 25% of the implants at a mean of 722 days (Table II).

The learning curve of the surgeon is blamed frequently as the cause for the high early failure rates. This is supported by the current data: 39% of the failures occurred in the first fifty
implantations of a respective surgeon. After approximately 100 procedures, this tendency decreased25-28.

Discussion

Since the present study is not a controlled clinical trial, we cannot give an indication of the actual rate of failure of hip surface replacement procedures. Such information is available elsewhere in the literature. In Australia, the rate of revision is currently 4.4% within five years. The present study, however, can provide an impression of the actual clinical situation, and it would be anticipated that the samples submitted represent a random sample of the total population of hip-resurfacing failures. Along with the well-documented problems of femoral neck fracture, it was found in this study that 33.5% of the revisions occurred without an acute fracture due to cup loosening or other nontraumatic reasons. While fractures occur mostly within the first nine months, revision for other reasons can be expected to occur after more than one year (cup loosening) or two years (other reasons). In general, early failures are mostly associated with the femoral component, whereas later failures tend to be associated with problems on the acetabular side. Acetabular problems include poor primary stability of the cup and inadequate cup positioning.

The positioning of implants has had a large effect on the function of large diameter metal-on-metal bearings. The good wear characteristics of these bearings are based on the generation of a fluid-film layer. Anything that disturbs this film will severely increase wear. As the contact zone between cup and head approaches the rim of the cup (edge-loading), the effective contact area is reduced, thereby increasing stresses and disrupting the fluid layer. This can lead to a dramatic increase in metal wear (in this study, the maximum total wear rate for an implant pair amounted to 71 mm/yr).

The mean cup inclination angle for implants without edge-loading was 50°, which is at the border of the "safe zone" of 40° ± 10° that is advocated by Lewinnek et al.29. The implants demonstrating edge-loading had a mean inclination angle far outside the safe zone (59°). The difference of 8.7° between instances of edge-loading and normal wear is significant, but at a rather low level. This suggests that another parameter, namely anteversion, may be as important, or even more so, for edge-loading20. Unfortunately the anteversion angle could not be determined in this study. Massive metal wear due to optimizing design, materials, manufacturing, and component placement should only lead to positive side effects because a dose-effect relation between metal ion concentration and negative side effects is present22. High metal wear due to inappropriate component placement has to be prevented by all means. A recent clinical study investigating metal ion concentrations showed very similar results with respect to critical inclination of the cup23.

During revision of fractured heads, the cups can frequently be left in situ. This is considered as one of the advantages of hip resurfacing. A new bedding-in phase occurs, mainly on the new head, and the wear that occurs during this phase is markedly lower than the wear that takes place during the bedding-in phase after primary implantation24. This reduction in bedding-in wear after revision is due to the optimized contact situation on the cup side since bedding-in of the cup has already taken place. However, it is important that the new head be an identical replacement with regard to size and orientation. In situations in which a malpositioned cup has caused heavy wear, it must be noted that revision of the head alone does not solve the problem. Should signs of heavy wear be observed at revision, the cup should also be replaced.

The low wear of modern, correctly positioned hip-resurfacing components fulfills the predictions of simulator studies, despite the greater number of cycles physiologically than the 1 million per year per leg that is taken as the testing norm21,25. The wear rates for the third and fourth-generation surface replacements that are being studied are clearly lower than those for first-generation metal-on-metal joints.

<table>
<thead>
<tr>
<th>TABLE II Time to Revision for the Different Groups According to Reason for Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

*The values represent the number of specimens with the respective reason for revision. The total number of implants does not add to 267 because implant pairs were only counted once and the final pathologic assessment for some of the last implants was not yet available at the time of publication. †The values represent the number of specimens with complete data sets used for analysis. §The p values pertain to the pairwise comparisons between types (power = 1.00).
(6 mm/yr)². For preclinical testing in the future, more stringent testing conditions should be imposed on implants, which are designed for younger and more active patients. With regard to the question of cause of failure, the explanations have to be viewed as somewhat speculative at this point in time. Revisions without an acute fracture due to excessive wear can often be attributed to the positioning of the cup. The cup loosening we observed should not be attributed to surface replacement itself but rather to the more difficult task of seating monobloc cups. Monobloc cups have no screw holes and consequently provide no view of the acetabular floor. Furthermore, large metal-on-metal bearings exhibit high startup moments, which must be counteracted by their anchorage capacity in the bone. Continuous impingement may also be a reason for cup loosening.

Regarding fractures of the femoral neck, the reasons are less clear. The situation becomes simpler if the fractures are separated into the two types defined in this study. Rim fractures can arise from notching (cutting the femoral neck during reaming), high implantation forces (in-house measurements have even indicated peak impaction forces up to 20 kN), or cysts, all of which can lead to stress concentrations and local overloading of the bone, increasing the risk of fracture. The second fracture type observed involved fractures inside the head. These occurred later than the rim fractures (Table II). The reasons for this could be initial microfractures underneath the implant (e.g., due to high implantation forces) and consequent osteonecrosis of the bone proximal to these fracture zones, leading to failure at the transition to the necrotic zone.

In this report, the problems of patient selection or cementing technique, which can generally be blamed for high implantation forces, were not addressed. These factors also play an important role in the failure scenario. A first analysis showed that a cement mantle thickness outside the desired 2 to 3 mm was present in 91.4% of the implants. These results, together with a detailed histological analysis, will be presented in a later report.

There is evidence from clinical studies that hip-resurfacing implants provide a valuable addition to the traditional designs of hip prostheses. Due to the technology available to date, nearly all of the implant-related problems of the first and second generation of hip resurfacings have been resolved. However, it must be recognized that resurfacing is challenging to the surgeon and requires extremely accurate and precise planning and surgery. Deviations can lead to early failures at a higher rate than is seen in other types of established hip prostheses. From a biomechanical perspective, this is not surprising: the shorter the implant, the smaller the margin of error. The superior wear characteristics of large hard-hard bearing couples, in comparison with those of traditional polyethylene bearings, come with the trade-off of greater sensitivity to cup malpositioning. The wear increase caused by malpositioning does not occur in a gradual way but rather in a sudden, dramatic way. Finally, it should be reiterated that, in percentage terms, most of the failures occur at the start of the learning curve. This is unacceptable for the patient. Increased efforts, such as compulsory educational and assessment schemes, should be undertaken to minimize technical errors and malpositioning of the components during surgery.

Note: The authors greatly acknowledge the advice and support of Guido Sauter, MD, in the histological and morphological analyses of the specimens.

Michael M. Morlock, PhD
Nick Bishop, Dipl-Ing
Biomechanics Section, T U HH Hamburg University of Technology,
Denickestrasse 15, 21073 Hamburg, Germany. E-mail address for
M.M. Morlock: morlock@tuhh.de

Jozef Zustin, MD
Michael Hahn, Dipl-Ing
Wolfgang Ritscher, MD
Michael Amling, MD
University Medical Center Hamburg-Eppendorf,
Martinistrasse 52, D-20246 Hamburg, Germany

References


Pages 34-56 exempt in full under section 47(1)(b) of the FOI Act
Winner of the Rand Award

Cementless Femoral Components in Young Patients
Review and Meta-Analysis of Total Hip Arthroplasty and Hip Resurfacing

Bryan D. Springer, MD,* Sarah E. Connelly, BScPharm, MSc†
Susan M. Odum, MEd, CCRC, ‡ Thomas K. Fehring, MD,* William L. Griffin, MD,*
J. Bohannon Mason, MD,* and John L. Masonis, MD*

Abstract: The study purpose was to analyze current results of modern cementless femoral components in young patients having total hip arthroplasty (THA) or hip resurfacing. Twenty-two studies (n = 5907; hips = 6408) evaluating modern cementless THA in young patients and 15 studies evaluating hip resurfacing (n = 3002; hips = 3269) were included. Meta-analysis techniques were used to pool failure rates. The pooled failure rate for THA using femoral revision for mechanical failure as an end point was 1.3% (95% confidence interval [CI], 1.0%-1.7%) at a mean 8.4 years of follow-up. At a mean of 3.9 years of follow-up, the pooled mechanical failure rate of the femoral component for hip resurfacing was 2.6% (95% CI, 2.0-3.4%). In conclusion, the enthusiasm for hip resurfacing should be tempered by these data. Longer follow-up and direct comparison trials are required to confirm these findings. Keywords: hip resurfacing, cementless, femoral component, total hip arthroplasty, meta-analysis.

© 2009 Published by Elsevier Inc.

There are several perceived advantages to hip resurfacing when compared to total hip arthroplasty (THA). These include improved range of motion with decreased risk of dislocation, more normal proprioception, preserved proximal femoral bone stock, and easy conversion to THA should failure occur [1,2]. Advocates of resurfacing often cite the high rate of failure of THA in young patients as justification for its use. These reports however often contain an older generation of hip arthroplasties with poor design and bearing surfaces that led to high failure rates [3,4].

There has been concern with regard to the short-term and long-term durability of the femoral component in hip resurfacing. Femoral neck fractures and failure of fixation (aseptic loosening) of the femoral component, secondary to poor cement technique, avascular necrosis or aseptic loosening are common modes of failure [5,6]. In addition, the lack of current long-term outcomes, proper patient selection, and technical factors (learning curve) make a widespread adoption of the procedure concerning [7].

The purpose of our study was to analyze failure rates of modern femoral components in young patients having THA or hip resurfacing. Meta-analysis techniques were used to analyze the current available literature with regard to pooled failure rates, the proportion of femoral component failures to overall failures and survival rates. Our hypothesis was that modern cementless femoral components in THA in young patients may in fact be more durable with a lower mechanical failure rate than those associated with hip resurfacing.

Methods

Search Strategy

Medline, PubMed, and Cinahl were systematically searched from their inception date to March 31, 2008, to identify relevant studies. Reference lists from review articles and potentially relevant studies were hand
Table 1. Baseline Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>HRA Studies</th>
<th>THA Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of studies</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>No. of hips (patients)</td>
<td>3269 (3002)</td>
<td>6408 (5907)</td>
</tr>
<tr>
<td>Average age, y (SD; range)</td>
<td>46.6</td>
<td>41.4</td>
</tr>
<tr>
<td>Average of mean length of follow-up, y (SD; range)</td>
<td>3.9 (2.1; 8.7-0.56)</td>
<td>8.5 (2.4; 13.5-4.8)</td>
</tr>
<tr>
<td>Bearing surface (no. of studies)</td>
<td>1853</td>
<td>3709</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>207</td>
<td>892</td>
</tr>
<tr>
<td>Avascular necrosis</td>
<td>181</td>
<td>446</td>
</tr>
<tr>
<td>Developmental dysplasia</td>
<td>24</td>
<td>200</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>42</td>
<td>66</td>
</tr>
<tr>
<td>Childhood disorder</td>
<td>113</td>
<td>130</td>
</tr>
</tbody>
</table>

MOM indicates metal on metal; MOP, metal on poly; COP, ceramic on poly; COM, ceramic on metal; multiple, multiple types of bearing surfaces studied.

*McLaughlin, 2000; Aldinger 2003; and Eskelinen, 2006, did not record an average age of study participants.

†Tracy 2005 did not provide an average length of follow-up for study participants.

‡ Eskelinen 2006 did not provide an average length of follow-up for study participants.

§ Not all studies listed specific numbers for diagnosis.

searched to identify additional studies. The search was restricted to English language studies.

Selection Criteria

Inclusion criteria for studies were established a priori. Studies were included in the systematic review if they met each of the following: (i) study design was a randomized controlled trial or observational, (ii) study participants were young adults (mean age, <55 years) undergoing THA with modern cementless components or hip resurfacing arthroplasty (HRA), (iii) the study either compared THA and HRA groups or reported on a single cohort of either THA or HRA patients, and (iv) study reported at least one of the predefined primary end points of femoral failure due to any reason, femoral failure due to revision, and femoral failure due to mechanical reasons.

Validity Assessment

Methodological quality assessment was performed by a single reviewer by assigning nonrandomized studies a Methodological Index for NonRandomized Studies score.

Data Abstraction

All variables intended for data abstraction were established a priori and included the following: baseline participant demographics, interventions (THA and HRA information), and outcome variables. Two reviewers independently abstracted outcome data from the included studies, and disagreements were solved through consensus. The remaining variables were extracted by a single reviewer.

Analysis

Event and survival rates were respectively calculated and recorded from included studies. Where possible, rates from single-arm THA or HRA studies were pooled, and forest plots were constructed. Pooled rates were displayed with their respective 95% confidence intervals (CIs). For comparison studies, odds ratios (ORs) and 95% CIs were calculated for dichotomous end points. Where possible,

Table 2. Total Hip Arthroplasty Studies Included in Meta-Analysis

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal (y)</th>
<th>Average Follow-Up</th>
<th>Average age (y)</th>
<th>No. of hips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kronick et al [22]</td>
<td>Clin Orthop (1997)</td>
<td>8.3 y</td>
<td>37.6</td>
<td>174</td>
</tr>
<tr>
<td>Olson et al [26]</td>
<td>Orth Tran (1996)</td>
<td>12.5 y</td>
<td>48</td>
<td>46</td>
</tr>
<tr>
<td>Petsatodes et al [27]</td>
<td>J Arthroplasty (2005)</td>
<td>13.5 y</td>
<td>47.5</td>
<td>205</td>
</tr>
</tbody>
</table>
Table 3. Hip Resurfacing Studies Included in Meta-analysis

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal (yr)</th>
<th>Average Follow-Up</th>
<th>Average Age</th>
<th>No. of Hips</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Smet et al [34]</td>
<td>Orth Clin N Am (2005)</td>
<td>3.3 y</td>
<td>48.3</td>
<td>446</td>
</tr>
<tr>
<td>Lillakas et al [35]</td>
<td>Ortho Clin N Am (2005)</td>
<td>28.5 mo</td>
<td>71.5</td>
<td>70</td>
</tr>
<tr>
<td>Schmalzried et al [38]</td>
<td>Clin Orthop (1996)</td>
<td>16 mo</td>
<td>42</td>
<td>21</td>
</tr>
</tbody>
</table>

Results

Baseline summary characteristics of all studies included in the meta-analysis are listed in Table 1. Twenty-two studies evaluating THA with a modern cementless femoral component in young patients were identified using the aforementioned search criteria. There were 5907 patients (6408 hips) with a mean average age of 41.4 years (range, 32-55.4 years). The mean average follow-up across all studies was 8.5 years (range, 4.8-13.5 years). Table 2 lists the studies included in the meta-analysis for THA.

Fifteen studies evaluating hip resurfacing were identified using the aforementioned search criteria. There were 3002 patients (3269 hips) with a mean average age of 46.6 years (range, 34.2-56.8 years). The mean average follow-up across all studies was 3.9 years (range, 0.56-8.7 years). Table 3 lists studies included in the meta-analysis for hip resurfacing. Table 4 lists the components evaluated in the meta-analysis for THA and HRA. All THA femoral components were cementless designs. All hip resurfacing components were of the hybrid type, with a cementless acetabular component and a cemented femoral component.

Pooled Failure Rates

Table 5 lists the pooled failure rates for those studies reporting overall failure for any reason (revision + radiographic failure) for modern cementless THA (n = 19) and HRA (n = 13). Table 6 lists the acetabular failure rate for those studies reporting overall acetabular failure rate using failure for any reason (revision + radiographic failure) for modern cementless THA (n = 21) and HRA (n = 15).

The pooled failure rates of the femoral component in both THA and hip resurfacing with various end points are listed in Table 7. The pooled failure rate of the femoral component in THA using revision of the femoral component for any reason (aseptic loosening, infection, dislocation, fracture, osteolysis, and others) was 3.1% (95% CI, 2.7%-3.5%) at a mean average follow-up of 8.4 years. The pooled failure rate of the femoral component in hip resurfacing using revision of the femoral component for any reason (aseptic loosening, infection, dislocation, fracture, and others) was 2.7% (95% CI, 2.1%-3.5%) at a mean average follow-up of 3.9 years.

Table 4. Hip Resurfacing and Femoral Component (THA) Used in Studies

<table>
<thead>
<tr>
<th>Hip Resurfacing Implant (Manufacturer)</th>
<th>Femoral Implant Hip Arthroplasty (Manufacturer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASR (Depuy, Warsaw, IN)</td>
<td>ABG (Stryker)</td>
</tr>
<tr>
<td>Birmingham (Smith and Nephew, Memphis, TN)</td>
<td>AML (Depuy)</td>
</tr>
<tr>
<td>Converse (Wright Medical, Arlington, TN)</td>
<td>Autophor 900 (Osteo AG, Selzach, Switzerland)</td>
</tr>
<tr>
<td>Corin (Corin Medical, Cirencester, UK)</td>
<td>BI-Metric (Biomet, Warsaw, IN)</td>
</tr>
<tr>
<td>Comet (Stryker, Malwah, NJ)</td>
<td>CLS (Sulzer)</td>
</tr>
<tr>
<td>Duroen (Zimmer, Warsaw, DE)</td>
<td>Mallory-Head (Biomet)</td>
</tr>
<tr>
<td>McMinn (Corin Medical)</td>
<td>Omnifit (Stryker)</td>
</tr>
<tr>
<td>Wagner (Sulzer, Hampshire, UK)</td>
<td>Profile (Depuy)</td>
</tr>
<tr>
<td></td>
<td>SROM (Depuy)</td>
</tr>
<tr>
<td></td>
<td>Taperloc (Biomet)</td>
</tr>
<tr>
<td></td>
<td>Zweymuller (Sulzer)</td>
</tr>
</tbody>
</table>

Table 5. Overall Failure Rates

<table>
<thead>
<tr>
<th>End point</th>
<th>Model</th>
<th>n</th>
<th>% (95% CI)</th>
<th>n</th>
<th>% (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall failure rate</td>
<td>Fixed</td>
<td>15</td>
<td>4.6 (3.7-5.6)</td>
<td>19</td>
<td>16.1 (14.9-17.3)</td>
</tr>
<tr>
<td></td>
<td>Random</td>
<td>15</td>
<td>3.7 (2.0-6.5)</td>
<td>19</td>
<td>11.6 (7.5-17.4)</td>
</tr>
</tbody>
</table>

MA indicates meta-analysis.
The mechanical failure rate of the femoral component in THA, defined as femoral revision for aseptic loosening, was 1.3% (95% CI, 1.0-1.7) at a mean average follow-up of 8.4 years. The mechanical failure rate of the femoral component in HRA, defined as femoral revision for aseptic loosening or femoral neck fracture, was 2.6% (95% CI, 2.0-3.4) at a mean average follow-up of 3.9 years.

Proportion of Femoral Component Failures

Femoral component failures requiring revision surgery due to any reason accounted for 70.7% (95% CI, 57.9-80.9) of all failures in HRA. In contrast, modern cementless femoral component failures requiring revision surgery for any reason in THA accounted for 14.7% (95% CI, 10.3-20.6) of all failures.

Discussion

The concept of hip resurfacing is not new. In fact, the procedure was first introduced in the 1930s and has spanned several decades of technological advancement [42]. Early results however were poor with unacceptably high rates of wear, osteolysis, and component loosening [43,44]. With the rising success of THA, the use of hip resurfacing diminished substantially in the United States. The advent of newer bearing surfaces, better fixation options, and improved surgical techniques have led to a resurgence of hip resurfacing. In Australia, hip resurfacing now represents 7.9% of all hip arthroplasties, and 46% of patients younger than 55 years undergoing arthroplasty in the United Kingdom had a resurfacing [45,46].

Proponents of hip resurfacing often cite poor results of THA in the young patient as justification for hip resurfacing. Many of these studies commonly died, however, include an older generation of cementless stems, cemented stems, and the use of suboptimal bearing surfaces resulting in high rates of osteolysis and aseptic loosening [3,4]. Callaghan et al [3] reported the result of cemented and hybrid fixation in a group of patient younger than 50 years. The hybrid group had an 18% failure rate of the femoral component and 24% prevalence of radiographic loosening at 5-year to 10-year follow-up. This femoral component was ultimately abandoned due to concerns with surface finish and distal geometry. Interestingly, the cemented Chamley femoral stems in this group had a femoral component failure rate of only 5% at 20 years. Joshi et al [4], however, reported a 51% survivorship at 20 years in young patients (age <40) with osteoarthritis. Both acetabular and femoral components were cemented.

The results of modern cementless THA in young patients are quite encouraging [8-28,47]. A meta-analysis of cementless femoral component survivorship in young patients (9 studies) in our study was 95% at 12 years. In addition, the mechanical failure rate of the femoral stem is extremely low, 1.3% at a mean average follow-up of 8.4 years. Petsodates et al [27] reported on the results of 205 hips (195 patients) with an average age of 47 years. Survivorship at 17 years using a fully porous-coated stem was 98% using femoral revision for any reason as an end point. Only 2 stems were revised at 10 years for aseptic loosening. Ellison et al [13] reported on the results of 249 hips (201 patients) with an average age of 34.7 years using a proximally coated femoral component. The survivorship at 15 years using revision of the femoral component for aseptic loosening was 99.2%.

Presently, there are no long-term data available on the current designs of hip resurfacing. The short to intermediate-term data that are available, while as whole show acceptable results, is concerning the femoral component. In reviewing 15 current studies available on hip resurfacing, the overall pooled failure rate is low (4.6%) [29-41,48,49]. The femoral component failure rate was 2.7% at 3.9 years; however, it accounted for 70% of all the failures in resurfacing arthroplasty. The most common reasons are femoral neck fracture and aseptic loosening of the femoral component.

The 2007 Australian registry reports a cumulative percentage of revision rate for hip resurfacing of 3.8% [46]. For patients younger than 55 years, this 5-year cumulative revision rate was 2.8%. In comparison, the

Table 6. Acetabular Failure Rates

<table>
<thead>
<tr>
<th>End point</th>
<th>Model</th>
<th>n</th>
<th>% (95% CI)</th>
<th>n</th>
<th>% (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral failure rate due to any reason</td>
<td>Fixed</td>
<td>15</td>
<td>2.8 (2.0-3.9)</td>
<td>21</td>
<td>14.1 (13.1-15.2)</td>
</tr>
<tr>
<td>Femoral failure rate due to any reason (including radiographic failure)</td>
<td>Random</td>
<td>15</td>
<td>1.4 (0.5-3.4)</td>
<td>21</td>
<td>10.5 (7.0-15.4)</td>
</tr>
</tbody>
</table>

Table 7. Femoral Failure Rates

<table>
<thead>
<tr>
<th>End point</th>
<th>Model</th>
<th>n</th>
<th>% (95% CI)</th>
<th>n</th>
<th>% (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral failure rate due to revision surgery</td>
<td>Fixed</td>
<td>15</td>
<td>2.7 (2.1-3.5)</td>
<td>22</td>
<td>3.1 (2.7-3.7)</td>
</tr>
<tr>
<td>Femoral failure rate due to any reason</td>
<td>Random</td>
<td>15</td>
<td>2.7 (1.8-4.0)</td>
<td>22</td>
<td>3.4 (2.9-4.0)</td>
</tr>
<tr>
<td>Femoral failure rate due to mechanical failure</td>
<td>Fixed</td>
<td>15</td>
<td>2.8 (2.0-4.0)</td>
<td>22</td>
<td>3.2 (2.4-4.2)</td>
</tr>
<tr>
<td>Femoral failure rate due to any reason</td>
<td>Random</td>
<td>15</td>
<td>2.6 (2.0-3.4)</td>
<td>20</td>
<td>1.3 (1.0-1.7)</td>
</tr>
</tbody>
</table>

* Eskellinen et al [14] recorded femoral failure rates for modern and nonmodern femoral stems. In this analysis, outcomes associated with nonmodern femoral stems were excluded from the pooled femoral failure rate.
cumulative percentage of revision rate for THA (all components, all ages) was 2.8%. For cementless THA in patients younger than 55 years, the 5-year cumulative percentage of revision rate was 3.1%.

Steffen [40] recently reported on the results of 610 hip resurfacings done at an independent center. Overall survivorship at 7 years was 95%. There were 23 failures (3.7%) requiring revision. Of the 23 failures, 13 occurred in the first year after surgery and 57% of failures were on the femoral side. In addition, 30% of patients had radiographic evidence of femoral neck narrowing of uncertain clinical significance. Interestingly, the older age group had improved survivorship compared to a younger cohort of patients. Hing [49] also reported an independent review of their first 230 hip resurfacing. Survivorship for worst case scenario was 97.8% at 5 years. Radiographic review however revealed 6 patients with progressive radiolucent lines around the femoral component, and 18 femoral components (8%) had migrated into varus.

Young patients often require arthroplasty for disease other than primary osteoarthritis. Secondary arthritides due to avascular necrosis and dysplasia are common in this age group. Revell et al [37] and Mont et al [36] in separate studies reported survivorship of 93.2% at 6 years and 94.5% at 41 months, respectively, in group of young patients with avascular necrosis. Amstutz [31] reported a 10% failure rate of hip resurfacing in 59 patients with a diagnosis of dysplasia at 6 years.

With no long-term data available, it is difficult to predict what if any failure mechanisms may develop. Narrowing of the femoral neck has been reported but is of unknown clinical consequence at this point [50]. Beck et al [51] has reported that men lose 18% and women 25% of their bone mineral density in the femoral neck from age 30 to 70. Ritter et al [52] evaluated failure modes of an older generation resurfacing and found that the average time to failure was 9.7 years. All late femoral failures (>10 years) had shown evidence of narrowing of the femoral neck.

Most surgeons would agree that hip resurfacing is technically more demanding than primary THA. The surgeon’s learning curve has been shown to be substantial and may require up to 55 to 60 cases to diminish the complications related to surgical technique [7]. The first 537 cases monitored in the Food and Drug Administration post market analysis of the Birmingham hip resurfacing in the United States shows a 7.4% adverse event rate and includes 9 nerve palsies and 9 dislocations. There were 14 reoperations (7.4%) within the first year and 10 for femoral neck fracture [53].

As with any procedure, patient selection is critical to the success of any procedure, and hip resurfacing may be particularly sensitive to patient selection [54]. Beaule et al [48] demonstrated a 12 times greater relative risk of early complications in hip resurfacing in patients in patients with a Surface Arthroplasty Index Score greater than 3. In addition, the ability to alter the biomechanics of the hip joint with regard to leg length and offset are limited with hip resurfacing [55,56]. In such instances, patients may be better optimized with THA.

We have shown in this meta-analysis of modern cementless femoral components a low rate of mechanical failure (1.3% at 8 years) of the femoral component in young patients undergoing THA. The femoral component in hip resurfacing likewise shows a low failure rate (2.7%) but only at short-term follow-up. In addition, many of the total hip studies analyzed implement poor bearing surfaces (non-cross-linked polyethylene) with high rates of osteolysis. The advent of modern bearing surfaces combined with these cementless stem designs is to be hoped to improve on the current results. The strength of this study includes the large number of patients analyzed with surgery performed by multiple surgeons and a variety of implants. Potential limitations are the retrospective review of the study, the limitations of each individual study, and the potential overlap of included patients who could be potentially reported twice in articles by the same author.

There is little doubt that hip resurfacing has an appropriate role in the arthroplasty arena, and the perceived benefits are appealing to both surgeons and patients. The preservation of proximal femoral bone stock in a young patient is advantageous and may yield to a potentially easy conversion to THA when failure occurs [57]. Surgeons and patients however should feel comfortable with the durability of modern cementless femoral component in this patient population. Our meta-analysis data show twice the mechanical failure rate of the femoral component in hip resurfacing with half the follow-up compared to modern cementless femoral components in THA. We believe that modern cementless femoral components should be used as the benchmark for comparison in hip resurfacing. Longer follow-up of resurfacing and prospective direct comparison trials are required to confirm these findings.

References
Cementless Femoral Components in Young Patients  • Springer et al


Pages 64-172 exempt in full under section 47(1)(b) of the FOI Act