Design Rationale
Cementless total hip arthroplasty has provided a proven method of treatment for several decades. The ECHELON Primary Hip system incorporates the design concepts learned throughout this period to offer a femoral implant system that addresses the clinical needs of both surgeons and patients alike. By offering dual offset implants in 1mm increments and simple yet precise instrumentation, the ECHELON Primary Hip system offers the surgeon unprecedented intraoperative flexibility. For the patient, ECHELON Primary stems are designed with the goal of providing long-term, pain-free restoration of joint function and normal hip biomechanics.
Cementless total hip arthroplasty has provided a proven method of treatment for several decades.

The ECHELON Primary Hip system incorporates the design concepts learned throughout this period to offer a femoral implant system that addresses the clinical needs of both surgeons and patients alike.

By offering dual offset implants in 1mm increments and simple yet precise instrumentation, the ECHELON Primary Hip system offers the surgeon unprecedented intraoperative flexibility. For the patient, ECHELON Primary stems are designed with the goal of providing long-term, pain-free restoration of joint function and normal hip biomechanics.
System features

The ECHELON™ Primary total hip system has been designed to simply address the clinical issues surrounding total hip arthroplasty.

Well-designed implants

Many surgeons favor a cylindrical stem design. Stems of this configuration have shown excellent long-term clinical results using diaphyseal biologic fixation. An extensively porous coated cylindrical stem offers many advantages.

- Solid fixation in the consistent cannular portion of the diaphysis.
- Simple, reproducible surgical technique.
- Proven long-term clinical results.

ECHELON implants also incorporate many design features that help the clinical success of the prosthesis.

- 1mm increment sizes to precisely fit the implant to the patient, and not the other way around.
- Dual offsets for proper joint tension.
- Optimized medial curve to fill the proximal femur and avoid confusion.
- Threaded driver hole that accepts a locking stem inserter for implant control during insertion.

Surgical Technique

ECHELON instruments have been designed to provide exact and reproducible results. Sharp reamers in 0.5mm increments allow precise preparation of the femoral canal and permit the surgeon to choose the amount of press fit. Precision ground broaches easily prepare the proximal femur for the implant.

A simple surgical technique avoids OR confusion. The prosthesis that is implanted is the same size as the final reamer and broach that are used.
A simple surgical technique avoids OR confusion. The prosthesis that is implanted is the same size as the final reamer and broach that are used.

Comprehensive system
ECHELON® Primary implants are part of a family of femoral stems that address primary and revision situations. With one set of instruments, a variety of stems can be implanted.

Acetabular options
R3® Acetabular System
R3 acetabular shells and liners offer the perfect complement to the ECHELON system. Available in a variety of options, the R3 acetabular cup is engineered for multiple bearing options and provides STIKTITE® Porous Coating designed to enhance fixation and bony in-growth.

Femoral head options
Cobalt Chrome, Zirconia and OXINIUM® femoral heads precisely fit the 12/14 taper on the ECHELON Primary stem.

Smith & Nephew femoral heads offer an additional 19mm of adjustment to ensure proper joint tension.
Addressing implant fixation

Immediate and continued fixation of a total joint prosthesis has been correlated to the long-term clinical success of an implant. Rough porous coating covers 2/3 of the ECHelon™ Primary stem, along with distal flutes to help the implant achieve short-term and long-term biological fixation.

Porous coating
Circumferential rough porous coating of sintered beads (ROUGHCOAT™ Coating) covering 2/3 of the stem increases the friction between the implant and bone, improving implant stability and providing a porous surface for bone ingrowth. This helps reduce the initial movement of the prosthesis and results in implant stability which contributes to a lower incidence of pain.

Rotational stability
Distal flutes help increase rotational stability by providing immediate fixation upon implantation. The flutes on the distal portion of the stem are .25mm larger than the porous coated diameter to provide extra penetration into the cortical bone for instant stability of the implant.

The ECHELON design was compared to a 5/8 porous coated cylindrical prosthesis for rotational stability. The distal flutes of the ECHELON stem allowed significantly less rotational micromotion compared to the scratch fit of the 5/8 porous coated prosthesis.
Proximal fill
The proximal body of the ECHELON® Primary stem was designed to work in conjunction with distal fixation. Based on a study of more than 100 radiographs, the proximal geometry of the stem provides optimum fill and easy insertion of the implant. This is accomplished by incorporating a 3° A-P proximal flare and an optimized medial curve.

A .5mm press-fit is achieved between the broach and the implant providing an interference fit and enhancing initial fixation.

Reducing Stem Stiffness
The effect of stem stiffness has been a concern of the long-term fixation of cylindrical stems. By design, cylindrical stems achieve tight distal fixation. However, this may lead to remodeling of the proximal femur. Although this has not led to significant clinical problems, researchers have concluded that the performance of distal fixation stems can be enhanced with increased stem flexibility.

Furthermore, by optimizing the porous coating length and overall stem length, tight distal fixation can be achieved with less bone resorptive remodeling. This provides for a more anatomic fit of the prosthesis which may also reduce thigh pain.

<table>
<thead>
<tr>
<th>Standard/ High Offset Size</th>
<th>Stem Length</th>
<th>Porous Coating Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-12</td>
<td>130mm</td>
<td>90mm</td>
</tr>
<tr>
<td>13-14</td>
<td>140mm</td>
<td>96mm</td>
</tr>
<tr>
<td>15-17</td>
<td>150mm</td>
<td>102mm</td>
</tr>
<tr>
<td>18-19</td>
<td>160mm</td>
<td>108mm</td>
</tr>
</tbody>
</table>

ECHELON Primary stems are proportionally sized to better match patient anatomy and conserve bone.
Addressing range of motion

Maximizing the patient’s range of motion (ROM) without impingement of the prosthesis is an important clinical goal in preventing:

- Increased poly debris which could lead to osteolysis
- Subluxation and possible joint dislocation
- Prosthetic loosening
- Dislodgement of a modular acetabular liner

ECHelon™ Primary stems have been designed to address these range of motion issues through implant design.

**Neck Geometry**

Optimizing neck geometry increases range of motion. The circulotrapezoidal neck on the ECHelon Primary stem is designed to provide a greater range of motion than a circular neck. By using more material in the medial/lateral direction where fatigue requirements are higher, and less material in the anterior/posterior direction where demands are smaller, the range of motion is maximized.

**Head and Neck Size**

Prosthesis ROM correlates with the ratio of head diameter to neck thickness. It has been suggested that the minimum recommended ratio to achieve adequate range of motion is 2 to 1. To achieve the recommended ratio with a 28mm head, the maximum neck diameter should be 14mm. The circulotrapezoidal neck on the ECHELON Primary helps minimize neck thickness, thereby increasing ROM and reducing impingement which could lead to dislocation.
Optimized 12/14 Taper

The size of a taper connection affects ROM. ECHELON® Primary stems have an optimized 12/14 taper that is buried inside the femoral head for increased range of motion compared to other taper designs. A large taper that is exposed beyond the femoral head may impinge on the cup, limiting ROM. Skirted heads also have a negative impact on range of motion.

Anteversion

It is not necessary to build anteversion into the neck of the stem to maximize range of motion. Built-in anteversion does not increase range of motion – it merely shifts the location of the ROM. With proper neck, taper, and acetabular liner geometry, a neutral stem neck can provide a greater ROM than a stem with a circular neck and built-in anteversion.

ROM for neutral circulotrapezoidal neck and anteverted circular neck were mapped on a two-dimensional plane.
Addressing implant design

Many details were considered when designing the ECHELON™ Primary femoral implants. Clinical performance along with surgical concerns have been addressed in the implant design.

**Femoral Offset**

Femoral offset is an important clinical requirement of proper joint function. When offset is not restored, medialization of the femur can occur resulting in impingement and possible instability. Furthermore, when offset is not restored at the time of surgery, laxity of the soft tissues can occur resulting in weakness and possible dislocation.

ECHELON Primary stems are offered in Standard Offset and High Offset configurations to provide proper joint tension without affecting leg length or surgical technique.

Femoral neck lengths are based on the SPECTRON™ Total Hip System which has 20 years of excellent clinical results.

**Size Range**

ECHELON Primary stems are proportionally sized. Larger diameter stems are longer and have more neck offset to accommodate the natural anatomy.

**Distal Bullet Tip**

The bullet tip reduces the stress between the distal implant tip and the bone to minimize end-of-stem thigh pain.

Implants are offered in 1mm increments (11-19mm) to better fit the patient.
Driving Platform
The ECHELON™ implants feature a threaded driving platform with an elliptical slot for rotational and axial implant control during insertion.

Shoulder Relief
A rounded shoulder has been incorporated into the design to ease insertion of the implant into the femur and reduce impingement of the implant into the greater trochanter which could cause fracture of the bone.

Material
All ECHELON implants are manufactured from Cobalt Chromium which allows for extensive porous coating of the stem.

To address stiffness concerns of Cobalt Chrome, the ECHELON design was tested in a 4-point bend configuration. The ECHELON stem demonstrated a reduced stiffness when tested in anterior/posterior and medial/lateral directions.14

![A four-point bend test was used to compare the stem stiffness of the ECHELON design to a commonly used femoral implant.](image)
Addressing surgical instrument design

Surgical instrument design is as equally important as the design of the implant itself. ECHELON® instruments have been designed to provide a simple, exact and reproducible surgical experience.

Proximal Reamer
A special reamer has been designed to open the proximal femur to ensure that subsequent reaming stays lateral. This proximal reamer can also be used to remove sclerotic bone.

Reamers
Sharp femoral reamers are available in .5mm increments for exact preparation of the femoral canal. Clear depth marks indicate the appropriate reaming depth.

Broaches
ECHELON broaches feature a tooth pattern that has been ground on a 5 axis machine. This tooth arrangement helps move bone chips up and out of the femoral canal which makes bone preparation straightforward and facilitates cleaning.

Broach Handles
Securely locking broach handles with a wide striking platform and a quick connect/disconnect facilitate easy broaching of the femoral canal.
Trial Necks
To avoid confusion, ECHELON™ trial necks are designed to work with the corresponding size of broach. Magnets are also embedded into the trial neck so that it stays in place when put through trial range of motion.

Trial Heads
A wide variety of trial heads are available (22, 26, 28, 32mm) to address soft tissue variability and surgeon preference. Femoral heads along with the optimized 12/14 taper have been designed to reduce the number of skirted femoral heads.

Stem Inserter
Stem implantation is made easy with a rigid, threaded attachment mechanism. The locking stem inserter provides maximum control during implant seating.

Anteversion Handles
A simple, knurled handle threads into both the broach handle and stem inserter giving extra visualization and control during preparation and implantation.
Addressing surgical technique

**Step 1**
Resect femoral neck with the osteotomy guide.

**Step 2**
Open femoral canal with box osteotome.

**Step 3**
Ream the femur with canal finder and modular t-handle.

**Step 4**
Ream canal in 0.5mm increments to selected size.

**Step 5**
Broach femur to size determined by last reamer used.

**Step 6**
Ream the calcar bone with the calcar reamer, if necessary.

**Step 9**
Seat the implant to the desired level.
Step 6. Ream the calcar bone with the calcar reamer, if necessary.

Step 7. Place the trial neck on the broach and perform trial reduction.

Step 8. Assemble the implant to the threaded stem inserter.

Step 9. Seat the implant to the desired level.


Step 11. Assemble the femoral head on to the stem.
References