ORIGINAL ARTICLE

REVISION HIP RESURFACING

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Abstract

Most hip resurfacing patients assume that when a resurfacing procedure fails, revision to a total hip replacement will be their only alternative. However, both components of a hip resurfacing rarely fail simultaneously; therefore, it is usually possible to revise a hip resurfacing prosthesis without conversion to total hip replacement. When the acetabular component fails because of loosening, wear, or adverse reactions to wear debris, a second acetabular component can be placed and the femoral resurfacing component with all the supporting femoral bone can be preserved. The use of specialized components that match the femoral prosthesis are necessary and additional fixation is sometimes needed. With improvements in polyethylene, this material is often preferred. Femoral component failure resulting from femoral neck fracture, loosening, or osteonecrosis is usually addressed by placing a stem-supported femoral prosthesis. The resurfacing acetabular component can be preserved. Occasionally a long-stem femoral resurfacing prosthesis is used. Matching a retained polyethylene resurfacing acetabular component is done by using a ceramic or metal femoral head prosthesis of appropriate size on a femoral stem. If the acetabular prosthesis is metal, a ceramic-polyethylene dual-mobility prosthesis is used.

Ninety-two percent of resurfacing prosthesis failures are appropriate for revision resurfacing and the success rate is 97%. The function of the resurfacing prosthesis is preserved and the recovery time, complications, and costs are less than with revision to total hip replacement. An in-depth knowledge of all aspects of resurfacing and available component parts, as well as extensive surgeon experience, are required.

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The author certifies that his institution has approved the human protocol for this investigation and the investigation was conducted in conformity with ethical principles of research and that informed consent was obtained.

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Introduction

The benefits of hip resurfacing are femoral bone preservation, better function, and a lower chance of dislocation. Other benefits are an easier revision, less involved area of infection (if it occurs), and reduced chance of periprosthetic fracture. Hip resurfacing patients perceive less leg-length difference and are more likely to forget they have a hip implant than total hip replacement patients.[4,14,16] Hip resurfacing avoids the stress shielding that will inevitably cause failure of a total hip replacement. The revision rate of a total hip replacement in patients 50 years of age and younger is 60% at 20 years.[13,15,17] The revision rate of hip resurfacing in most national registries is 3.5% over 15 years. Resurfacing success rates vary depending on the diagnosis and size of the femoral head. Highly experienced surgeons have a higher success rate than less experienced surgeons.[4,16,17] Surgeons without significant resurfacing experience – and most patients – assume that any second procedure after a resurfacing procedure will be revision to total hip

replacement. The purpose of this report is to identify and describe the revision resurfacing options and results. The methods and results described are based on revision procedures performed at our referral practice in patients coming from Belgium, Canada, England, India, Germany, and several centers in the United States since 1985.

Treatment Philosophy

For many patients in need of revision surgery, the same reasons that supported the hip resurfacing choice are still present. Patients are often young, active, and in need of a high-functioning, stable, and durable hip implant. Revision of the resurfacing procedure by changing one or both components is the most useful procedure. Managing disappointment is an important part of revision resurfacing surgery for both the patient and surgeon. Patients can become discouraged with their surgeon and look for help in distant places. Because of the success of total hip replacement, it is tempting to assume every resurfacing patient would have been better served and still can be better served by a total hip replacement. Patients can wonder whether they made a mistake in their choice of hip resurfacing. However, it is important not to let a prior setback exclude a possible well-conceived future solution. Patients can be overwhelmed and open to the seduction of a simplistic solution. Fear can be disempowering.

The treatment plan for any patient must be individualized. It is tempting to choose the most common or most familiar method available to the surgeon. Patients and surgeons must remain reasoned, honest, and objective in their approach. Surgeons who perform hip resurfacing surgery and especially revision hip resurfacing surgery must be creative, knowledgeable, and willing to spend additional time planning procedures and discussing different possibilities with their patients. The outcomes are their own reward, as surgical skill is not a commodity that can be bought and sold. Hip resurfacing skill is acquired at the surgeon's own time, trouble, and expense and it takes years of experience to perform revision hip resurfacing successfully.

There is limited information about hip resurfacing revision surgery.[9,10] Creative solutions are necessary and an in-depth knowledge of all options is required.[19] A strong base in both the concepts and historical origins of hip resurfacing is needed to solve specific patient issues.[8,20,21,23] The patient and surgeon must accept that it may be necessary, when indicated, to combine components from different sources to rescue a failed hip resurfacing. Detailed knowledge of the acceptable tolerances and compatibilities for matching components is needed. Initially there was one primary vendor for medical-grade cobalt chromium (Vitallium).[8,20,23] Metal implants from different companies could be combined because there was no mismatch in metallurgy. However, current manufacturers use different metal treatments and it is not recommended to combine metal implants from different companies; thus, alternate solutions are employed to solve these issues.

Conversion to a total hip replacement is always an option and may be the correct option for older patients and for those whose activity levels have changed and the need for the hip resurfacing is no longer present. The surgical exposure is easier, since the femoral head and neck are removed with hip replacement. There is a wide choice of implants for total hip replacement but resurfacing components must match the patient's own bone perfectly. Hip replacement surgery is available from most orthopedic surgeons, yet hip resurfacing is a specialized skill.

The disadvantages of a total hip replacement are that the femoral head size will be reduced and, therefore, the hip's function and stability will be reduced. Thus, patients who have been accustomed to the freedom afforded by hip resurfacing will be at a higher risk of dislocation. With hip replacement, more bone will be removed, leading to a more difficult and longer recovery time as compared to resurfacing revision. The cost and risk of surgery are greater with hip replacement as a revision strategy compared to resurfacing revision.[11] Ninety-two percent of patients needing a second procedure can be treated by keeping one or both parts of the initial resurfacing prosthesis.

Indications

The decision to revise a resurfacing procedure can be obvious, as in the case of femoral neck fracture, or more subtle, as in the case of adverse reactions to metal wear debris.[18,19] I do not perform revision resurfacing surgery without a definite indication. Revision surgery is not indicated for pain that cannot be attributed to a definite implant- or anatomical-related finding. Testing and observation should continue until the reason for the unsatisfactory outcome is known. The indications for complete revision to total hip replacement rather than resurfacing revision are: chronic infection, severe wear of the resurfacing prostheses, extreme sensitivity to cobalt, and severe bone loss. An additional indication is the need for a revision acetabular component that is not compatible with the retained femoral resurfacing component.

Lessons Learned and Experience Gained

The keys to a successful outcome for revision hip resurfacing are an in-depth understanding of the reason for failure, complete knowledge of all the available alternatives, and comprehensive availability of necessary equipment, laboratory support, imaging technology, and experienced personnel. Complete and extensile surgical exposure is recommended and the posterolateral approach is best for complex revision surgery. It is imperative to have equipment for explanting the component in the most bone-conserving way possible. Also, full pathology support for intraoperative determinations of infection and tissue reactions to metal debris is necessary. Intraoperative imaging with x-ray and, if needed, CT scan using the O-arm is required. Meticulous attention to soft-tissue handling is mandatory. Close instruction and supervision of patients with adherence to follow-up is critical.

Each resurfacing system has its specifics. The size of components is not consistent across manufacturers. As an example, a size 50 mm DePuy ASR femoral prosthesis will measure 50.5 mm. Polyethylene implants are accepting of small size differences and a slightly larger polyethylene acetabular component can be used. Metal implants are intolerant of any difference in size or metallurgy and cannot be mixed and matched. Inspecting the tissues and implants for damage is important. All implants upon explantation are measured to confirm their size rather than relying on the nominal size from the manufacturer. Minor damage to the femoral head can be treated by intraoperative polishing. Polyethylene is more tolerant than metal to imperfections. Damaged acetabular shells are revised. Unfavorably positioned or infected components are removed.

It is unusual and unnecessary to be able to obtain complete bone coverage for an acetabular shell in either primary or revision hip resurfacing surgery. An acetabular component that is uncovered in the superior lateral area is expected if a correct inclination angle is achieved. This causes no symptoms. Seventy percent coverage of an acetabular component shell is perfectly adequate for stability and ingrowth.[2] There may be mild impingement of the femoral neck with the acetabular component but in most instances bony remodeling occurs over several years and excellent survivorship and function are expected. Incomplete coverage posteriorly is also not a concern. Bony coverage of the acetabular component anteriorly and inferiorly is important. Incomplete anterior coverage can lead to groin pain and impingement.

I use components with an anterior or inferior cut out if necessary (Fig. 1). There are occasional

Fig 1. This two-piece titanium with polyethylene resurfacing acetabular prosthesis has anterior and inferior relief to reduce soft-tissue irritation.

circumstances in which a medial protrusion technique (placing part of the acetabular implant inside the pelvis) for an acetabular component is an acceptable option but most deficiencies

medially and superiorly are treated by bone grafting.[24] It is not acceptable to remove a femoral component by sawing the femoral neck below or into the femoral stem. All femoral components should be removed prior to making the femoral neck cut when conversion to a stem-supported prosthesis is necessary. Also, when helpful, the healthy bone from the femoral head and neck is used as an autograft for the acetabular or femoral reconstruction.

Infection is a concern with revision of metal-on-metal implants. The soft tissues can become inflamed, ischemic, and swollen. The tissue bed is acidotic. Cultures are obtained in all revision cases and antibiotics are continued until the results are known. Vancomycin powder is placed in all wounds during closure and wounds are covered with a silver-impregnated occlusive dressing for 2 weeks.

Revision Resurfacing for the Acetabular Component

The reasons for acetabular revision are wear, loosening, unfavorable position, and impingement. Acetabular concerns are the most common reason to perform revision hip resurfacing surgery.[9,10] If a metal-on-metal resurfacing implant has been used, an adverse reaction to metal wear debris can be the indication for revision. Adverse reactions to metal wear debris are common with the recalled ASR prosthesis (DePuy, Warsaw, IN). They are not common with the Durom (Zimmer, Warsaw, IN). Metal reactions when seen, are most common with femoral head sizes of 46 mm or less for the Conserve (Wright Medical, Arlington TN), Birmingham (Smith & Nephew, Memphis TN), Biomet (Warsaw, IN), and Corin (Tampa, FL) (Fig. 2). The diagnosis of an adverse reaction to metal wear debris is based on pain that appears most commonly in the 4th year following surgery. The diagnosis is confirmed by elevated whole blood cobalt levels and the presence of inflamed or necrotic soft tissues with or without pseudotumor formation. Aspiration of the fluid from around the prosthesis or MRI scanning can also assist with the diagnosis.[18,19] The treatment of an adverse reaction to metal wear debris is to change the bearing surface to a polyethylene acetabular prosthesis. In certain instances of loosening or component malposition, a new metal component is placed (Figs. 2, 3).

Fig. 2. A. This 40-year-old gymnastics instructor presented with an adverse reaction to metal wear debris 4 years after her Conserve Plus hip resurfacing. B. Her 46 mm (OD) metal acetabular component was revised to a two-piece titanium back cross-linked polyethylene implant that matched her 40 mm femur and she returned to gymnastics.

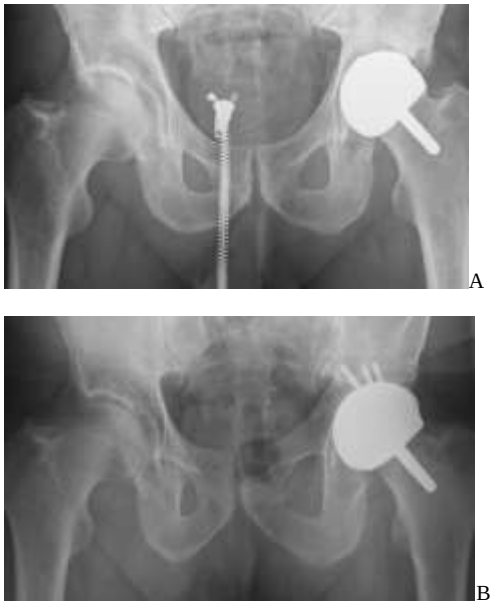


Fig. 3. A. A 44-year-old professional cyclist developed an adverse reaction to metal wear debris 5 years after his Birmingham Hip Resurfacing. B. A two-piece metal revision acetabular component was placed and he returned to professional cycling.


B

Revision acetabular prostheses possibly with adjunctive screw fixation can be helpful. The results of single-component hip resurfacing revision for an adverse reaction to metal wear debris are favorable.[19] There were three re-revisions in 90 procedures. The average Harris Hip score following revision resurfacing was 93.5 (excellent) and the mean UCLA activity score was 7. These results compare favorably to primary resurfacing outcomes. Acetabular revision for polyethylene wear consists of a bearing surface only exchange. This has not been necessary with cross-linked polyethylene bearings as none has failed, but has been successful with prior implants using conventional polyethylene.[1,7] Revision of one-piece polyethylene resurfacing components consists of revision to a two-piece current-generation component. Revision for painful acetabular loosening is performed by placing a new acetabular component with adjunctive screw fixation, if needed (Fig. 4).


C

Fig. 4. A. This 41-year-old professional golfer presented with severe arthritis that prevented him from continuing his career. B. He was treated with hip resurfacing using an all polyethylene acetabular component and a curved-stem femur. He returned to professional golf and won an event. Ten years later his acetabular component loosened. C. He underwent revision surgery with another cemented all polyethylene acetabular component that had one fixation screw. He won a senior professional event.


A

The new implant can be metal (Fig. 5) or polyethylene (Fig. 6).


A


B

Fig. 5. A. A 37-year-old tennis professional presented with a loose Zimmer Durom metal-on-metal acetabular prosthesis. B. A revision metal acetabular prosthesis was placed and he returned to professional tennis.

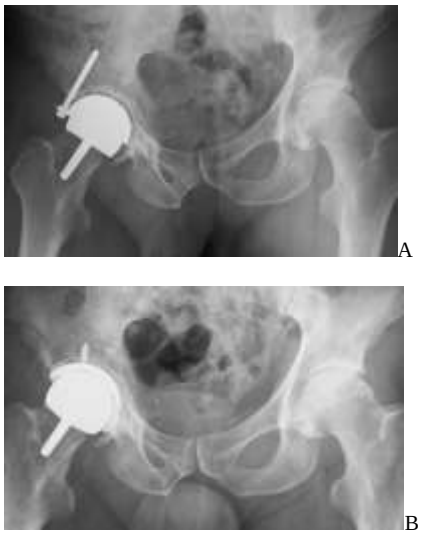


Fig. 6. A. A 55-year-old fire fighter presented with a loose metal acetabular prosthesis. The largest metal component that matched his femoral prosthesis was insecure despite screw fixation through the Birmingham dysplasia socket. B. A revision two-piece polyethylene component was 5 mm larger externally but matched his femur. Subsequently, he was able to return to full duty.

If the manufacturer of the metal component no longer provides implants (e.g., ASR, Durom), revision to polyethylene is necessary (Fig. 7).

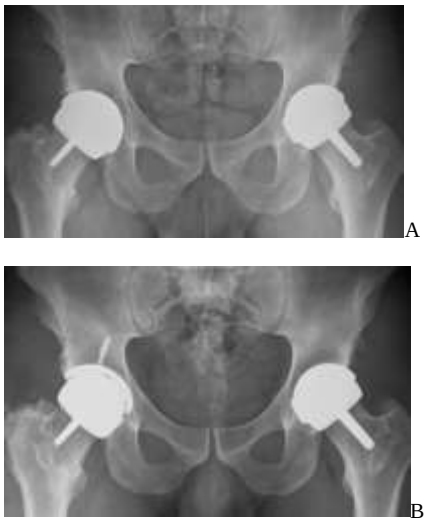


Fig. 7. A. This 31-year-old man who competes in martial arts presented with an adverse reaction to metal wear debris 4 years following his DePuy ASR right hip resurfacing. B. Because the ASR prosthesis was recalled and no compatible metal component was possible, a matching two-piece metal/polyethylene acetabular revision was performed. He returned to competition.

If the manufacturer still provides implants (Birmingham, Biomet), another metal implant can be used. The Conserve is available outside the United States. There is an occasional need for acetabular revision for unfavorable component position. Patients may present with painful hip impingement that does not improve over a much extended interval or, very rarely, recurrent dislocation (Fig. 8).

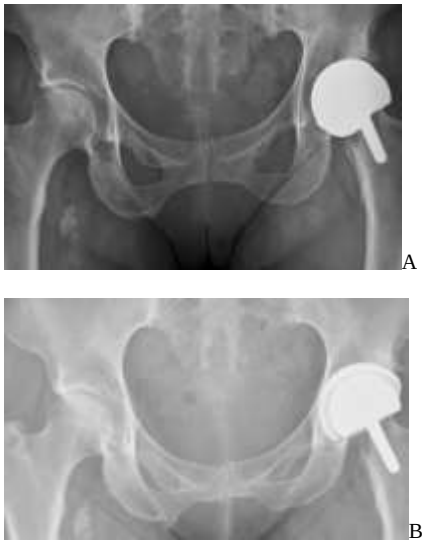


Fig. 8. A. This 49-year-old woman teaches Pilates. There was anterior/inferior impingement on her psoas tendon following metal-on-metal hip resurfacing with signs of an adverse reaction to metal wear debris. She was unable to continue teaching. B. Revision to a two-piece metal/polyethylene acetabular component allowed her to teach again and she also began teaching yoga.

Revisions in these instances follow the same pathway as revision for acetabular loosening. Among 92 acetabular revisions for polyethylene wear, component position concerns, or loosening, there have been two re-revisions (98% success rate).

Revision of Femoral Resurfacing Components

The indications for femoral component revision are femoral neck fracture (most common), loosening, and impingement. With rare exception, revision to a stem-supported prosthesis is the correct procedure. Occasionally,

internal fixation of a nondisplaced femoral neck fracture can result in uneventful healing (Fig. 9).

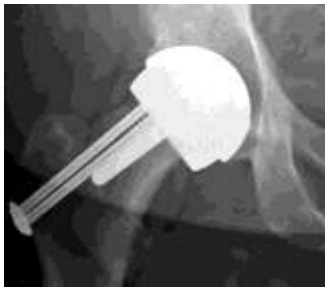


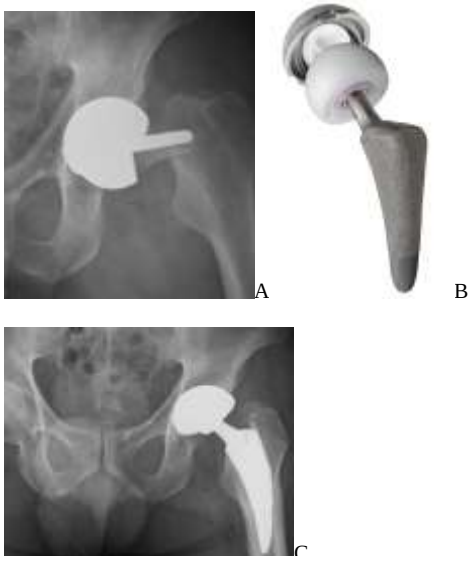
Fig. 9. This 35-year-old man is a trail rider who presented with a nondisplaced femoral neck fracture. This was treated by internal fixation using screws (courtesy film).

Typically, a femoral neck fracture with or without a resurfacing prosthesis in place will not heal and prosthetic replacement is needed. Loosening of the femoral component can be treated by revising the femoral resurfacing prosthesis or placing an intramedullary stem-supported femoral prosthesis. Custom long-stem resurfacing prostheses for difficult femoral geometry are used when necessary (Fig. 10).

A B C

Fig. 10. A. This 36-year-old woman was extremely active teaching cross fit. She had groin pain and her bone scan showed increased uptake of labeled phosphorus in her very thin femoral neck. There was no arthritis in the joint so the diagnosis was a chronic femoral neck stress reaction. B. A long-stem femoral resurfacing prosthesis was placed matching her natural femoral head size. Her pain was relieved and no arthritis has developed over 20 years. C. This is a photograph of a long-stem resurfacing prosthesis that has also been used for certain revision procedures.

Stem-Supported Femoral Revision if There is a Metal Acetabular Component It the metal acetabulum is well fixed and well positioned, revision for femoral failure is performed by femoral component revision only. The goal is to match the retained acetabular prosthesis with a polyethylene femur. This will maintain the joint stability and is the least intrusive revision option. A dual mobility prosthesis is used (Fig. 11). These prostheses place a 28 mm ceramic femoral prosthesis on any suitable stem and then a second femoral head of polyethylene is placed over the ceramic via a snap fit.



A B C

Fig. 11. A. This 48-year-old man works in a warehouse and presented with an acute femoral neck fracture several years following metal-on-metal Birmingham hip resurfacing. B. This is photograph of a dual mobility prosthesis that can be matched to a metal acetabular resurfacing prosthesis. C. The radiograph shows the 28 mm ceramic femoral head of the dual mobility (the cross-linked polyethylene to match the acetabular prosthesis of 52 mm is not visible).

This procedure is no more complex than any other bipolar hemiarthroplasty. I first performed the procedure under the name of tripolar prosthesis in 1992. We are now contributing these patients to a multicenter study through Rush University Medical Center. There are now more than 100 patients with at least 3 years of follow-up. There is a 97% success rate when matching a dual mobility prosthesis with a retained metal acetabular resurfacing component. The mean Harris Hip score is 93 and the mean UCLA activity score is 7. There were three revisions, one

each for femoral shaft fracture, infection, and mechanical failure of the dual mobility bearing. There were no revisions for instability or polyethylene wear.[6]

There are favorable reports of converting the resurfacing procedure to a metal-on-metal total hip replacement when there has been a femoral failure after hip resurfacing. This is not recommended, as there is too great a potential for cumulative collection of cobalt to occur in the tissues from the combined contribution from the bearing surface wear and trunnion (capture point of the femoral head on the stem).[3,5]

Polyethylene Acetabular Component

If there is a femoral failure with a polyethylene acetabular component, the femoral component can be revised with or without touching the acetabular component.[8,19] If the polyethylene quality is good and not worn it is retained and a matching femoral prosthesis is used (Fig. 12).[21,23]

Fig 12. This 56-year-old woman is a runner and she received a polyethylene resurfacing procedure that allowed her to keep running. A. She sustained a femoral neck fracture. B. A ceramic femoral head that matched her acetabular component was placed on a stem-supported femoral prosthesis. She returned to running again.

This is usually ceramic and any femoral stem can be used. A fully hemispherical femoral head rather than a hollow head with a stem is now used. Ceramic heads come in all available sizes from either CeramTec North America (Biolox®delta) (Laurens, SC) or BioPro® Inc., (Port Huron, MI) (magnesium stabilized zirconium) (Fig. 13).

Fig. 13. These ceramic femoral head prostheses are appropriate for use on a stemmed femoral implant. A. The femoral head is a Biolox delta that is available in even-numbered millimeter sizes. B. This femoral head is a magnesium-stabilized zirconia and it is available in odd-numbered millimeter sizes. It comes as a full hemisphere, which is preferred over smaller and less stable conventional total hip femoral head components.

It is possible to revise the acetabular polyethylene to a new polyethylene liner of either the same or smaller size. Generally it is preferred to continue with the resurfacing size polyethylene to preserve the stability of the joint rather than reduce the size to 32 or 36 mm, which is typical for total hip replacement.[8,19,22]

The outcomes of femoral component revisions with polyethylene acetabular components are the same as other primary total hip replacement procedures, with a 1% mechanical failure rate. Is possible to place a new polyethylene bearing without disturbing the bony fixation of the components if there is wear at any future date.

Complications

There are complications possible with resurfacing revision, namely infection, dislocation, periprosthetic fracture, nerve palsy, residual pain, heterotopic ossification, and pulmonary embolus, all occurring at a frequency of less than 1%.

Discussion

Not everything that isn't perfectly successful is a failure. However, in the terminology of joint implant surgery revision of a component for any reason is termed a "failure." This terminology is used even when there was a successful outcome from the initial surgery for many years and even when the revision surgery completely resolves the issue. Revision resurfacing surgery was successful for 97% of patients. Revision resurfacing surgery rather than complete revision to total hip replacement was performed for 92% of patients presenting for revision procedures. Limited revision surgery that maintains part of the original resurfacing prosthesis is more efficient for the patient and surgeon and results in better outcomes with less risk, less cost, and better bone preservation.

New resurfacing options for both primary and revision indications are under development. With the improved polyethylenes and ceramics now available, we will be able use polyethylene or ceramic femoral resurfacing components (Fig. 14) in addition to metal.

Fig. 14. A. This is cross-linked polyethylene and can be directly applied as a femoral component to the femoral neck or used with a small stem as a resurfacing prosthesis. B. This polymer-stemmed prosthesis prototype can be produced in variable stem lengths and thicknesses for direct use as a femoral component with a metal acetabular component. C. This modular stemmed entirely ceramic femoral prosthesis can be used with a polyethylene acetabular prosthesis.

Previous attempts to use polyethylene femoral components were not successful due to the poor quality of the polyethylene but this has been solved.[12]

Conclusion

Revision hip resurfacing is a strong option if a resurfacing procedure fails. Several options exist and an in-depth knowledge of the possibilities is necessary to offer this surgery. Revision to total hip replacement is not the only – and in most instances – not the best option. Revision surgery for failed hip resurfacing surgery produces outcomes that are superior to total hip replacement surgery because the dislocation rate is lower and the functional outcome is better.

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