SURGICAL TECHNIQUE

3 DIMENSIONAL FRACTURE MANAGEMENT SYSTEM
PROXIMAL HUMERUS
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The Conventus PH CAGE™ implant is comprised of an expandable scaffold, made from nitinol and titanium deployed into the metaphysis to support the medial calcar and articular surface.

It offers:

- A targeted solution for 2-, 3-, and 4-part fractures
- Fragment-specific fixation
- Secure fixation, even in osteoporotic bone
- Three dimensional support of the articular surface
- Screw fixation through any fracture fragment that engages multiple layers of CAGE inside the bone
Indication:

The Conventus PH CAGE is indicated for the fixation of proximal humerus fractures except when there are too many fracture fragments to repair the articular surface.

Contraindications:

The PH CAGE should not be implanted in patients with:

- any active or suspected latent infection, or marked local inflammation, in or about the affected area
- suspected or known sensitivity or allergies to Nickel or Titanium
- mental conditions that preclude cooperation with the rehabilitation regimen

Warnings:

Fracture fixation devices are neither intended to carry the full load of the patient, nor intended to carry a significant portion of the load for extended periods of time.

Do not use the PH CAGE with components from other manufacturers. Use only Conventus Orthopaedics’ devices.
Implantation Steps:

The Conventus PH CAGE does not eliminate the need to reduce and hold the fracture fragments prior to implantation. It is implanted using standard ORIF technique with two additional steps to accommodate the insertion of the PH CAGE (shown in bold below).

A. Position Patient
B. Surgical Approach
C. Reduce Fracture and Position Plate
D. Provisionally Fix Plate
E. Prepare Cavity for PH CAGE
F. Insert PH CAGE
G. Insert Screw Fixation
H. Close Incision
A. Position Patient

Patient positioning is at the discretion of the surgeon and can be done in any of the beach chair, supine, or supine rolled toward the contralateral side positions on a radiolucent fracture table, or other suitable C-arm and table combination (Figure 1). Set up should facilitate taking AP and lateral images without unnecessary movement of the arm or disruption of provisional fixation.

B. Surgical Approach

The deltopectoral surgical approach for internal fixation of proximal humerus fractures uses the interval between the deltoid and pectoral muscles. The skin incision starts from the coracoid process and is slightly convex toward the medial side, extending distally as far as the deltoid muscle on the lateral humeral shaft.

During dissection, take care to avoid damaging the vasculature of the bone fragments. Avoid ligation or coagulation of the anterior circumflex humeral artery. This can normally be ensured by keeping all dissection lateral to the intertubercular groove (Figure 2).

The PH CAGE can also be implanted through the deltoid split incision or with minimally invasive technique.
C. Reduce Fracture and Position Plate

1. Reduce the fracture using direct or indirect reduction techniques as with other ORIF procedures.

2. Sutures passed through the base of the rotator cuff attachments can help to obtain and maintain reduction and allow later fixation to the implants.

3. Attach the Right or Left Drill Guide Block to the plate by the middle set screw using the H10 Solid Driver and place on the proximal humerus.

When properly positioned for average anatomy, a 2.0mm K-wire through the top hole of the Drill Guide Block targets the superior aspect of the greater tuberosity (Figure 3). In the lateral view, the plate aligns with the shaft and runs along the lateral aspect of the bicipital groove. Adjust the final position based on the specific anatomy and fracture.

4. Check plate position in the AP and lateral views.

5. Proper plate position for CAGE deployment can also be determined using a Colored Sizing Wire and 8.2mm Angled Drill Sleeve, Central. This wire shows the location of the center of the CAGE (Figures 4 & 5). The location and trajectory of the CAGE can be adjusted by moving the plate or using the Lateral or Medial 8.2mm Angled Drill Sleeve.

PH CAGE™ Instruments

- **K-Wire**: 2.0mm (.078”) x 150mm (6”) (1169-2)
- **K-Wire**: Sizing Wire, Colored (6781-1)
- **8.2mm Angled Drill Sleeve** (Lateral: 8019-1; Central: 8019-2; Medial: 8019-3)
- **8.2mm/2.5mm Sizing Wire Sleeve** (8122-1)
- **PH Drill Guide Block** (Left: 8225-1; Right: 8225-2)
D. Provisionally Fix Plate

1. Insert 2.0mm K-Wires to provisionally stabilize the reduced fracture and hold the plate to the bone.
2. Use a 2.5mm Reduction Wire, Handle, and Knob for provisional fixation through the slot in the anterior aspect of the Drill Guide Block (Figure 6). Insert the wire centrally to allow proximal/distal adjustment of the plate.

Wires should avoid interference with the future central position of the CAGE. The plate and Drill Guide Block provide several K-Wire holes for provisional fixation.

Use the holes labeled 1 and 2 in Figure 6 along with any other fixation needed for the fracture.

The holes labeled L (Lateral), C (Central), and M (Medial) provide a provisional medial calcar wire option. The Central hole indicates the lower limit of a fully expanded Large CAGE near the medial calcar when inserted at the central angle (Figure 7). Use the Lateral (hole L) or Medial (hole M) options for a different CAGE orientation (Figure 7-1).

<table>
<thead>
<tr>
<th>MEDIAL</th>
<th>CENTRAL</th>
<th>LATERAL</th>
</tr>
</thead>
</table>

**Figure 7-1:** Medial, Central, and Lateral Cage Placement

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**PH CAGE™ Instruments**

K-Wire: 2.0mm (.078”) x 150mm (6”)  
(1169-2)

Reduction Wire, 2.5mm x 50mm  
(6497-3)

Reduction Wire Handle Knob  
(6935-1)

Reduction Wire Handle  
(6931-1)
D. Provisionally Fix Plate (Continued)

Insert a 3.5mm Cortex Screw in the distal slotted hole and either a Locking or Cortex Screw in another distal hole to hold the plate in place during CAGE insertion.

For a Cortex Screw:

1. Insert using standard cortex screw technique with the 2.9mm Drill Bit, 2.9mm Drill Sleeve, Depth Gauge, and H10 Solid Driver (Figure 8).

For a Locking Screw:

1. Insert using standard locking screw technique with the 2.9mm Drill Bit, 2.9mm Threaded Drill Sleeve, Plate, and H10 Solid Driver. The Drill Sleeve must be removed prior to screw insertion.

A 3.5mm Screw can be inserted for additional fixation in the most proximal screw hole (Figure 9). This screw may interfere with a large or medium CAGE. Substitute the 2.9mm Threaded Drill Sleeve, Guide Block with the standard locking screw steps above, even if inserting a Cortex Screw, to pull the plate and bone together. The screw can be inserted through the Drill Sleeve.

Note: Do not use power to insert screws into the plate.

PH CAGE™ Instruments

- Depth Gauge (1078-2)
- 2.9mm Drill Sleeve (7837-1)
- Driver Handle (Ratcheting: 5542-1 or Fixed: 5450-1)
- 2.9mm Drill Bit, 180mm (7814-1)
- H10 Solid Driver, 120mm (7768-1)
- 2.9mm Threaded Drill Sleeve, Guide Block (7886-1)
- 2.9mm Threaded Drill Sleeve, Plate (7450-1)
E. Prepare Cavity for CAGE

1. Insert the 8.2mm/2.5mm Sizing Wire Sleeve and the 8.2mm Angled Drill Sleeve established in the previous steps into the Drill Guide Block as shown.

2. Insert a Colored Sizing K-Wire. Confirm the tip of the Sizing Wire is located correctly in the AP and lateral radiographic views, typically 5-8mm from the joint surface (Figure 10). To adjust the CAGE placement or trajectory, reposition the plate or change the CAGE angle with a different 8.2mm Angled Drill Sleeve.

2. Read the CAGE size off the back of the Sizing K-Wire (Figure 10-1).
   - Blue-Small
   - Green-Medium
   - Red-Large

3. Remove the Sizing Wire and Sizing Wire Sleeve.

4. Drill through the 8.2mm Angled Drill Sleeve with the 8.2mm Drill Bit. Rotate the drill at full speed and advance slowly. Monitor progress radiographically (Figure 11).

   Note: The CAGE size can be confirmed at this step (Figure 11-1)

   Note: For any Large CAGE or a Medium CAGE at the lateral angle, replace the two temporary reduction K-wires in holes 1 & 2 with ones through holes 3 & 4.

PH CAGE™ Instruments

K-Wires: Sizing Wire, Colored (6781-1)

8.2mm Drill Bit, Colored, 230mm (Solid: 8092-1; Cannulated 7882-1)

8.2mm/2.5mm Sizing Wire Sleeve (8122-1)

8.2mm Angled Drill Sleeve (Lateral: 8019-1; Central: 8019-2; Medial: 8019-3)
E. Prepare Cavity for CAGE (Continued)

5. Insert the fully collapsed PH Cavity Prep Device through the 8.2mm Angled Drill Sleeve and advance the tip to the target location. Confirm position radiographically (Figure 12).

6. Hold the black handle and rotate the gray knob clockwise 1/2 turn (1-2 clicks) to expand the cutting blades.

7. Maintain forward pressure and rotate the Prep Device three times or until no resistance is felt (Figure 13).

8. For a small CAGE, repeat steps 6 and 7 until the black line on the gray knob reaches the handle (Figure 13-1). For a medium or large CAGE fully expand Prep Device. Take regular radiographic images to monitor progress, orienting the flats on the handle perpendicular to the beam to indicate the orientation of the blades.

Note: The Prep Device does not need to be fully expanded; the implant is effective in a wide range of diameters. The blades will deflect and some chatter will indicate contact with cortical bone, often at the medial calcar. Cavity preparation is complete at that point. If the blades bind prior to appropriate expansion, it can help to spin them counterclockwise 1-2 turns to clear the blades.

Note: If any K-wires interfere with cavity prep, they can be removed and replaced by other wire positions.

9. Confirm the final CAGE size using the laser markings on the Prep Device (Figure 14-1).

10. After preparation is complete, collapse the Prep Device by rotating the expansion dial counter-clockwise and remove the device.
F. Insert PH CAGE

1. Open the sterile boxed implant indicated by the measurement in the previous step.

2. Align the square in the CAGE Delivery Tube with the laser marked square in the Delivery Handle and push until they click together (Figure 15).

3. Insert the CAGE Delivery Tube to the target location, aligning the marked square on the Delivery Handle laterally.

4. Maintain forward pressure on the Delivery Handle and rotate the gray knob clockwise to gently deploy the CAGE into the prepared cavity (Figure 16).

5. Once the CAGE is fully deployed, gently pull the Delivery Handle to disengage it from the implant. **Note:** If previous screws or K-Wires interfere with CAGE placement, they can be retracted during deployment and reinserted through the CAGE.

6. Attach the Rotation Instrument to the Driver Handle and the CAGE Delivery Tail using the quick connect features (Figure 17) and rotate 2-3 times to properly seat the CAGE while maintaining forward pressure (Figure 18).

7. Align the lever of the Rotation Instrument with the line on the Drill Guide Block (facing laterally) when rotation is complete. Confirm expansion of the CAGE radiographically. **Note:** Do not rotate the CAGE if it requires excessive force or compromises fracture reduction.

**PH CAGE™ Instruments**

- Delivery Handle, PH (4511-1)
- Driver Handle (Ratcheting: 5542-1 or Fixed: 5450-1)
- Implant Rotation Instrument (4975-1)
F. Insert PH CAGE (Continued)

8. Insert the **H10 Solid Driver, 160mm** into the **CAGE Delivery Tube** until it engages the screw in the CAGE tail.

9. Turn the screw clockwise until it stops (about 12 turns) to lock the size of the CAGE. The laser mark on the driver shaft indicates when the screw has advanced fully as it reaches the back of the **Delivery Tube** (Figure 19).

**Note:** This locking step should be done to two-finger tight only. Do not overtighten.

10. Remove the **Angled Drill Guide** and attach the **Jig, Distal Screw Targeting** to the tail of the **CAGE Delivery Tube**.

11. Drill through the far cortex using the **2.9mm Drill Bit** (Figure 20).

**Note:** Generally, the near cortex at this level has already been removed. This step drills the far cortex only.

12. Measure screw length off the back of the **Drill Bit**.

13. Insert a **3.5mm Locking Screw** using the **H10 Solid Driver** through the **Targeting Jig**.

**Note:** The laser mark on the driver shaft indicates when the screw is seated in the plate as it reaches the back of the **Targeting Jig** or **Drill Sleeve**.

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**PH CAGE™ Instruments**

- **H10 Solid Driver, 120mm** (7768-1)
- **2.9mm Drill Bit** (7814-1)
- **H10 Solid Driver, 160mm** (7798-1)
- **Jig, Distal Screw Targeting** (6650-1)
- **Driver Handle** (Ratcheting: 5542-1 or Fixed: 5450-1)
G. Insert Screw Fixation

Screws can be inserted through the plate or outside of the plate with cannulated instrumentation as dictated by the fracture pattern. When possible, screws should target the CAGE for optimal fixation.

Proximal Screws Through the Plate (Figures 21-1,2):

First, insert the two proximal CAGE screws and one of the inferior CAGE screws (Figure 21). Once these screws are inserted, provisional fixation can be removed and additional screws inserted as dictated by the fracture.

Note: K-wire 5 should be removed before placing mid plate screws.

1. Insert screws using standard locking screw technique with the 2.9mm Drill Bit, 2.9mm Threaded Drill Sleeve, Guide Block, 3.5mm Screw Depth Probe, and H10 Solid Driver (Figure 21-2, 3). Screws can be inserted through the Drill Sleeve.

Note: Do not use power to insert screws into the plate.

PH CAGE™ Instruments

- 2.9mm Threaded Drill Sleeve, Guide Block (7886-1)
- 2.9mm Drill Bit (7814-1)
- H10 Solid Driver, 120mm (7768-1)
- 3.5mm Screw Depth Probe, 58mm (7785-1)
- Driver Handle (Ratcheting: 5542-1; Fixed: 5450-1)
G. Insert Screw Fixation (Continued)

Cannulated Screws Outside the Plate:

1. Insert using standard cannulated screw technique with the 1.6mm K-Wire, Cannulated Depth Gauge, 2.9mm Cannulated Drill Bit, and H10 Cannulated Driver (Figure 22, -1).

2. If additional fixation within the bone is needed or for later attachment of sutures, slide a Suture Washer, 3.5mm over the screw prior to insertion. Additional exposure may be needed (Figure 22-1).

Note: Monitor screw insertion radiographically to ensure the wire is not inadvertently advanced.

Note: When using outside of the plate, the Cannulated Depth Gauge gives a true reading. When used to place cannulated screws through the plate, 2mm should be added to the measurement to accommodate the thickness of the plate.

PH CAGE™ Instruments

K-Wires:
- 1.6mm (.062") x 200mm (8") (8117-1)
- 1.6mm (.062") x 370mm (14.5") (6290-1)

Cannulated Depth Gauge, 1.6mm, 180mm K-Wire (8116-1)

H10 Cannulated Driver, 120mm (7036-1)

2.9mm Cannulated Drill Bit, 150mm (4754-1)

Driver Handle
(Ratcheting: 5542-1 or Fixed: 5450-1)
G. Insert Screw Fixation (Continued)

Distal Screws Through the Plate:

Distal screws through the plate can be either 3.5mm Cortex Screws for all holes or 3.5mm Locking Screws for the round threaded holes.

1. If not previously done, remove the CAGE Delivery Tail using the Delivery Tube Removal Hex Driver.

For a Cortex Screw:

2. Insert using standard cortex screw technique with the 2.9mm Drill Bit, 2.9mm Drill Sleeve, Depth Gauge, and H10 Solid Driver (Figure 23).

For a Locking Screw:

2. Insert using standard locking screw technique with the 2.9mm Drill Bit, 2.9mm Threaded Drill Sleeve, Plate, and H10 Solid Driver. The Drill Sleeve must be removed prior to screw insertion.

Note: Do not use power to insert screws into the plate.

PH CAGE™ Instruments

- 2.9mm Drill Bit (7814-1)
- Depth Gauge (1078-2)
- H10 Solid Driver, 120mm (7768-1)
- 2.9mm Threaded Drill Sleeve, Plate (7450-1)
- Delivery Tube Removal Hex Driver (7792-1)
- 2.9mm Drill Sleeve (7837-1)
G. Insert Screw Fixation (Continued)

Distal Screw Through the PH CAGE Tail:

An additional 3.5mm Cortex Screw can be inserted by freehand technique into the tail of the CAGE as dictated by the fracture pattern (Figure 24-1, 2).

1. Drill the far cortex using the 2.9mm Drill Bit through the 2.9mm Drill Sleeve (Figure 24-1).

2. Measure screw length using the Depth Gauge.

3. Insert the screw using the H10 Solid Driver.

Note: Do not use power to insert screws into the tail.

PH CAGE™ Instruments

2.9mm Drill Bit (7814-1)

2.9mm Drill Sleeve (7837-1)

Depth Gauge (1078-2)

H10 Solid Driver, 120mm (7768-1)
H. Close Incision

1. Attach the previously placed sutures to the proximal suture holes in the plate or to the Suture Washer used with the independent screws. If attaching sutures to a washer, avoid bending washer eyelets and ensure each eyelet of the washer accommodates only one suture.

2. Close the incision using standard technique.
Implants, Screws, Plates

Conventus PH CAGE
• Small 59 mm (PH-S)
• Medium 67 mm (PH-M)
• Large 73 mm (PH-L)

Cortex Screws, 3.5mm
• Screw Lengths: 20mm-56mm, in 2mm increments (SC35xx)

Locking Screws, 3.5mm
• Screw Lengths: 20mm-56mm, in 2mm increments (SL35xx)

Canulated Screws, 3.5mm
• Screw Lengths: 16mm-68mm, in 2mm increments (CH35xx)

Suture Washer
(6038-1)

PH Locking Plate, Short, 86mm (PH-LPS)

PH Locking Plate, Long, 112mm (PH-LPL)
**Wires**

- K-Wires:
  - 1.6mm (.062”) x 200mm (8”) (8117-1)
  - 1.6mm (.062”) x 370mm (14.5”) (6290-1)
  - 2.0mm (.078”) x 150mm (6”) (1169-2)

- 2.5mm Colored Sizing Wire (6781-1)

- Reduction Wire 2.5mm x 50mm (6497-3)

**Drills and Drivers**

- 2.9mm Drill Bit, 180mm (7814-1)

- 8.2mm Drill Bit, Colored, 230mm (Solid: 8092-1; Cannulated 7882-1)

- 2.5mm Guide Pin, Blunt Tip (3663-1)

- Drill Bit, 2.9mm Cannulated (4754-1)

- H10 Solid Driver, 120mm (7768-1)

- H10 Solid Driver, 160mm (7798-1)

- H10 Cannulated Driver, 120mm (7036-1)

- Delivery Tube Removal Hex Driver (7792-1)
Surgical Instruments

PH Drill Guide Block
(Left: 8225-1)
(Right: 8225-2)

PH Drill Guide Block Screw
(7896-1)

8.2mm Angled Drill Sleeve
(Lateral: 8019-1)
(Central: 8019-2)
(Medial: 8019-3)

8.2mm/2.5mm Sizing Wire Sleeve
(8122-1)

Driver Handle, AO Fixed
(5450-1)

Driver Handle, AO, Ratcheting
(5542-1)
### Surgical Instruments

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<th>Instrument</th>
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## Surgical Instruments

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This page contains an overview of the PH CAGE™ Surgical Technique, highlighting the surgical instruments used in the procedure.
### Surgical Instruments

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<td>Screw Forceps</td>
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<td>Wire Plunger, PH</td>
<td>(4601-1)</td>
<td>PH Cage™ Surgical Technique</td>
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</table>

**Note:** Instrument in standard set not shown - 8.2mm Obturator (6456-1)

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Products listed may not be available in all markets.