We would like to thank the following surgeons for their participation as part of the R3° Acetabular System design team:

Robert Barrack, MD  
St. Louis, Missouri

Robert Bourne, MD  
London Health Sciences Center  
London, Ontario, Canada

Jonathan Garino, MD  
University of Pennsylvania School of Medicine  
Philadelphia, Pennsylvania

Wayne M. Goldstein, MD  
Clinical Professor of Orthopaedics  
University of Illinois at Chicago  
Illinois Bone and Joint Institute  
Chicago, Illinois

Richard Kyle, MD  
Minneapolis, Minnesota

Stephen J. McMahon MB BS, FRACS(Orth), FA(Orth)A  
Senior Lecturer Monash University  
Malabar Orthopaedic Clinic  
Melbourne, Australia

John L. Masonis, MD  
OrthoCarolina  
Hip & Knee Center  
Charlotte, North Carolina

Henrik Malchau, MD  
Associate Professor Harvard Medical School  
Codirector The Harris Orthopaedic Biomechanics and Biomaterials Laboratory  
Massachusetts General Hospital  
Boston, Massachusetts

Michael Ries, MD  
University of California  
San Francisco, California

Cecil Rorabeck, MD  
Professor of Orthopaedic Surgery  
University of Western Ontario  
London, Ontario, Canada

Van Paul Stamos, MD  
Illinois Bone and Joint Institute  
Glenview, Illinois  
Clinical Instructor of Orthopaedic Surgery  
Northwestern University Medical School  
Chicago, Illinois
R3volution in motion

The R3° Acetabular System combined with the Smith & Nephew portfolio of hip stems provides the most advanced hip replacement system with:

• Widest range of advanced bearing options
• Excellent primary stability
• Flexible instrumentation

General features

NO HOLE & THREE HOLE hemispherical shell offering

Polished inner surface to minimize backside wear

STIKTITE® Porous Coating for enhanced scratch-fit feel and enhanced initial fixation

Modular resurfacing* offered with the clinically proven BHR® hip metallurgy and clearances

*available after FDA approval
Ceramic-on-ceramic* offered in BIOLOX® Forte

*available after FDA approval

XLPE offered in 0 & 20 degree and in 0 & 20 degree +4mm lateralized options
Advanced bearing surfaces: modular resurfacing

R3° modular resurfacing advantage

Superior metallurgy and optimal clearances, also used in the clinically proven, highly successful, world-leading BIRMINGHAM HIP™ Resurfacing System, provide the Smith & Nephew R3 modular resurfacing system superior performance compared to similar competitive systems.

The R3 modular resurfacing and the BHR system utilize high-carbide cobalt chrome in the as-cast micro-structural condition, providing superior wear resistance.1,2,3

Recent publications have highlighted the difference in wear rates of heat-treated casting versus as-cast. The cumulative linear wear rate data showed substantially more wear with the heat-treated metallurgy than with as-cast devices.3

As-cast CoCr has performed significantly better than the thermally treated CoCr by generating a lower wear factor. Additional heat treatments of the as-cast metal deteriorates the metallurgy by depleting the carbide content. This leads to a less durable bearing surface and increased wear.

Microabrasive pin-on-disc wear test using as-cast and heat-treated cobalt chrome alloy

Typical microstructure of As-cast modular resurfacing

Typical microstructure of a heat-treated modular resurfacing device

Modular resurfacing available after FDA approval.
Advanced bearing surfaces: modular resurfacing

The importance of modular resurfacing clearances

Studies have shown that the modular resurfacing design of the BIRMINGHAM HIP® implant offers improved wear properties. An essential part of that design is a smaller femoral head within a larger acetabular cup, with an optimized radial clearance. This clearance provides a space in which viscous fluids – blood and synovial fluid – can lubricate the movement of the head within the cup.

The system’s optimized radial clearance draws lubricating fluids (viscous entrainment) extremely well – dramatically reducing bearing friction and inhibiting long-term wear properties.

**Generation of fluid film**

At rest

![Image of fluid film at rest](image1)

In motion

![Image of fluid film in motion](image2)

**Radial clearance**

Radial clearance is the space defined by the difference between the radius of the femoral head and the radius of the cup. This dynamic space (a converging wedge) between the cup and the head draws and transports fluid between the components, lubricating the system. When fluid is present, there is less friction between the metallic head and consequently, far less wear.

Modular resurfacing available after FDA approval.
R3° ceramic-on-ceramic bearing couple

Ceramic-on-ceramic bearing surfaces have been used worldwide in total hip replacement for more than 30 years. Renewed interest in ceramics as an alternate bearing surface has been driven by the following:

- New technology
- Improved manufacturing processes and standards
- New designs

This translates into improvements in the following:

- Mechanical and physical properties
- Wear characteristics
- Optimized biocompatibility
- Reliability expected by today's more active patients

Due to the reduced grain size, ceramic components are harder than before. That has led to wear rates as low as 0.001mm/year.\textsuperscript{5,6}

Impingement in ceramic bearing systems increases wear and decreases implant longevity. The improved design of R3 ceramic acetabular components:

- Reduces the effects of impingement
- Enhances wear and durability by utilizing liners that sit flush with the shell face

Advanced bearing surfaces: ceramic-on-ceramic

Ceramic-on-ceramic available after FDA approval.
The R3° system’s ceramic design is an assembled combination of:

- A ceramic component made from orthopaedic industry standard material, BIOLOX® Forte
- A precision-machined support ring made of a Titanium alloy (Ti6Al4V) that is commonly used in orthopaedic implants.

**BIOLOX® Forte**

Burst strength has improved from BIOLOX® (400 MPa) to BIOLOX® Forte (580 MPa). The R3 system’s design of BIOLOX® Forte with the titanium band has a burst load of over 91kN.

BIOLOX® Forte, introduced in 1995, is the only ceramic material currently approved in the US for ceramic-on-ceramic articulation.

Advanced bearing surfaces: ceramic-on-ceramic

Ceramic-on-ceramic available after FDA approval.
Titanium support ring for added strength

The unique feature about R3 ceramic liners is that they come with a titanium support ring around the periphery of the liner. The support ring and ceramic liner are precisely assembled utilizing a cold pressing process, which assures that the material properties of the ceramic and titanium are not altered.

The support ring offers greater protection against chipped edges and tensile forces for the ceramic insert that result in high fatigue and burst performance for insert assembly. Lab tests have shown that the burst strength of these liners is significantly higher than that of traditional ceramic liners with no band. Based on these test results, it can be hypothesized that these liners with titanium band would reduce the incidence of fracture of the ceramic liners.

Ceramic-on-ceramic available after FDA approval.
Titanium band

Ceramic-on-ceramic available after FDA approval.
Advanced bearing surfaces: OXINIUM™ alloy-on-XLPE

R3° system with OXINIUM alloy is the most advanced bearing option available

OXINIUM is an Oxidized Zirconium alloy (97.5% Zirconium and 2.5% Niobium) with a transformed ceramic surface providing the wear performance of ceramics and the strength of metals. This provides all of the benefits of ceramic and metal bearing technology. OXINIUM material is especially useful for nickel-sensitive patients. OXINIUM material is an award winning, clinically proven advanced bearing material that is designed for active patients.

OXINIUM material along with 10 Mrad XLPE provides the wear performance of hard bearings along with the intraoperative options of hard-on-soft bearing.

OXINIUM material has a clinical history of more than 10 years. Over 190,000 components have been implanted successfully to date. Impressively clinical wear performance of OXINIUM heads was supported by an RSA clinical study from Dr. Bo Nivbrant.⁸

OXINIUM material along with 10 Mrad XLPE provides the wear performance of hard bearings along with the intraoperative options of hard-on-soft bearing.

OXINIUM material has a clinical history of more than 10 years. Over 190,000 components have been implanted successfully to date. Impressively clinical wear performance of OXINIUM heads was supported by an RSA clinical study from Dr. Bo Nivbrant.⁸

Wear reduction of standard bearing vs. advanced bearings

Ceramic-on-ceramic and modular resurfacing available after FDA approval.
Advanced bearing surfaces: OXINIUM™ alloy-on-XLPE

R3° system with OXINIUM alloy-on-XLPE

The Smith & Nephew 10 Mrad, fully annealed XLPE is the only crosslinked polyethylene proven to produce less volume of wear debris particles in all size ranges.\textsuperscript{11,12} Less wear debris provides a reduced chance for osteolysis.

All currently marketed crosslinked poly indicates a significant improvement in the volume of wear debris, which would lead one to assume all crosslinked poly is the same. However, Smith & Nephew investigated more closely and found that not all crosslinked poly minimizes the amount of particles generated. Because the wear particles of crosslinked poly can be smaller in size than with UHMWPE, it is possible to reduce the volume but actually increase the number of particles.\textsuperscript{11,12} Even though there are questions about some crosslinked poly increasing the number of particles, many surgeons are adopting the use of these materials in most of their more active patients.

The Smith & Nephew crosslinked polyethylene significantly reduces the number of particles generated. The gravimetric wear rate of R3 XLPE is not measurable in a hip simulator, but the number of particles generated is reduced by 80\% compared to traditional CoCr on conventional poly bearing.\textsuperscript{13}
Stability: head/shell ratios

Optimized head/shell ratios

Use of larger diameter femoral heads has been clinically reported to decrease the probability of dislocation in patients.\textsuperscript{14,15,16,17}

- Large heads increase the ROM of the joint
- Large heads reduce the incidence of neck impingement with soft tissue or the edge of the shell
With the R3™ Acetabular System, surgeons have the option of using larger head sizes in smaller acetabular shells:

- R3 ceramic-on-ceramic acetabular system: 36mm ceramic head with a 52mm cup size
- R3 modular resurfacing acetabular system: 38mm metal head with a 50mm cup size
- R3 OXINIUM™ alloy-on-XLPE acetabular system: 36mm head in a 52mm cup size

### R3 liner offering chart

<table>
<thead>
<tr>
<th>Cup size</th>
<th>XLPE 22</th>
<th>XLPE 28</th>
<th>XLPE 32</th>
<th>XLPE 36</th>
<th>Ceramic 32</th>
<th>Ceramic 36</th>
<th>Metal 38</th>
<th>Metal 40</th>
<th>Metal 42</th>
<th>Metal 44</th>
<th>Metal 46</th>
<th>Metal 48</th>
<th>Metal 50</th>
<th>Metal 52</th>
<th>Metal 54</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>66/68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Larger diameter heads increase the jump distance and reduce the dislocation risk.

Greater jump distance equals greater stability.

Ceramic-on-ceramic and modular resurfacing available after FDA approval.
R3° locking mechanism design features:

- Locking taper that supports metal and ceramic liners
- Double-channel lock design that provides axial stability for poly liners
- 12 large anti-rotational tabs on the poly liner that provide rotational stability

Intraoperative adjustments to the liner position may be performed with true confidence. Independent researchers confirm that in some competitive locking designs, the liner can be significantly damaged by extraction, which prohibits liner repositioning.\textsuperscript{18} Laboratory tests of the R3 locking mechanism have shown it withstands consecutive insertions of the same liner without damaging its locking integrity.
Push-out and torque-to-failure tests of the R3° locking mechanism demonstrate that it offers the benefit of a secure and stable liner. The R3 lock can withstand over 1112N of push-out force in any of its liner options and over 40 N-m of torque.
Enhanced stability and fixation with STIKTITE Porous Coating

Utilizing STIKTITE coating on the R3° Acetabular Shells allows for a true scratch-fit feel during the shell seating and a clinically proven ingrowth surface for long-term implant success.20
Stability: STIKTITE° Porous Coating

STIKTITE Porous Coating demonstrated a higher coefficient of friction compared to trabecular metal when tested by the same method. The mean coefficient of friction for STIKTITE coating was higher than that of trabecular metal against both cancellous and cortical bone. These results indicate that STIKTITE coating should have superior friction, scratch-fit feel and initial fixation stability as compared to trabecular metal.

**Frictional coefficients of bone ingrowth structures against cancellous and cortical bone (n=96 to 100)**

STIKTITE coating is a sintered three-dimensional asymmetric titanium powder that has a porosity of about 60%. Increased porosity allows for potentially greater bone ingrowth, which can enhance long-term fixation and implant stability. STIKTITE coating provides enhanced initial mechanical stability, which is particularly important in damaged or less biologically active bone. The average pore size of STIKTITE coating (200 μm) is within the 100– to 500–μm range for optimal bone ingrowth.
Streamlined instrumentation improves surgical efficiency

This seemingly simple technique is a very effective way of precisely placing the hard bearing liners inside the shell without the issue of improper seating due to misalignment as seen in other competitive systems.\textsuperscript{22,23} Cocking of a ceramic liner, in particular, during impaction can lead to a fracture of the liner.

Preassembled alignment ring on all hard bearing liners.

Alignment ring allows for easy placement of the hard bearing liner in the shell. The liner impactor can then be inserted through an opening in the alignment ring and the liner can be seated with an impaction force.

Upon impaction the ring will disengage and remain on the liner impactor for later disposal. The hard bearing liner is now perfectly seated in the shell.

Ceramic-on-ceramic available after FDA approval.
References


