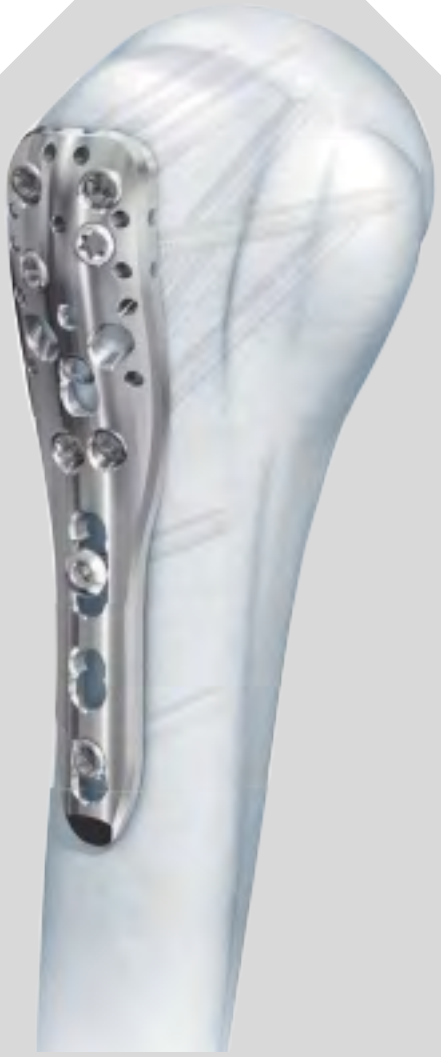
Auxein



Surgical Technique

3.5mm Wise-Lock Proximal Humerus Plate

www.auxein.com

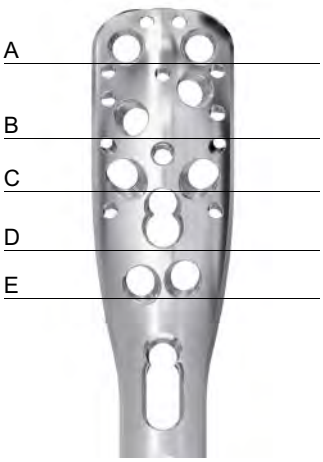
3.5mm Wise-Lock Proximal Humerus Plates

Proximal locking holes

- Provide flexibility in screw placement, allowing different constructs
- Permit multiple points of fixation to support the humeral head

Note:

For information on fixation principles using conventional and locked plating techniques, please refer to the *Small Fragment Locking Compression Plate (Wise-Lock) System Technique Guide*.



A, C, D, and E level screws for a “diverging” screw pattern

A, B, and D level screws for a “converging” screw pattern

Clinical example using A, B, C, and E level screws

INDICATIONS

The 3.5 mm Wise-Lock Proximal Humerus Plate is part of the small fragment Wise-Lock system. This plate addresses complex fractures of the proximal humerus.

The 3.5 mm Wise-Lock Proximal Humerus Plate is indicated for fractures and fracture dislocations, osteotomies, and nonunions of the proximal humerus, particularly for patients with osteopenic bone.

Patient position

A beach-chair position is recommended to provide easy access to the shoulder with imaging equipment.

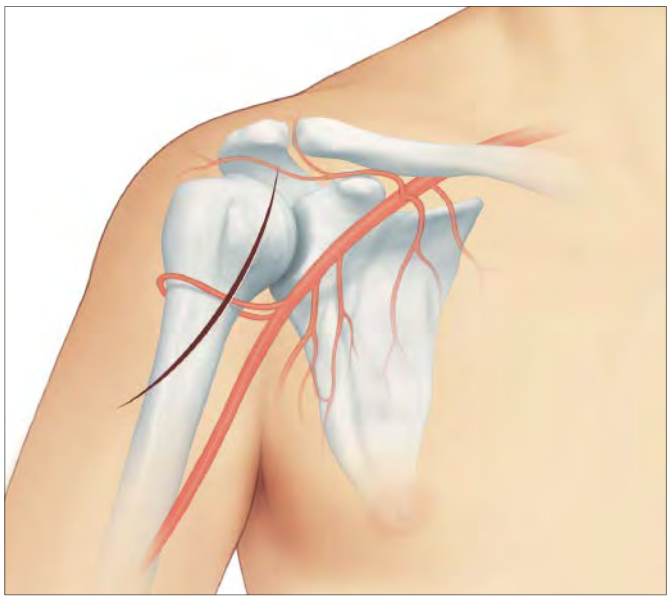
Approach

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

For long plates, the incision may be extended as an anterior approach to the humeral shaft, which proceeds distally between the biceps and the brachialis, and then down the anterolateral aspect of the arm to just above the elbow flexion crease.

During the dissection, care should be taken to avoid damaging the vasculature of the bone fragments. Care should also be taken to avoid ligation or coagulation of the anterior circumflex humeral artery. This can normally be assured by keeping all dissection lateral to the intertubercular groove.

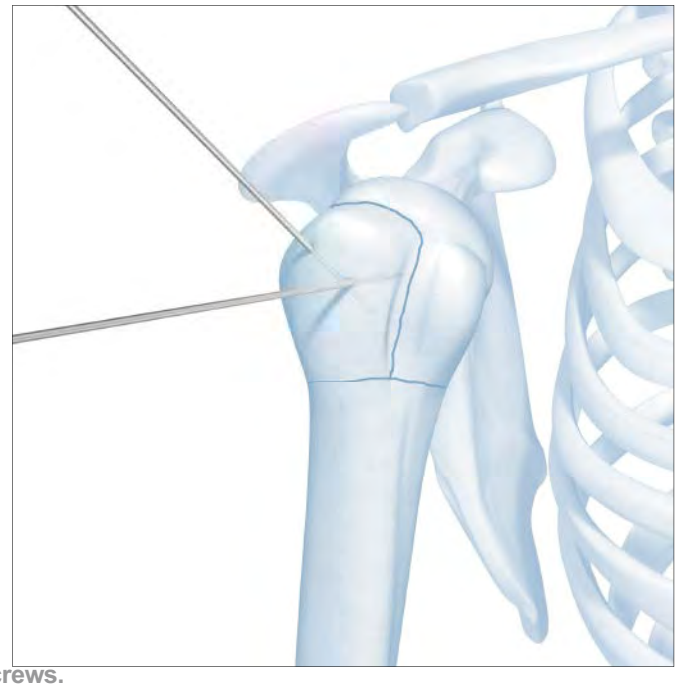
Note:
For information on open reduction approaches for proximal humerus, please refer to Rüedi TP and Murphy WM: *AO Principles of Fracture Management* Stuttgart, New York; Thieme, 2000, pp. 274–277.



Warnings:

- Do not injure the axillary nerve. The axillary nerve can be palpated at the lower margin of the incision.
- To avoid damaging the axillary nerve, do not split the deltoid more than 4 cm distal to its origin.

Reduce fracture



Reduce the fracture fragments and confirm the reduction under image intensification.

The humeral head and tuberosity fragments may be manipulated and provisionally fixed with sutures and/or Kirschner wires. However, Kirschner wires should be placed where they will not interfere with plate application.

Note: The locking screws do not provide any compression for a lag screw effect. Therefore, humeral head fragments must be reduced, and any desired interfragmentary compression must be obtained prior to applying the 3.5 mm Wise-Lock Proximal Humerus Plate with locking screws.

Optional technique: tension band with sutures
The stability of the construct can be increased with the insertion of 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.

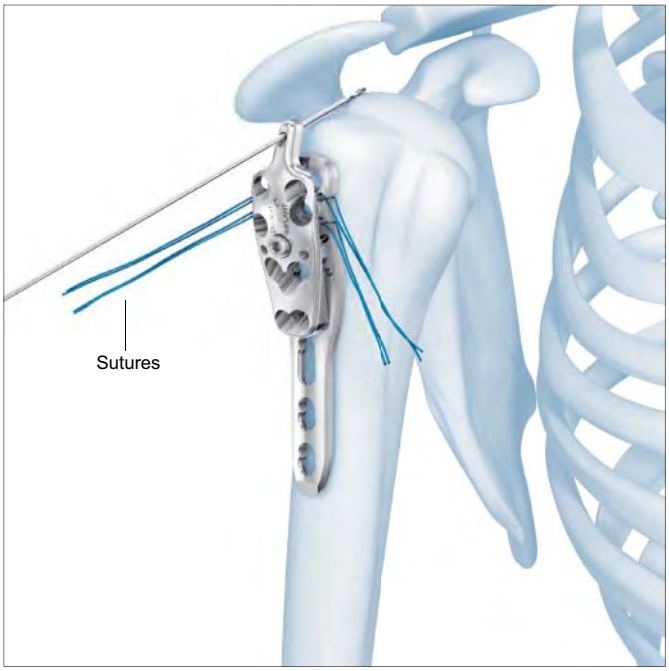
Note:
If the insertion guide is attached to the plate while passing the sutures, remove the insertion guide so that the sutures can be attached to the plate.

Attach insertion guide to plate

Insertion guide: top view (left) and bottom view (right).

To facilitate insertion of the proximal locking screws, place the insertion guide against the plate and tighten the guide's attachment screw with the small hexagonal screwdriver, to lock the guide against the plate.

Position plate on bone



Positioning from AP view
The plate should be placed approximately 8 mm distal to the rotator cuff attachment on the upper edge of the greater tuberosity.

Determine plate position by placing a 1.6 mm K-wire through the proximal guide hole of the insertion guide so that the K-wire rests on top of the humeral head and aims at the proximal joint surface.

Precaution:

Placing the plate too high increases the risk of subacromial impingement. Placing the plate too low can prevent the optimal distribution of screws in the humeral head.

Warnings:

- **Do not injure the axillary nerve. The axillary nerve can be palpated at the lower margin of the incision.**
- **To avoid damaging the axillary nerve, do not split the deltoid more than 4 cm distal to its origin.**

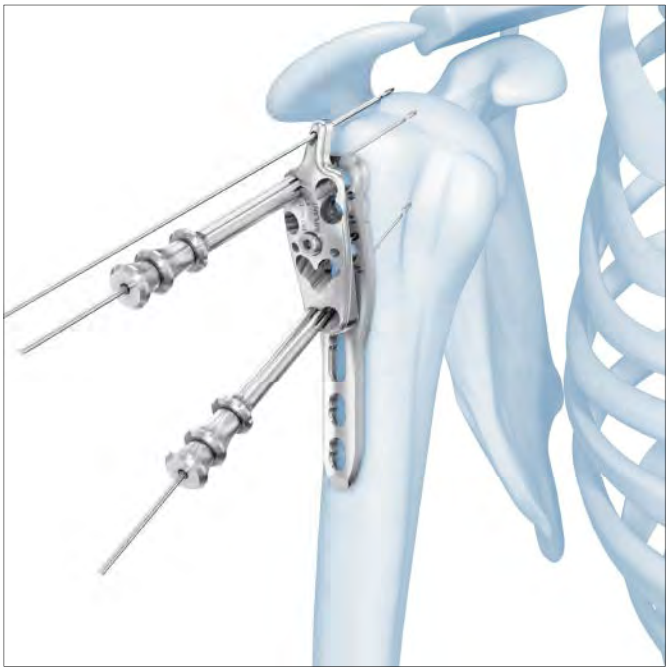
Positioning from a lateral view
The plate should be centered against the lateral aspect of the greater tuberosity, ensuring that a sufficient gap is maintained between the plate and the long biceps tendon (to avoid interfering with arterial blood supply).

To check final placement of the plate, 1.6 mm K-wires and two sleeve assemblies can be used: one in the hole for the most proximal screw and one in the hole for the most distal screw to be placed in the humeral head. If possible, the distal K-wire should be positioned approximately 5 mm above the calcar.

Additional considerations for long plates
The additional length of the long plates will usually require a plan for handling the deltoid insertion distally. Depending on the length of the plate used, a slightly anterior placement of the distal shaft, contouring of the plate shaft to wrap anteriorly around the humerus, or partial elevation of the deltoid insertion may be required.

Precaution:

To maintain proper alignment between the insertion guide and the plate, intraoperative bending of the proximal portion of the plate is not recommended.



Insert screws
Determine the combination of screws to be used for fixation. If a combination of locking and cortex screws will be used, cortex screws should be inserted first to pull the plate to the bone.

The placement of the initial screw will depend on the fracture type and the reduction achieved. There are two options for the order of screw insertion:

Option 1

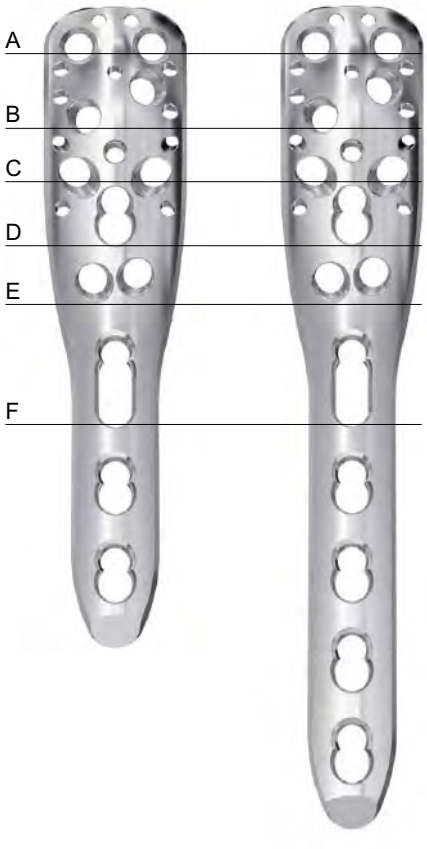
Insertion of a proximal screw first
This technique permits fixation of the proximal fragments first and then fixation with or without compression distally.

It is necessary to control the height of the plate in the AP view under image intensification before insertion of the screws.

Option 2

Insertion of a distal screw first
This technique permits reduction of the distal shaft fragment against the plate and a final height adjustment prior to the insertion of the other screws in the shaft.

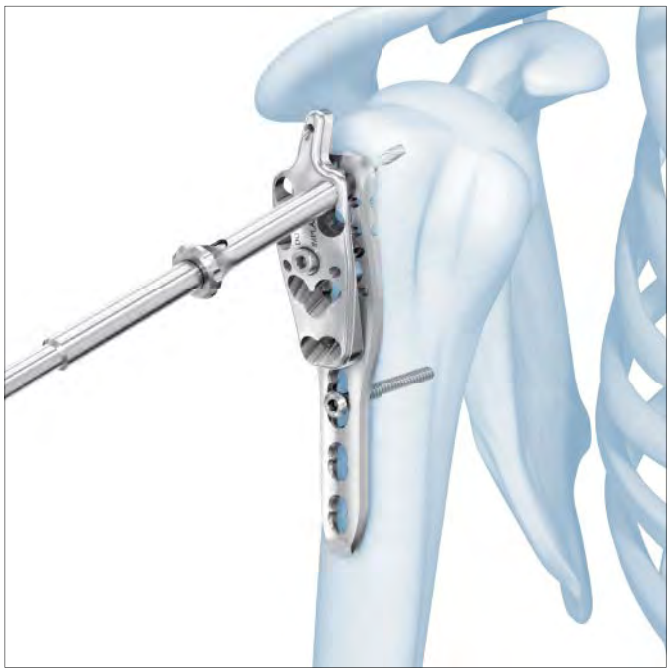
Insert a standard cortex screw into the compression portion of hole F (elongated hole) of the standard plate, or in any of the elongated holes of a long plate. After making a final height adjustment, insert proximal locking screws.



Proximal locking screws in osteoporotic bone
The following technique is recommended for measuring screw length in osteoporotic bone. If normal bone is present, use the alternative technique on page 15.

Insert the outer sleeve for insertion guide into the insertion guide with nose.

Predrill the lateral cortex using the 2.8 mm drill bit with stop.



Warnings:
- **In porotic bone, only drill the lateral cortex.**
- **Do not drill through the joint surface.**
- **Do not insert overly long screws in order to prevent primary or secondary screw penetration.**

Proximal locking screws in osteoporotic bone (continued)

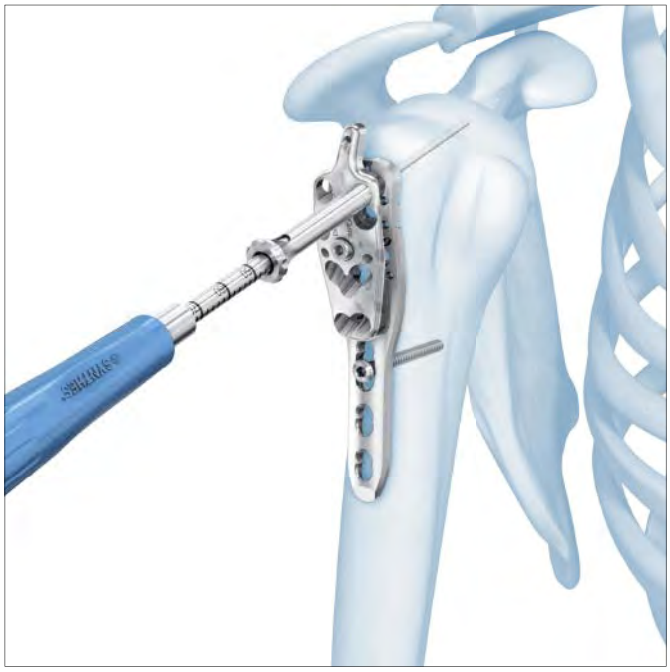
Insert the depth probe through the outer sleeve. Stop when increased resistance from the subchondral bone is felt. Read the required screw length on the depth probe.

Note:
The depth probe tip should come as close as possible to the subchondral bone, approximately 5 mm–8 mm from the joint surface. Since it may not always be possible to feel the resistance from the subchondral bone, and the depth probe represents the final position of the locking screw, the use of image intensification is recommended.

Warning:
Do not push the depth probe through the joint surface.

Use the StarDriveScrewdriver to insert the appropriate length locking screw through the outer sleeve for insertion guide.

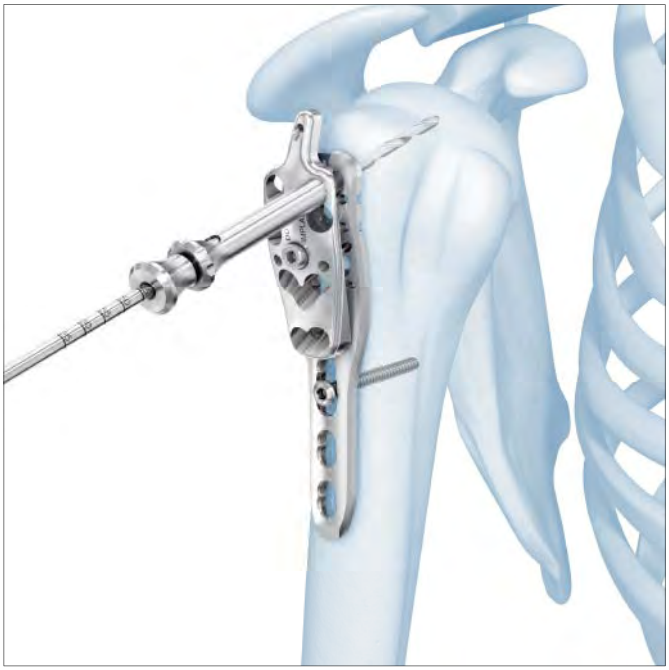
Warning:
Locking screws should be inserted under power using the torque limiting attachment. The audible click will notify the surgeon that the maximum torque value has been reached and that power insertion is complete.



Proximal locking screws in normal bone
The following techniques are recommended for measuring screw length in normal bone.

Insert the outer sleeve and 2.8 mm drill sleeve into the insertion guide with nose.

Using the 2.8 mm calibrated drill bit through the drill sleeve, drill to the desired depth.



Warning:

Do not penetrate the joint surface with the pull reduction device.

Precaution:

The plate should be secured with at least 4 proximal screws of Ø 3.5 mm. In poor bone stock, multiple fixation points using all screws is recommended.

Proximal locking screws in normal bone (continued)

Read the measurement directly from the calibrated drill bit.

Note: The drill bit tip should come as close as possible to the subchondral bone, approximately 5 mm–8 mm from the joint surface. Since it may not always be possible to feel the resistance from the subchondral bone, and the drill bit represents the final position of the locking screw, the use of image intensification is recommended.

Warning:
Do not push the drill bit through the joint surface.

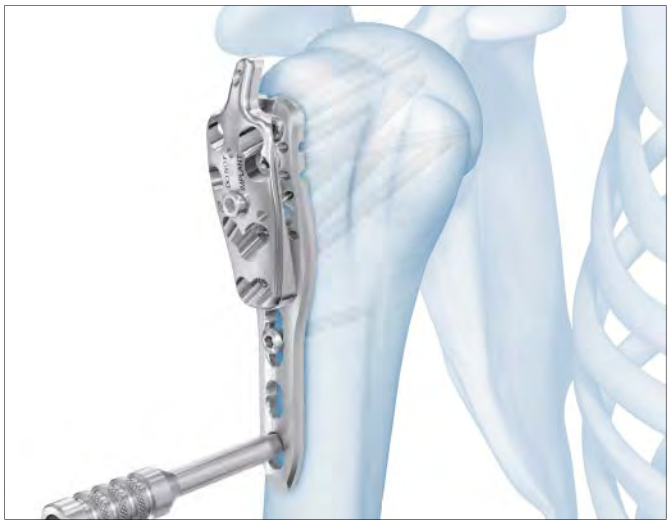
Remove the 2.8 mm drill sleeve.

Use the StarDrive Screwdriver to insert the appropriate length locking screw through the outer sleeve for insertion guide.

Warning:

Locking screws should be inserted under power using the torque limiting attachment. The audible click will notify the surgeon that the maximum torque value has been reached and that power insertion is complete.

Distal locking screw



For proper drilling of the shaft holes, the 2.8 mm threaded drill guide must be used.

Thread the drill guide into the threaded part of the shaft hole.

Drill with the 2.8 mm drill bit and remove the drill guide.

Measure screw length with the depth gauge.

Note: For more stable fixation, insertion of the locking screw through both cortices is recommended.

Distal standard screw
For nonlocking screws, use the standard AO screw insertion technique.

Warning:
Do not insert overly long screws in order to prevent primary or secondary screw penetration.

Note:
If a combination of cortex and locking screws is used, cortex screws must be inserted first to pull the plate to the bone.

Patient position

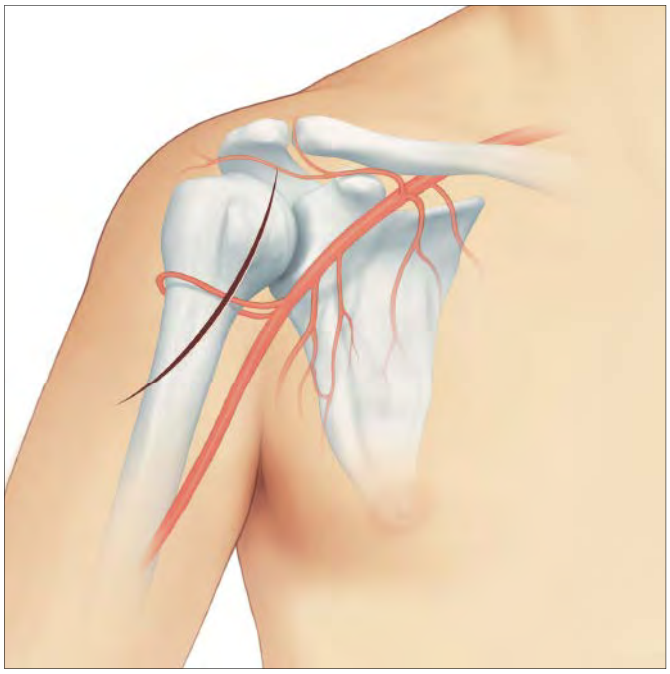
A beach-chair position is recommended to provide easy access to the shoulder with imaging equipment.

Approach

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

For long plates, the incision may be extended as an anterior approach to the humeral shaft, which proceeds distally between the biceps and the brachialis, and then down the anterolateral aspect of the arm to just above the elbow flexion crease.

During the dissection, care should be taken to avoid damaging the vasculature of the bone fragments. Care should also be taken to avoid ligation or coagulation of the anterior circumflex humeral artery. This can normally be assured by keeping all dissection lateral to the intertubercular groove.



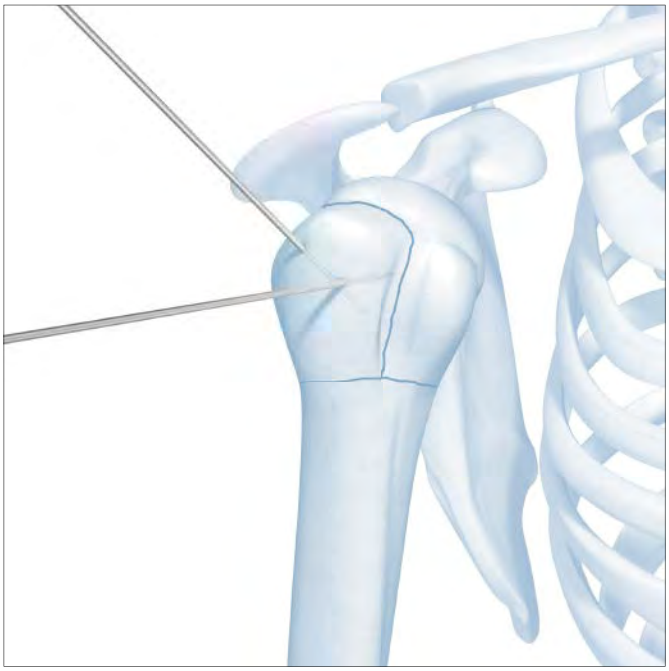
Note:

For information on open reduction approaches for proximal humerus, please refer to Rüedi TP and Murphy WM: *AO Principles of Fracture Management* Stuttgart, New York; Thieme, 2000, pp. 274–277.

Warnings:

- Do not injure the axillary nerve. The axillary nerve can be palpated at the lower margin of the incision.
- To avoid damaging the axillary nerve, do not split the deltoid more than 4 cm distal to its origin.

Reduce fracture



Reduce the fracture fragments and confirm the reduction under image intensification.

The humeral head and tuberosity fragments may be manipulated and provisionally fixed with sutures and/or K-wires. However, K-wires should be placed where they will not interfere with plate application.

Note:

The locking screws do not provide any compression for a lag screw effect. Therefore, humeral head fragments must be reduced, and any desired interfragmentary compression must be obtained prior to applying the 3.5 mm Wise-Lock Proximal Humerus Plate with locking screws.

Optional technique: Tension band with sutures

The stability of the construct can be increased with the insertion of 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.

Note:

If the insertion guide is attached to the plate while passing the sutures, remove the insertion guide so that the sutures can be attached to the plate.

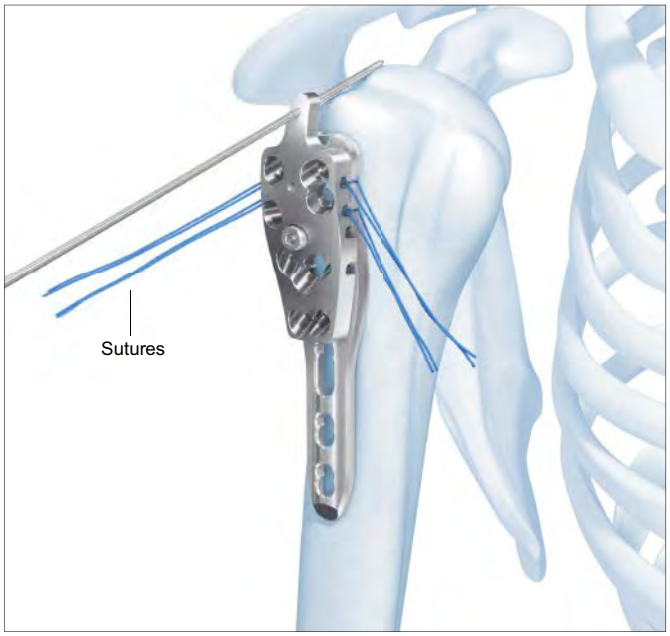
Attach insertion guide to plate

To facilitate insertion of the proximal locking screws, place the insertion guide against the plate and tighten the guide's attachment screw with the small hexagonal screwdriver, to lock the guide against the plate.

Note:
The stability of the construct can be increased by the insertion of sutures. If sutures are to be used with the plate, they should be passed through the plate before attaching the insertion guide.

Insertion guide: top view (left) and bottom view (right).

Position plate on bone



Positioning from AP view
The plate should be placed approximately 8 mm distal to the rotator cuff attachment on the upper edge of the greater tuberosity.

Determine plate position by placing a 1.6 mm K-wire through the proximal guide hole of the insertion guide so that the K-wire rests on top of the humeral head and aims at the proximal joint surface.

Precaution:

Placing the plate too high increases the risk of subacromial impingement. Placing the plate too low can prevent the optimal distribution of screws in the humeral head.

Warnings:

- **Do not injure the axillary nerve. The axillary nerve can be palpated at the lower margin of the incision.**
- **To avoid damaging the axillary nerve, do not split the deltoid more than 4 cm distal to its origin.**

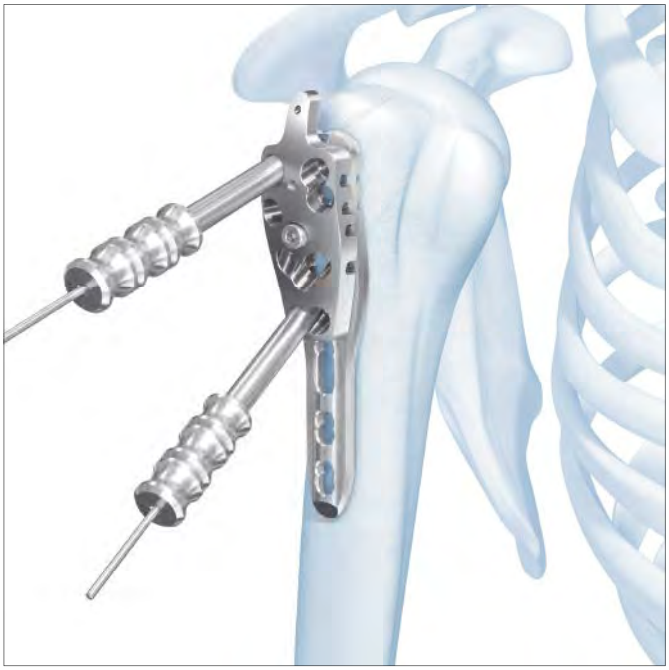
6. Position plate on bone (continued)

Positioning from a lateral view
The plate should be centered against the lateral aspect of the greater tuberosity, ensuring that a sufficient gap is maintained between the plate and the long biceps tendon (to avoid interfering with arterial blood supply).

To check final placement of the plate, 1.6 mm K-wires and two sleeve assemblies can be used: one in the hole for the most proximal screw and one in the hole for the most distal screw to be placed in the humeral head. If possible, the distal K-wire should be positioned approximately 5 mm above the calcar.

Additional considerations for long plates
The additional length of the long plates will usually require a plan for handling the deltoid insertion distally. Depending on the length of the plate used, a slightly anterior placement of the distal shaft, contouring of the plate shaft to wrap anteriorly around the humerus, or partial elevation of the deltoid insertion may be required.

Note: To maintain proper alignment between the insertion guide and the plate, intraoperative bending of the proximal portion of the plate is not recommended.



Insert screws
Determine the combination of screws to be used for fixation. If a combination of locking and cortex screws will be used, cortex screws should be inserted first to pull the plate to the bone.

The placement of the initial screw will depend on the fracture type and the reduction achieved. There are two options for the order of screw insertion:

Option 1

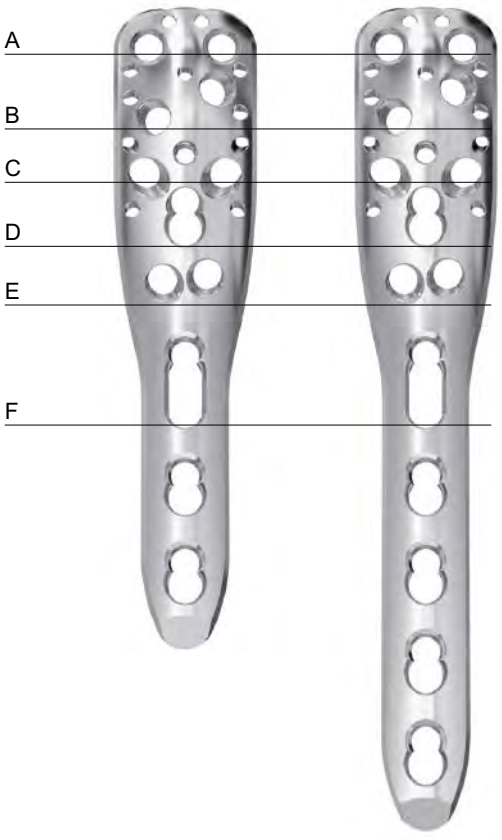
Insertion of a proximal screw first
This technique permits fixation of the proximal fragments first and then fixation with or without compression distally.

It is necessary to control the height of the plate in the AP view under image intensification before insertion of the screws.

Option 2

Insertion of a distal screw first
This technique permits reduction of the distal shaft fragment against the plate and a final height adjustment prior to the insertion of the other screws in the shaft.

Insert a standard cortex screw into the compression portion of hole F (elongated hole) of the standard plate, or in any of the elongated holes of a long plate. After making a final height adjustment, insert proximal locking screws.



Proximal locking screw insertion

Insert the 3.5 mm locking screw sleeve, the 2.8 mm drill sleeve, and the 1.6 mm wire sleeve into the insertion guide.

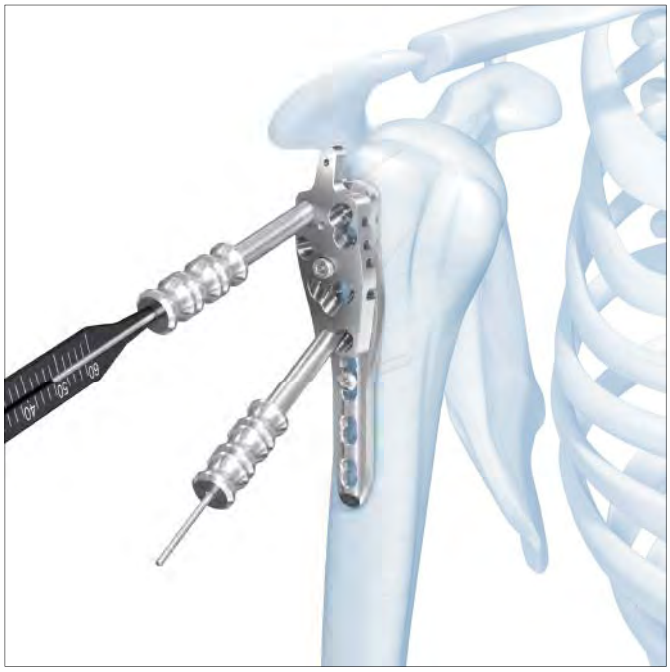
Insert a 1.6 mm K-wire through the sleeve assembly. Stop when increased resistance from the subchondral bone is felt. Since it may not always be possible to feel this resistance, the use of image intensification is recommended.

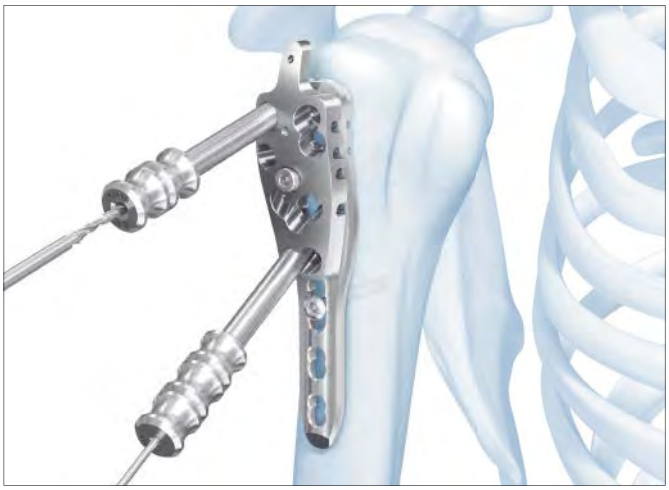
Note: The K-wire tip should come as close as possibleto the subchondral bone, approximately 5 mm–8 mm from the joint surface.

Slide the direct measuring device over the K-wire and push it against the sleeve assembly.

Note:
All three sleeves must be present. The direct measuring device provides an approximate screw length.

Important:
When selecting the appropriate screw length, the possibility of bone resorption at the fracture site must be taken into account. Care should be taken to ensure that the screw tip is a sufficient distance from the joint surface. Check that the plate supports the lateral aspect of the greater tuberosity.

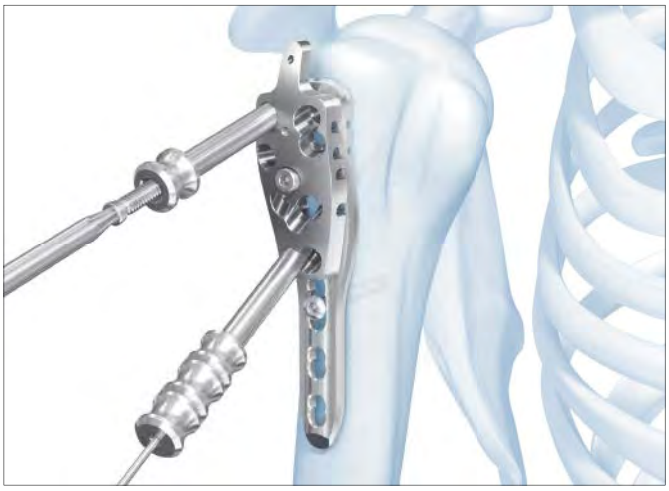




Remove the K-wire and the K-wire centering sleeve.

Drill the near cortex with the 2.8 mm drill bit through the drill sleeve. Remove the drill sleeve.

Use the StarDrive Screwdriver to insert the appropriate length locking screw through the 3.5 mm locking screw sleeve.

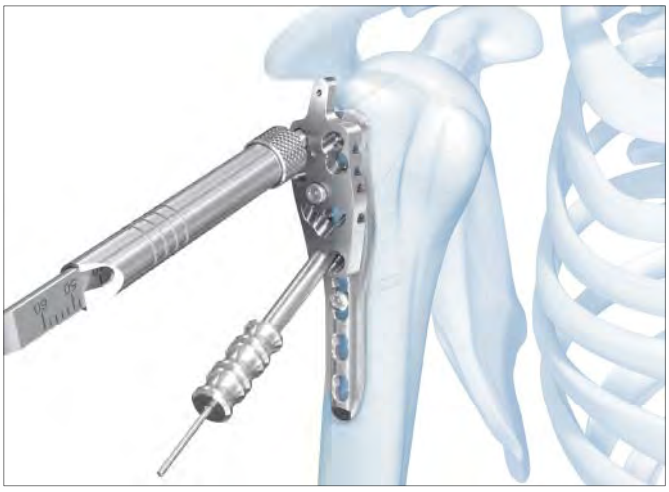


Note:

Since it may not always be possible to feel resistance from the subchondral bone, and the drill bit represents the final position of the locking screw, the use of image intensification is recommended.

Warning:

Locking screws should be inserted under power using the torque limiting attachment. The audible ”click” will notify the surgeon that the maximum torque value has been reached and that power insertion is complete.

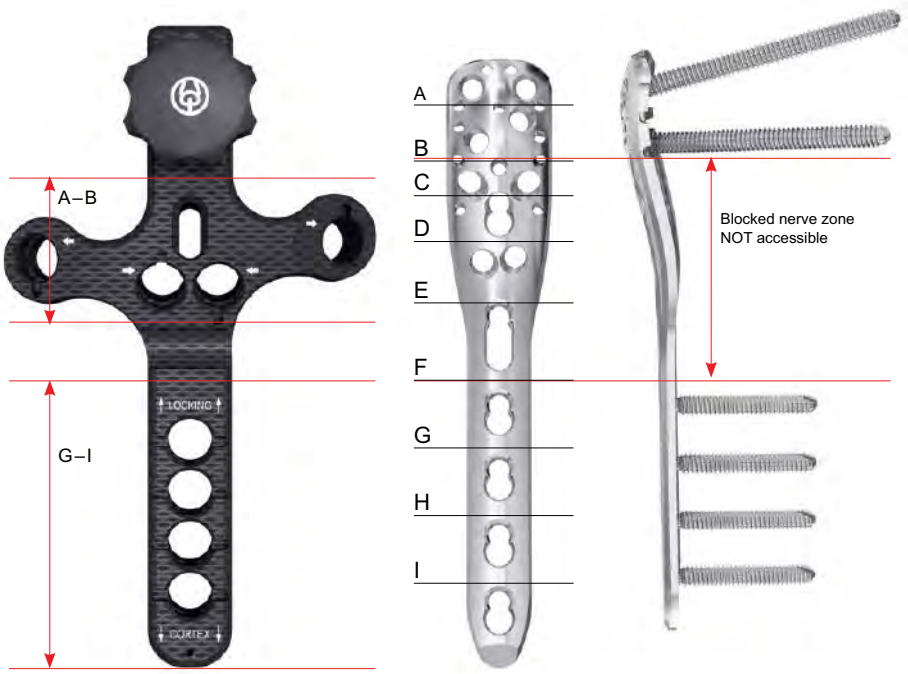


The depth gauge may also be used to determine screw length. This depth gauge will give an approximate measurement for the proximal screws when used through the insertion guide and will give an approximate measurement for the distal screws when placed against the plate. To ensure that the screw tip is a sufficient distance from the joint surface, 10 mm should be deducted from depth gauge readings for the proximal screw.

ALTERNATIVE TECHNIQUE—Wise-Lock PERCUTANEOUS AIMING SYSTEM

The design of the Wise-Lock Percutaneous Aiming System and technique facilitate less invasive plate fixation of the proximal humerus via the transdeltoid approach, while reducing the risk of interfering with the axillary nerve.

To protect the axillary nerve, screw levels C–F are blocked. Screw holes in these sections cannot be accessed through the Wise-Lock Percutaneous Aiming System.



Position patient

Place the patient in the beach-chair position on a radiolucent table.

A lateral side table is recommended to place the abducted arm and to relax the deltoid muscle.

Ensure the fluoroscope is located to allow visualization of the proximal humerus in two axes (AP and lateral/axial).

Prepare the patient's arm so that it can be mobilized intraoperatively.

Approach

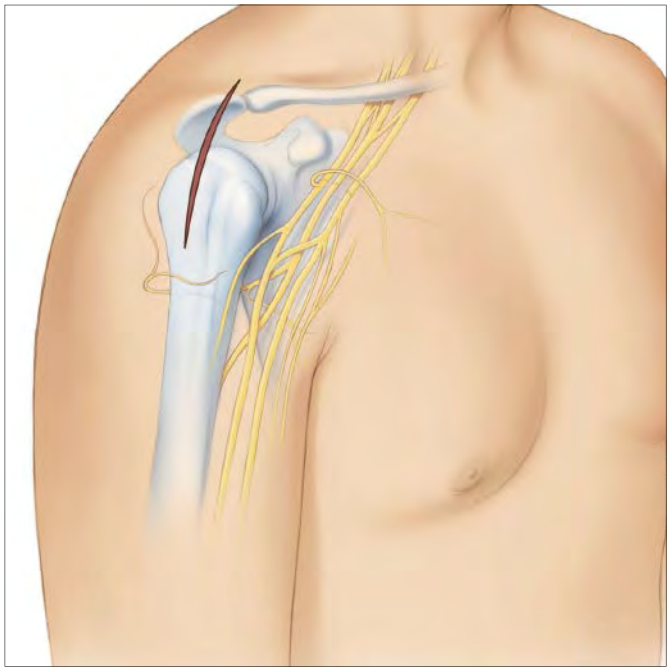
Perform a transdeltoid approach. Begin the incision at the anterolateral tip of the acromion and extend it about 4 cm distally over the deltoid muscle.

Precaution

: The axillary nerve runs approximately transverse at the level of the surgical neck.

Warning:

To avoid damaging the axillary nerve, do not split the deltoid more than 4 cm distal to its origin.



Reduce fracture and fix temporarily

Proper reduction of the fracture is crucial for good bone healing and function. In some cases, closed reduction before prepping the patient is beneficial.

Reduce the head fragments and check the reduction under imaging.

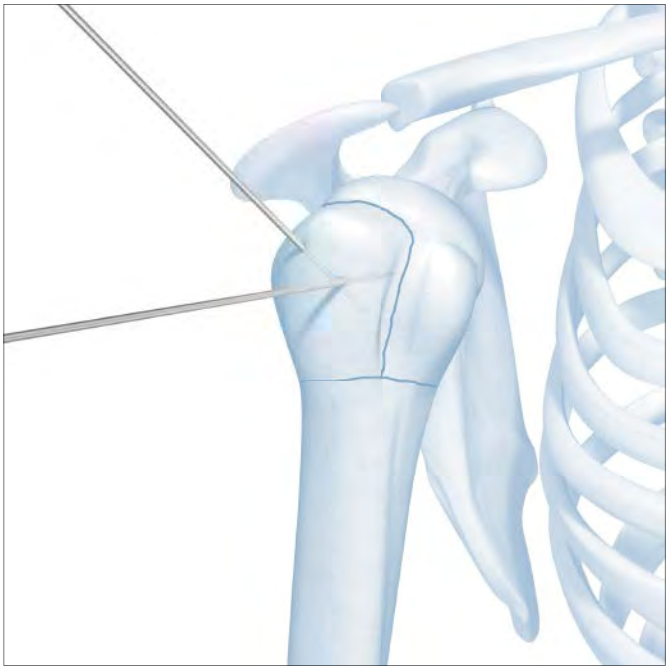
K-wires can be used as joysticks in the fragments for reduction and for temporary fixation. Ensure that K-wires do not interfere with correct plate placement.

Note:

The locking screws are not suitable for reduction since they cannot exert compression. The head fragments must be reduced before insertion of locking screws.

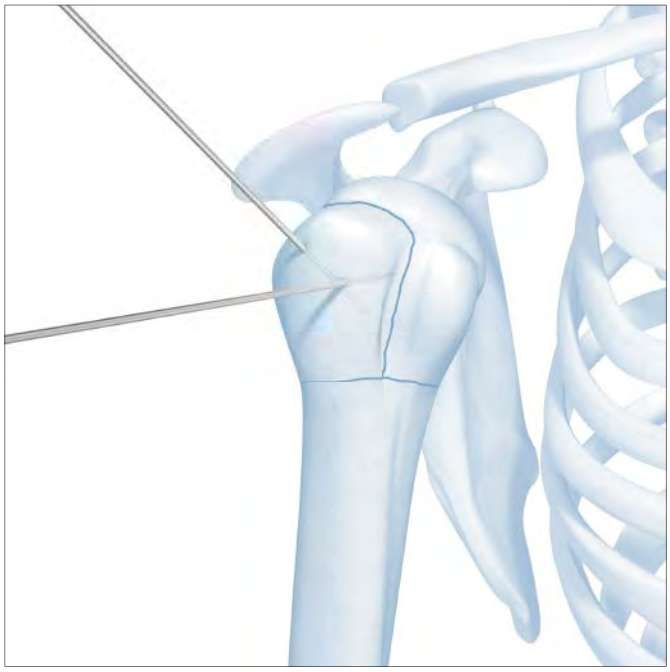
Provisionally reduce the tuberosities using sutures through the insertions of the subscapularis, infraspinatus, and supraspinatus. The sutures will help to maintain the stability of the reconstruction when fixing them to the plate later.

The insertion of sutures is especially recommended in weak bone where only short screws can be used because of the risk of penetration through settling.



Prepare plate position

For optimal plate positioning, insert two positioning K-wires, 2 mm–4 mm lateral to the bicipital groove and 5 mm–7 mm below the tip of the greater tuberosity.



Precaution:

Placing the plate too high increases the risk of subacromial impingement. Placing the plate too low can prevent the optimal distribution of screws in the humeral head.

Determine the position of the plate using a K-wire. Assemble the aiming system as described in Step 6. Insert the K-wire into the proximal guide hole of the insertion handle (analogous to the proximal guide hole of the aiming block) below the rotator cuff, so that the K-wire aims at the proximal joint surface.

Assemble aiming system

Attach the insertion handle to the plate by aligning the stabilization pin of the insertion handle with the connection hole in the plate. Use the appropriate screwdriver to tighten the connecting screw of the insertion handle and securely connect the insertion handle to the plate.

Note:

The aiming arm can be connected to the insertion handle before or after plate insertion. The proximal screws may be inserted through the aiming arm, or through the insertion handle using the insertion handle as a guide.

The following technique describes insertion of proximal screws through the aiming arm.

Precautions:

- Intraoperative bending of the proximal portion of the plate is not recommended for maintaining proper alignment between the aiming device and the plate.
- Do not attempt to use the Wise-Lock Percutaneous Aiming System with longer Proximal Humerus Plates.

Insert plate

Caution:

- Do not injure the axillary nerve.
- The axillary nerve can be palpated at the lower margin of the incision.

Slide the plate into the subdeltoid space and along the bone. Always keep the plate in contact with the bone.

Precaution:

Do not use the insertion handle and the plate for soft tissue retraction, or for release or dissection of the deltoid insertion.

Position and align plate

Position the plate between the positioning K-wires described in Step 4.

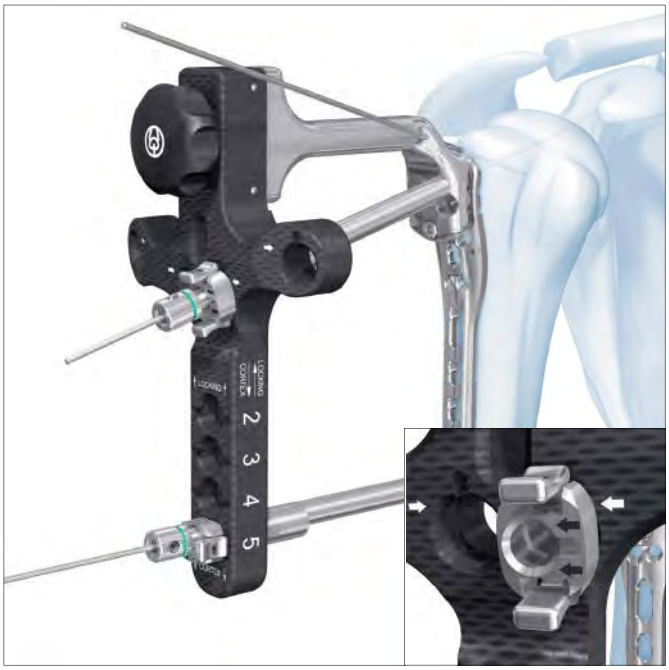
Ensure the plate shaft is aligned with the bone. To aid this alignment, a K-wire can be placed through the insertion handle. Alternatively, plate alignment can be palpated through the skin.

Provisionally fix the plate to the bone, using the K-wire holes in the aiming device and wire sleeves, if needed. Insert the K-wires monocortically to ensure they do not constrain subsequent movement.

Important:

It is advisable to thread the sutures of the infraspinatus, supraspinatus, and the subscapularis tendon through the suture holes in the plate before placing the plate on the bone.

Determine proximal screw lengths



Warning:

To prevent primary or secondary screw penetration, do not drill through the joint surface.

Insert the outer sleeve into one of the proximal holes of the aiming arm (section “A” and “B” in the plate; see page 28). The arrows on the sleeve should point in the same direction as the arrow next to the hole in the aiming arm.

Add the percutaneous threaded wire guide (aqua mark) and insert a 1.6 mm threaded tip guide wire.

Check the position of the K-wire by image intensification in several planes. Verify it does not perforate the articular surface.

Note:
The tip of the K-wire should be located in the subchondral bone (approximately 5 mm below the joint surface).

Slide the direct measuring device over the K-wire and determine the required screw length.

Alternatively, read the required screw length on the drill bit, as described in Step 10.

Note:
Always use a 1.6 mm threaded tip guide wire with the sleeves of the aiming system.

Warnings:

- **Do not penetrate the joint surface with the K-wires.**
- **Do not insert overly long screws in order to prevent primary or secondary screw penetration.**

Insert proximal screws

Remove the direct measuring device, K-wire, and threaded wire guide. Insert the locking threaded drill guide (black mark) and predrill the screw hole, using the 2.8 mm drill bit. Remove the drill bit and drill guide.

Warning:

Do not push the drill bit through the joint surface.

Note:

The drill stop is designed to ride up against the percutaneous drill guide. The side of the stop facing the drill guide indicates the correct drilling depth as shown.

Warning:

In osteoporotic bone, it is recommended to predrill only the lateral cortex.

Use the StarDrive Screwdriver shaft to insert the appropriate length locking screw through the outer sleeve.

Warning:

Locking screws should be inserted under power using the torque limiting attachment. The audible ”click” will notify the surgeon that the maximum torque value has been reached and that power insertion is complete.

Repeat the above steps for all required proximal screw holes.

Precaution:

The plate should be secured with all 4 proximal screws.

Sleeve System Technique
Insert the outer sleeve through the aiming arm.

Precautions:

- If a cortex screw will be used, the arrows on the sleeve should correspond to the arrow under the etched “CORTEX” on the aiming arm.
- If a locking screw will be used, ensure the arrows on the sleeve correspond to the arrow under the etched “LOCKING” on the aiming arm.

Make a small skin incision, and use the outer sleeve with the trocar to stab down to the plate.

Note:
If necessary, mark the incision point on the skin with a marker and remove the aiming arm to obtain good access and visibility during blunt dissection.

Cortex

Locking

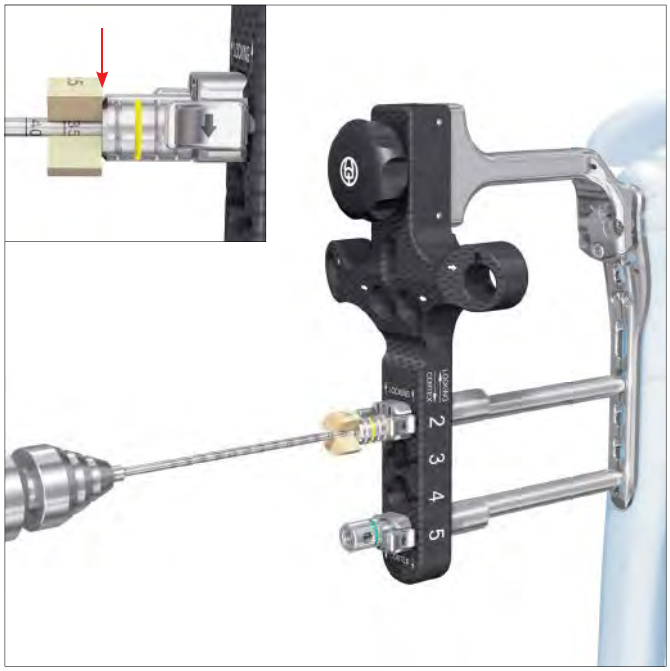
Insert cortex screws

Precaution:

To ensure plate-device alignment, the aiming arm must be locked to the plate on both ends. An outer sleeve and a threaded drill guide must be threaded into the most distal locking hole, to create a stable box.

Insert the neutral drill guide (yellow mark, neutral) into the outer sleeve.

Use the 2.5 mm drill bit (yellow mark) to drill toward the far cortex. Verify drill depth under radiograph. Read the calibration directly from drill bit and select the appropriate screw.



Option:

If interfragment compression is required, use the compression drill guide (yellow mark, load) for predrilling the hole. This technique, using the compression drill guide, is analogous to the technique for standard LC-DCP Plates, using the LC-DCP Drill Guide.

Note:

The drill stop is designed to ride up against the percutaneous drill guide. The side of the stop facing the drill guide indicates the correct drilling depth as shown.

Insert locking screws

Screw the threaded drill guide (black mark) through the outer sleeve into the threaded section of the desired Combi hole.

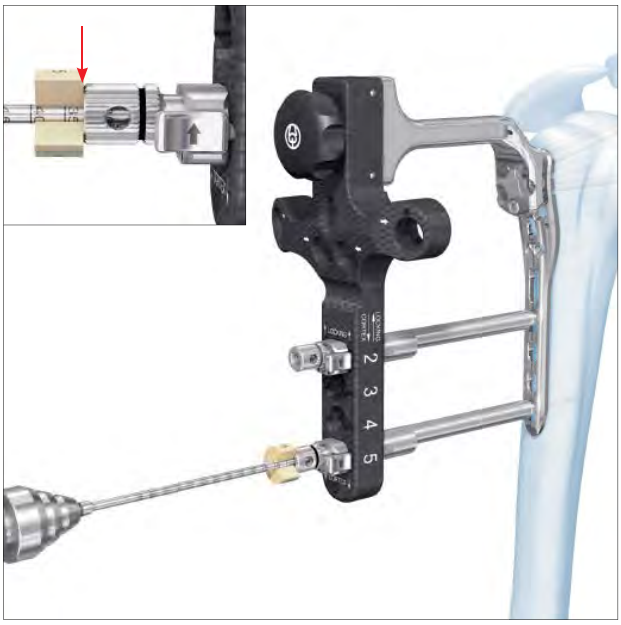
Use the 2.8 mm drill bit (black mark) to drill toward the far cortex. Verify drill depth under radiograph. Read the calibration directly from drill bit and select the appropriate screw.

Note:

The drill stop is designed to ride up against the percutaneous drill guide. The side of the stop facing the drill guide indicates the correct drilling depth as shown.

Use the StarDrive Screwdriver shaft to insert the appropriate length locking screw through the outer sleeve.

Warning: **Locking screws should be inserted under power using the torque limiting attachment. The audible click will notify the surgeon that the maximum torque value has been reached and that power insertion is complete.**



Remove aiming arm

Remove the sleeves and aiming arm assembly from the plate.

Suture attachment

Knot the sutures through the designated holes in the plate. This construct functions as a tension band and transmits the forces of the rotator cuff over the plate into the shaft, and serves to prevent fragment displacement during the early rehabilitation period.

Final check

Before closing the wound, check screw lengths and the stability of the suture fixation. Check screws under imaging in the full range of glenohumeral motion and ensure they do not penetrate the articular surface. The sutures must not rupture during motion.

Precaution:

It is important to check the screw lengths in all planes as their angulation and direction may be difficult to visualize.

IMPLANT REMOVAL

Implant removal

To remove locking screws, unlock all screws from the plate and then begin to remove the screws completely from the bone. This avoids rotation of the plate when removing the last locking screw.

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