Surgical Techniques
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Conventus Cage™ PH

Features:

- The Conventus CAGE™ PH (PH Cage) is a permanent implant comprised of an expandable scaffold, made from nitinol and titanium, which is deployed into the medullary canal and provides a structure to which bone fragments are attached using fragment screws.
- Effective solution for 2, 3, and 4 part fractures.
- Provide fragment specific fixation.
- Designed for secure fixation in all bone, even osteoporotic.
- May preserve soft tissues.
- Multiple size and location options are available.

Multiple Size and Location Options
Central, Lateral, and Medial Implant Placement
AO Principles

**Anatomic Reduction**
Fracture reduction and fixation to restore anatomical relationships

**Stable Fixation**
Stability by fixation or splintage, as the personality of the fracture and injury requires

**Preservation of Blood Supply**
Preservation of the blood supply to soft tissue and bone by careful handling

**Early, Active Mobilization**
Early and safe mobilization of the part and the patient
Indications & Contraindications

Indication:
The Conventus CAGE™ PH 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.
OR Set-Up

Recommended OR Set-Up:
Radiolucent fracture table, or other suitable C-arm / table combination. Must be able to obtain AP & lateral images without unnecessary movement/disruption of provisional fixation. C-arm must remain in place during surgery and be rotated to obtain AP & lateral images.

Approach:
The standard surgical approach for internal fixation of proximal humerus fractures is 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 (solid red line).
During the 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.

Image courtesy of AO Foundation.
Retrograde – Direct Access Jig*

**Step 1 – Fracture Reduction and Provisional Stabilization**

**Instruments Needed**
- Direct Access Jig
- 2.0mm K-Wires, 4” long
- 2.0mm, 2.5mm, 3.0mm Reduction Wires
- Reduction Handle
- Distal Drill Guide
- 3.1mm Non-Cannulated Drill
- Depth Gauge, 50mm

Apply Direct Access Jig while maintaining provisional reduction manually or with temporary reduction wires. (Figure A)

Plate can be adjusted laterally in necessary. When properly aligned, the 2.0mm K-wire should be directed toward the center of the humeral head in a lateral view.

Confirm proper alignment of humeral head to humeral shaft. Place K-wires through Direct Access Jig into humeral shaft. (Figures B & C)

Typically, two wires in the head and two in the shaft are sufficient to maintain reduction.

**Note:** Distal screw can also be used to provide fixation. Use Distal Drill Guide to align the 3.1mm Drill and measure required screw length. Screw length can be measured using marks on 3.1mm Drill as shown in Figure B, or alternatively the standard Depth Gauge.

**Optional Technique: Tension band with sutures**

Use sutures attached to the tuberosity fragments to manipulate them until provisional fixation is obtained. The sutures can later be attached to the plate by passing them through the suture holes with undercuts.
Step 2 – Access

Instruments Needed
Angled Bushing (25°, 30°, 35°)
Sizing Wire Guide Bushing
2.0mm K-wire, 6”
8.0mm Cannulated Drill

Place Angled Bushing and Sizing Wire Guide Bushing into the distal boss of the Direct Access Jig.

Use appropriate Angled Bushing according to target location (25°, 30°, 35°).

Drive 2.0mm K-wire through Wire Guide Bushing into humeral head. (Figure D)

Confirm tip of K-wire is located centrally within the humeral head in AP and lateral radiographic views (target location). Exchange bushings 25°, 30°, 35° and repeat target wire step to obtain desired implant location; central, medial, lateral.

Remove Sizing Wire Guide Bushing and K-wire. Place 8.0mm Cannulated Drill through Angled Bushing and advance drill slowly with spindle rotating at high speed to reach target location. (Figure E)

8.0mm Cannulated Drill is typically advanced until it is 5-8mm from the joint surface.

Note: Drill should be perpendicular to fluoroscopic detector for accurate measurement.
Step 3 – Site Preparation

Instruments Needed

Implantation Site Preparation Instrument

Insert the fully collapsed Implantation Site Preparation Instrument into the Angled Bushing and advance to the target location. Confirm position fluoroscopically.

Measure implant length on Implantation Site Preparation Instrument (small, medium, large). Repeat 8.0mm Cannulated Drill step if larger implant is desired, being careful under fluoroscopy not to drill too close to subchondral surface.

Rotate the entire Implantation Site Preparation Instrument 3 times.

Slightly expand the cutting flutes by rotating the expansion knob clockwise ¼ turn (1-2 clicks).

Complete site preparation by repeating 3 entire device turns per each expansion knob click until tactile and audible feedback and/or fluoroscopy indicate the cutting flutes are nearing the cortical wall. (Figure F)

Remove or retract any wires that interfere with rotation of the Implantation Site Preparation Instrument.

Note: The Implantation Site Preparation Instrument does not need to be fully expanded; the implant is effective in a wide range of diameters.

Fully collapse the Implantation Site Preparation Instrument by rotating the expansion dial counterclockwise until it stops and remove from the access site.
Step 4 – Conventus CAGE™ PH Implant Delivery, Rotation and Locking

**Instruments Needed**

Delivery Handle with preloaded Cage Delivery Tube
Implant Rotation Instrument
H10 Long Driver

Advance Delivery Device up to target location. Deploy Cage by rotating Delivery Handle knob clockwise.

Using H10 Long Driver, lock implant locking screw. (Figure G)

Attach Implant Rotation Instrument to Cage Delivery Tube and manually rotate the Cage multiple times to properly seat Cage. (Figure H)

**Note:** Cage should not be rotated if excessive force is required or fracture reduction is being compromised.

Ensure that release lever of Implant Rotation Instrument is aligned with center of Direct Access Jig when rotation is complete.

Confirm expansion of Cage fluoroscopically.

Tighten Cage locking screw to lock Cage in expanded state.
Step 5 – Distal Targeting/Implant Fixation

Instruments Needed
Distal Screw Targeting Jig
3.1mm Non-Cannulated Drill
3.5mm Cannulated Screw

Attach Distal Targeting Jig to Cage Delivery Tube.
Ensure Cage Locking Screw is fully advanced prior to drilling.
Drill bicortically using 3.1mm Non-Cannulated Drill. (Figure I)
Measure 3.5mm Cannulated Screw length using markings on drill.
Insert 3.5mm Cannulated Screw. (Figure J)

Note: Drill should be perpendicular to fluoroscopic detector for accurate measurement.
Step 6 – Secure Fragments

Instruments Needed

0.062” K-wire
Cannulated Depth Gauge
2.9mm Tissue Protector
2.9mm Cannulated Drill
3.5mm Cannulated Screw

Use 2.9mm Tissue Protector to find trajectory as defined by Tissue Protector in plate hole. Fully seat Tissue Protector into plate. (Figure K)

Place 0.062” K-wire through Tissue Protector.

The wire should come close to the subchondral bone, approximately 5mm from the joint surface. Wire should be perpendicular to fluoroscopic detector for accurate measurement.

Remove Tissue Protector and measure screw length using Depth Gauge. (Figure L)

Place 2.9mm Tissue Protector over K-wire and drill near cortex with 2.9mm Cannulated Drill. (Figure M)

Place 3.5mm Cannulated Screw.

Repeat above procedure for additional proximal screws.
Recommended Screw Pattern

Left Arm (Figure N)

Right Arm (Figure O)
Step 7 – Proximal Targeting

Instruments Needed

Proximal Screw Targeting Jig
.062" K-wires
Depth Gauge, 50mm
2.9mm Cannulated Drill
3.5mm Cannulated Screws
Suture Washers
Delivery Tube Removal, 5/32 Hex
Wire Plunger

Attach Proximal Screw Targeting Jig to Cage Delivery Tube.

Insert 0.062" K-wires for Cannulated Screws. Measure screw length using Depth Gauge. (Figure P)

Drill using 2.9mm Cannulated Drill over K-wire.

Insert 3.5mm Cannulated Screws, with 5-hole suture washers, over the K-wires and through the Cage to secure fragments. (Suture Washers may be used with any fragment screw for buttress of poor quality bone or attachment of suture).

Remove Cage Delivery Tube utilizing 5/32 Hex Driver.

Note: Care should be taken when drilling over .062" K-wire to avoid advancing the K-wire into the Axilla or other soft-tissue structures on the medial aspect.

Note: A Wire Plunger may be used with short (5") K-wires to avoid removing the K-wire with the drill. Alternatively, longer K-wires may be used to manage wire and avoid advancing or removal of K-wire with drilling.
Step 8 – Final Construct

Instruments Needed
3.5mm Cannulated Screws

Drill, measure, and insert final distal 3.5mm screws. Remove all K-wires and remove Direct Access Jig. Repair cuff attaching suture to Suture Washers and/or suture attachment points on Large Plate.

**Note:** The stability of the construct can be increased with the insertion of sutures. Use sutures attached to the tuberosity fragments attached to the plate by passing them through the suture holes with undercuts.

**Note:** Avoid bending washer eyelets. One suture per eyelet recommended.

**Note:** Use recommended screw pattern as a guide for the minimum number of screws inserted during final construct.

Close all incisions in standard fashion.

Standard post-operative protocol for surgical treatment of proximal humerus fractures is followed per surgeon discretion.

**Recommended Screw Pattern: Left arm (Figures Q & R)**

For right arm, location of screws 3, 4, and 5 switches to opposite side of plate (denoted by blue circles in Figure Q).
Retrograde – Manual

Step 1 – Fracture Reduction and Provisional Stabilization

Instruments Needed

- Reduction Jig
- .062” K-Wires
- 4” Target Wire

Apply Reduction Jig while maintaining provisional reduction manually or with temporary reduction wires.

Use 0.062” K-wire to align Reduction Jig with the top of the Greater Tuberosity (Figures A & B) and position anterior jig leg over Bicipital Groove (center of jig frame aligned just lateral to insertion of pectoralis major).

Place K-wires or temporary screws though Reduction Jig into humeral head.

Confirm proper alignment of humeral head to humeral shaft. Place K-wires external to Jig frame.

Insert 4” Target Wire (shown in blue) through jig with wire tip 3-5 mm below articular surface. (Figures C & D)
Step 2 – Access

**Instruments Needed**

Access Targeting Jig
2.5mm Side-Cutting Drill
2.5mm Guide Pin
8.0mm Cannulated Drill

Use calibrated X-ray or CT to choose Cage size, location and associated Access Targeting Jig. Full expanded Large, Medium, and Small PH Cages are 73mm, 67mm, and 59mm long, respectively.

The access point is identified using the implant Access Targeting Jig placed over the Target Wire. (Figure E)

Access the intramedullary canal with 2.5mm Side-Cutting Drill.

**Note:** 2.5mm drill should be centered between Reduction Jig Arms and centered on bone. (Figure F)

With drill aimed at the Target Wire, advance with spindle rotating at high speed. Confirm via fluoroscopy (2 projections).

Replace drill with 2.5mm Guide Pin and manually advance to the Target Wire. Confirm position fluoroscopically (2 projections).

Place 8.0mm Cannulated Drill over Guide Pin. Advance drill slowly with spindle rotating at high speed. (Figure G)

**Note:** The target wire may need to be partially retracted to allow the 8.0mm Cannulated Drill to reach target location.
Step 3 – Site Preparation

Instruments Needed

Implantation Site Preparation Instrument

Utilize calibrated X-Ray or CT to choose Cage size, location and associated Access Targeting Jig. Large, Medium, and Small PH Cages are 73mm, 67mm, and 59mm long fully expanded.

Insert the fully collapsed Implantation Site Preparation Instrument into the access site and advance to the implant Target Wire. Confirm position fluoroscopically. (Figure H)

Rotate the entire Implantation Site Preparation Instrument 3 times.

Slightly expand the cutting flutes by rotating the expansion knob clockwise ¼ turn (1-2 clicks).

Complete cavity preparation by repeating 3 entire device turns per each expansion knob click until tactile and audible feedback and/or fluoroscopy indicate the cutting flutes are nearing the cortical wall.

Remove any wires that interfere with rotation of the Implantation Site Preparation Instrument.

Note: The Implantation Site Preparation Instrument does not need to be fully expanded; the implant is effective in a wide range of diameters. The Target Wire may need to be partially retracted to fully expand the Implantation Site Preparation Instrument.

Fully collapse the Implantation Site Preparation Instrument by rotating the expansion dial counterclockwise until it stops and remove from the access site.
Step 4 – PH Cage Implant Delivery, Rotation, and Locking

Instruments Needed

Delivery Handle with preloaded Cage Delivery Tube
Implant Rotation Instrument
H10 Long Driver

Advance Delivery Device through access site and up to Target Wire. Deploy Cage by rotating Delivery Handle knob clockwise.

Using H10 Long Driver, lock implant locking screw. (Figure I)

Attach Implant Rotation Instrument to Cage Delivery Tube and manually rotate Cage multiple times to properly seat Cage. (Figure J)

Note: Cage should not be rotated if excessive force is required or fracture reduction is being compromised.

Ensure that release lever of Implant Rotation Instrument is aligned with center of Reduction Jig when rotation is complete.

Confirm expansion of Cage fluoroscopically.

Tighten Cage Locking Screw to lock Cage in expanded state.

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Step 5 – Distal Targeting/Implant Fixation

Instruments Needed
Distal Screw Targeting Jig
3.1mm Non-Cannulated Drill
3.5mm Cannulated Screws

Attach Distal Targeting Jig to Cage Delivery Tube.

Note: Ensure Cage Locking screw is fully advanced prior to drilling.

Drill bicortically using 3.1 mm Non-Cannulated Drill.
Measure screw length using graduations on drill. (Figure L)
Insert 3.5 mm Cannulated Screw.
### Step 6 – Proximal Targeting/Fragment Fixation

#### Instruments Needed
- Proximal Screw Targeting Jig
- 0.062” K-wires
- 2.9mm Cannulated Drill
- 3.5mm Cannulated Headed Screws
- Suture Washers
- Depth Gauge
- Delivery Tube Removal, 5/32 Hex Driver

Attach Proximal Screw Targeting Jig to Cage Delivery Tube.

Insert 0.062” K-wires for Cannulated Headed Screws. Measure screw length using Depth Gauge. (Figure M)

Drill using 2.9mm Cannulated Drill over K-wire.

Insert 3.5mm Cannulated Headed Screws over the K-wires and through the Cage to secure fragments. (Suture Washers may be used with any fragment screw for buttress of poor quality bone or attachment of suture).

**Note**: Two bicortical screws across the fracture line will provide optimal biomechanical integrity.

Remove Cage Delivery Tube utilizing 5/32 Hex Driver.
Step 7 – Final Construct

Instruments Needed

2.9mm Cannulated Drill
Depth Gauge
3.5mm Cannulated Headed Screws
Suture Washers

Drill, measure, and insert final distal 3.5mm screw(s).

Remove K-wires for proximal screws and provisional fixation.

Repair cuff attaching suture to Suture Washers.

Recommended Screw Pattern Figures M & N.

Note: Avoid bending washer eyelets. One suture per eyelet recommended.

Note: Use recommended screw pattern as a guide for the minimum number of screws inserted during final construct.

Close all incisions in standard fashion.

Standard post-operative protocol for surgical treatment of proximal humerus fractures is followed per surgeon discretion.
POST-OPERATIVE REMOVAL: The Conventus Cage – PH is intended to be a permanent implant and does not need to be removed. If removal is desired after healing has started, the Conventus Removal Set should be used. Please contact a Conventus representative to obtain a removal set and removal technique.

Acute Removal

Intra-operative removal of the Cage after delivery and expansion, the Cage Delivery Tube still attached (A) and removed (B). Prior to Cage Removal, ensure all fragment screws are removed and Cage locking screw is disengaged.

A. Step 1

Instruments Needed

Acute Removal Connector
Delivery Handle

Insert Acute Removal Connector (ARC) into the distal end of the Cage Delivery Tube until it clicks in place.
A. Step 2

Turn gray knob clockwise to retract shuttle in preparation for attaching Delivery Handle. Attach Delivery Handle by rotating black body clockwise to engage threads on ARC.
A. Step 3
Retract implant into the Cage Delivery Tube by rotating gray knob on Delivery Handle counter-clock-wise. When fully retracted, remove Cage.

Note: ARC can be removed from Cage Delivery Tube by depressing locking tab and pulling.
B. Step 1

**Instruments Needed**

Acute Removal Extension  
Delivery Handle

Acute Removal Extension threads into Cage.

Turn gray knob clockwise to retract shuttle in preparation for attaching Delivery Handle. Attach Delivery Handle by rotating black body clockwise to engage threads on Acute Removal Extension.
B. Step 2

Retract implant into the Cage Delivery Tube by rotating gray knob on Delivery Handle counterclockwise. When fully retracted, remove Cage.
Implants and Screws

Conventus Cage
- Small (PH-S), 59mm length
- Medium (PH-M), 67mm length
- Large (PH-L), 73mm length

Cannulated Head Screws Ø 3.5mm
- Chip-breaking (3.5mm major diameter; 3.0mm minor diameter)
- Screw Lengths (16mm – 68mm in 2mm increments)

Suture Washer, 3.5mm, 5 Hole

Large Plate
Surgical Instruments

Drills, Driver Tips, and Pins
- 2.5mm Side Cut
- 2.9mm Cannulated
- 3.1mm Non-Cannulated
- 8.0mm Cannulated
- 2.5mm Guide Pin
- Driver Assembly H10, Long
- Driver Assembly H10, Short
- Hex Driver

Implantation Site Preparation Instrument

Driver Handle, Ratcheting

Direct Access Jig

Direct Access Handle

Wire Plunger

Depth Gauge, 50mm
Cannulated Depth Gauge

Access Targeting Jig
- Small
- Medium
- Large

Delivery Handle

Implant Rotation Instrument

Bushings
- Angled Bushings 25°, 30°, 35°
- Sizing Wire Guide Bushing

Distal Screw Targeting Jig
Screw Forceps

Proximal Screw Targeting Jig

Tissue Protectors
- Tissue Protector, 8.0mm Drill
- Obturator, 8mm Drill
- Tissue Protector, 2.9mm/4.7mm Drill
- Tissue Protector, K-wires, .062”/2.0mm
Reduction Wire Handle

Reduction Wire
- 2.0mm x 50mm
- 2.5mm x 50mm
- 3.0mm x 50mm

Reduction Wrench

Reduction Jig

K-Wires
- .078" x 4"
- .078" x 6"
- .062" x 5"
- .062" x 14.5"

Acute Removal Connector

Acute Removal Extension

Distal Drill Guide