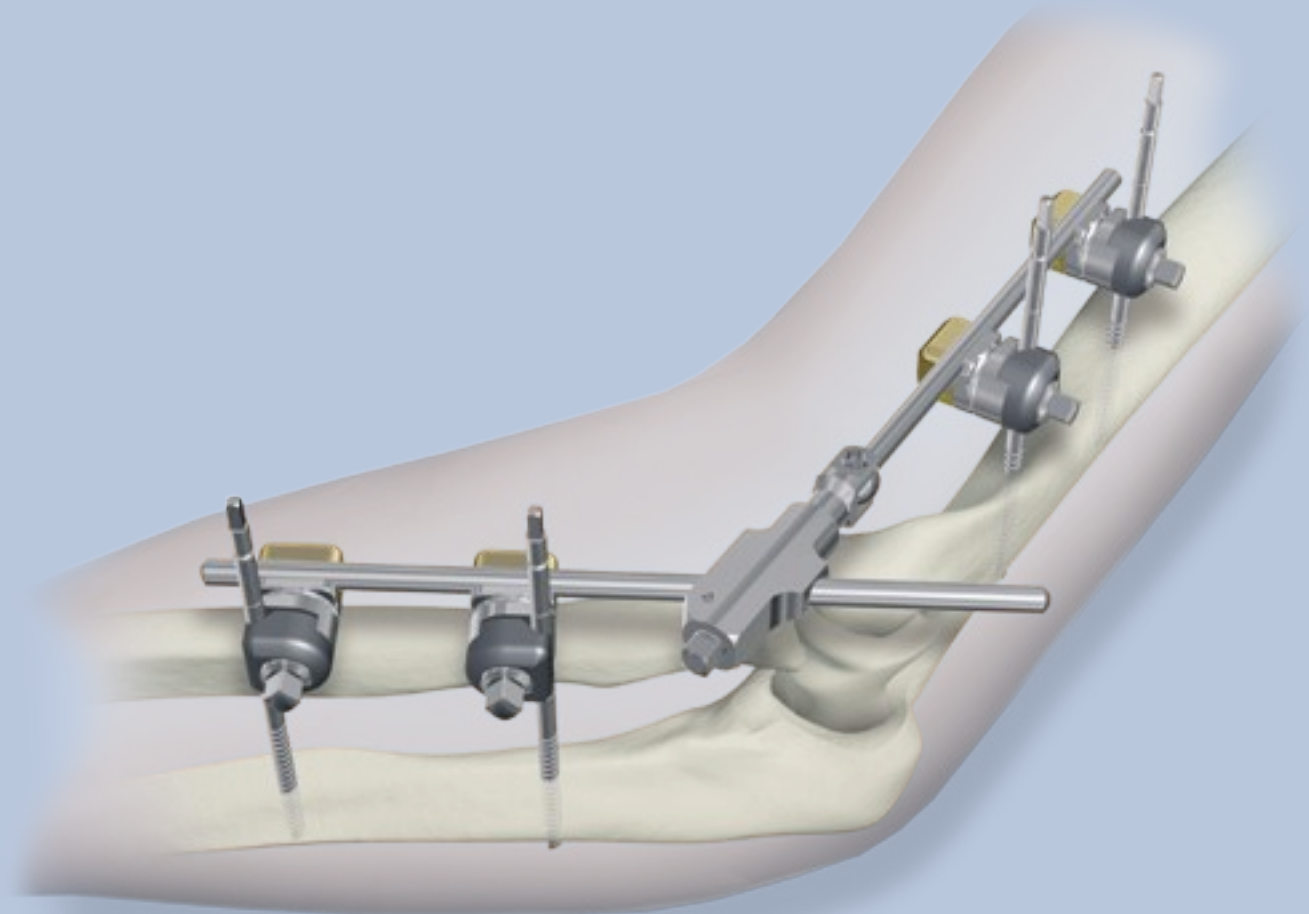


Dynamic Joint Distractor II

External Fixation System

Operative Technique

- Modular Hinged System for the Elbow



Overview

There are two principal goals simultaneously achieved with the DJD II:

- 1) to allow active or passive motion,
- 2) to protect the articular surfaces and the collateral ligaments.

Design Concept

Reliable identification of the axis of rotation and rigid skeletal fixation can be obtained by an articular device which replicates the axis of rotation.

Skeletal fixation on the ulna with the DJD II allows protection or neutralization of the articular surface for a variety of clinical circumstances. Motion in flexion/extension is allowed without encumbrance particularly in both the articular surface and the collateral ligaments.

Options

The DJD II may be used in either a monolateral or bilateral configuration. This allows a great deal of flexibility of use and a wider range of indications (Fig. 1).

Author

B.F. Morrey, M.D.

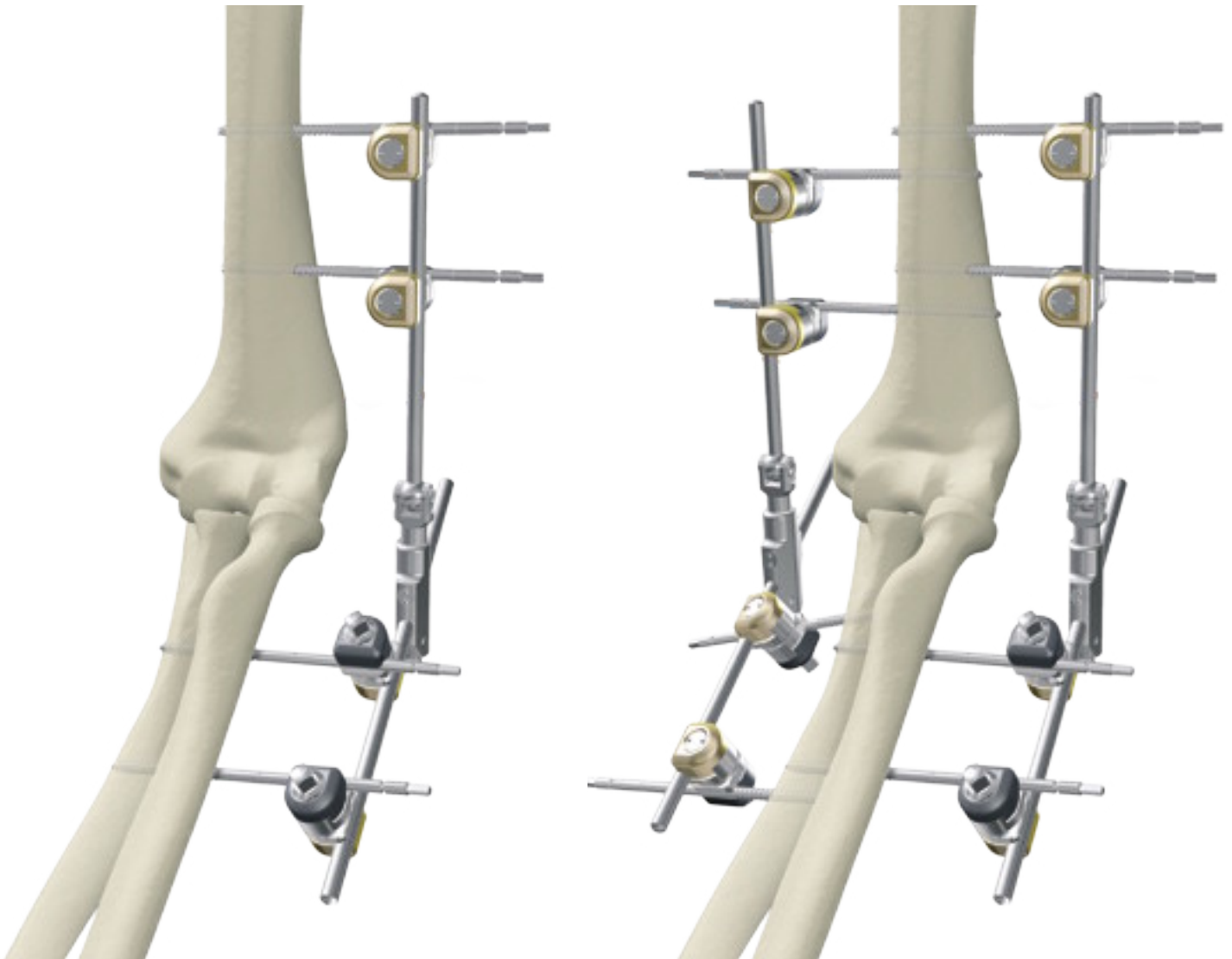
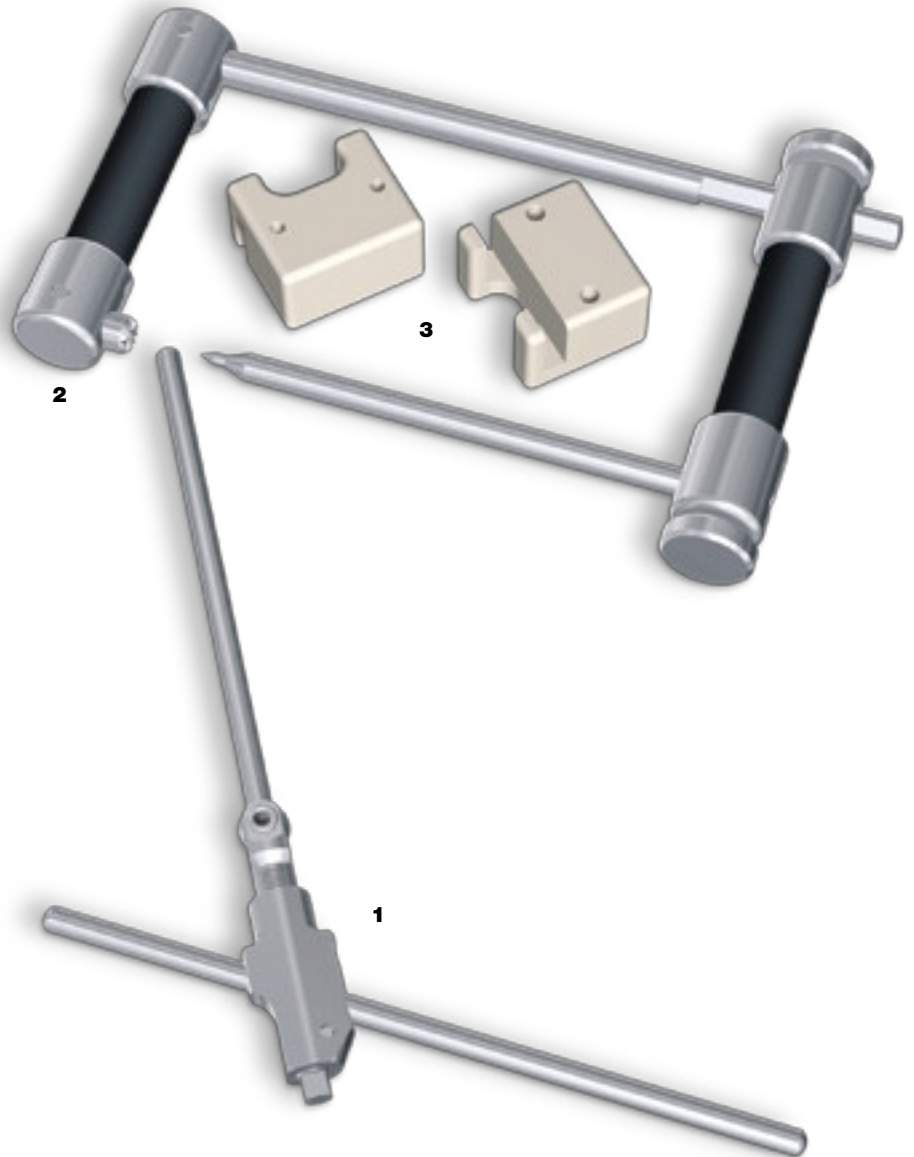


Fig. 1
Fixation with uni- or bilateral
frame application offers significant
flexibility and wider range of
indications for the DJD II.

Overview

Dynamic Joint Distractor II

1. DJD II Body
2. Humeral Guide
3. Pin Insertion Guides
4. Hoffmann® II Compact™ Instruments
5. Hoffmann® II Compact™ Components and Apex® Pins



Relative Indications & Contraindications

Trauma indications

When protection of the articular surface is required:

- 1) Coronoid fracture with or without fixation;
- 2) Olecranon fracture with tenuous fixation;
- 3) Distal humerus articular fractures;
- 4) Unstable ulnohumeral joint after acute collateral ligament disruption;
- 5) Combination of instability with any of the above fractures (complex instability).

Reconstruction Indications

As an adjunct for individuals undergoing release of stiff elbow. This is most common in the post-traumatic condition, but occasionally is used with inflammatory stiffness. The use of distraction is generally indicated in these circumstances:

- 1) There has been a significant amount of dissection suggesting that maintaining the intraoperative motion will be difficult.
- 2) If the pathology has modified the joint contour requiring refashioning of the joint surface, with or without an interposition membrane.
- 3) When an interposition procedure is performed.
- 4) If the collateral ligament has been reconstructed or repaired in association with the release.

Contraindications

- 1) Inexperience with the use of external fixation devices is considered a relative contraindication. Application of the DJD II is technically demanding and requires accurate placement of the skeletal pins.
- 2) If uncertainty exists with regard to the anatomic location of the neurovascular structures due to post-traumatic destruction of the joint, the DJD II should be used only with extreme caution. The pins, under these circumstances, may be inserted under direct vision.
- 3) Local sepsis is a relative contraindication to the application of the DJD II.
- 4) The presence of some internal fracture fixation devices in the distal humerus or proximal ulna.
- 5) Pre-emptive medical condition, e.g. severe osteoporosis.
- 6) See package insert for a complete list of potential adverse effects and contraindications. The surgeon must discuss all relevant risks, including the finite lifetime of the device, with the patient, when necessary.

Operative Technique

Unilateral Frame Options

Patient Positioning & Anatomical Repair

The patient is supine with a sandbag under the scapula, the arm is draped free with a non-sterile tourniquet and brought across the chest (Fig. 2). The elbow is exposed according to the pathology present. Regardless of the exposure or pathology, identifying the essential landmarks for axis pin placement is critical.

On the lateral aspect of the capitellum, a tubercle is present at the site of the origin of the lateral collateral ligament. This tubercle also represents the geometric center of curvature of the capitellum, which is the site of the flexion axis of the elbow, and is the point through which a $\varnothing 3\text{mm}$ Apex[®] humeral reference pin will pass (Fig. 3). If this anatomic feature has been altered by pathology, then the center of the curvature of the trochlea is identified as the axis of rotation since the ulna rotates on the humerus and rotation on the capitellum is a secondary feature.

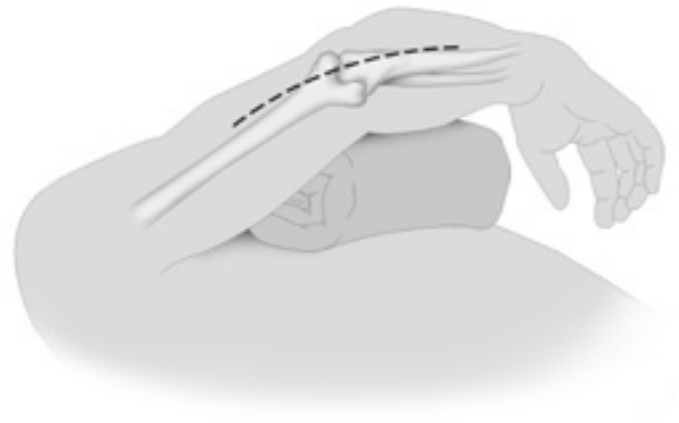
On the medial aspect of the distal humerus, the axis of rotation lies just anterior and inferior to the medial epicondyle. The reference pin is placed in this region, or slightly anterior and proximal to this location (Fig. 3). This represents a safe zone relative to the ulnar nerve. If a medial frame is to be applied, the ulnar nerve is identified and protected at the time of insertion of the 3mm Apex[®] humeral reference pin.

For all frame applications the $\varnothing 3\text{mm}$ Apex[®] humeral reference pin is drilled or tapped 10-20mm into the distal humerus along the axis of rotation.

Articular Fracture

The articular fracture is approached according to surgeon preference, the specific pathology, and the treatment goals. Olecranon fractures are easily exposed and the fixator readily applied. Fractures involving the coronoid require more extensive exposures as described below for the release of the stiff elbow. Distal humeral fractures may be treated by exposure with olecranon osteotomy or a triceps reflection technique. If the fracture fixation device(s) or collateral ligament reattachment precludes the introduction of a $\varnothing 3\text{mm}$ reference pin, a small Kirschner wire is inserted in a manner to replicate the axis of rotation.

Fig.2
"Universal" posterior skin incision



The patient is supine, the arm is brought across the chest.

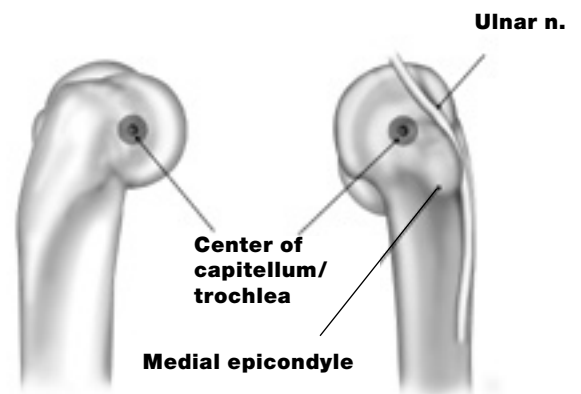


Fig.3
The landmarks on the distal humerus medial and lateral.

Operative Technique

The Stiff Elbow

If treating the elbow for stiffness, the previous incision is entered, and an extensile postero-lateral joint release is used.

Typically, the triceps is reflected from the tip of the olecranon. However, in some instances, such as when elbow flexion is normal, the triceps may be left intact. A complete anterior capsular excision is required. The capsule is exposed by releasing the common extensor tendon. If the pathology is extrinsic to the joint, the anterior capsule is excised but the lateral collateral ligament is preserved. If the joint is abnormal and is to be altered, such as with an interposition arthroplasty, the lateral collateral ligament is elevated as a flap of tissue from its origin at the lateral condyle. This is tagged and reflected distally, providing an extensive exposure (Fig. 4), but must be repaired and reattached at closure.

When the pathology involves a joint surface that requires an extensive dissection, the identification and protection of the ulnar nerve is necessary.

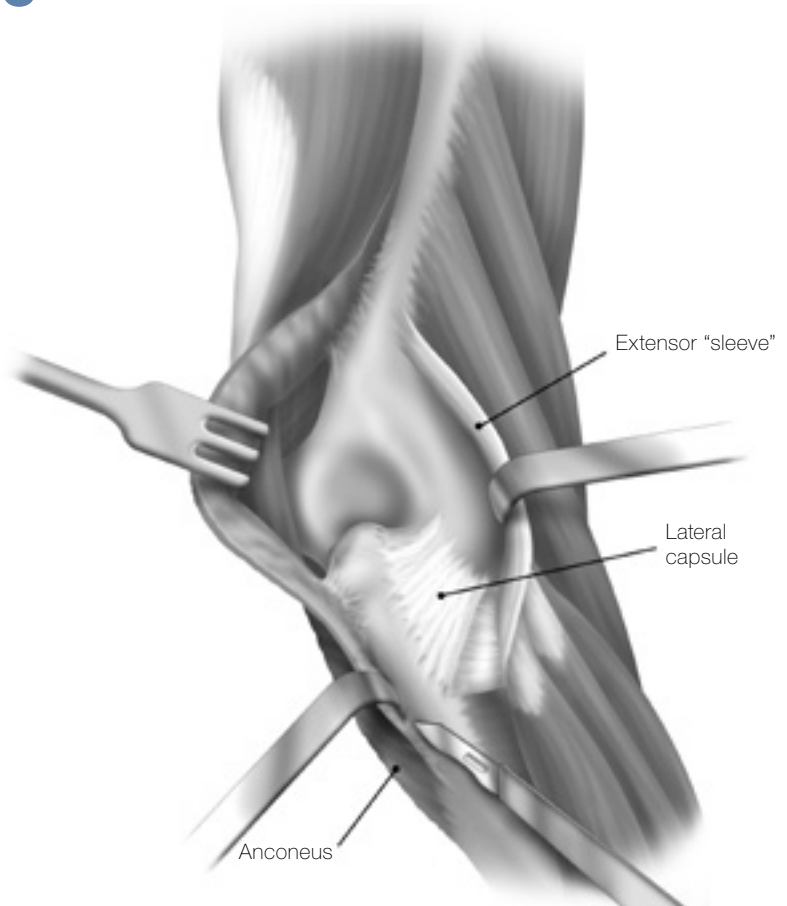


Fig.4
An extensile surgical exposure typically involves releasing of the lateral collateral ligament.

Ideally, a single posterior incision is utilized, and a subcutaneous dissection is carried out to the medial aspect of the triceps. If a previous Kocher skin incision has been placed laterally, ulnar nerve exposure is accomplished through a supplemental medial incision. In any event, the ulnar nerve is identified, but is usually not translocated anteriorly. Instead, it is simply protected, first during the capsular dissection and later at the time of the $\varnothing 3\text{mm}$ Apex[®] humeral reference pin placement. If ulnar nerve symptoms are present, then the nerve is decompressed with definitive management, according to the dictates of the pathology. At closure with the 3mm Apex[®] humeral reference pin in place (see Fig. 6), $\varnothing 2\text{mm}$ holes are made distal and proximal to the pin for reattachment of the lateral collateral ligament (Fig. 5). Bunnell sutures or suture anchors are placed through the radial (lateral) collateral ligament and through the holes drilled through the lateral column around the flexion pin.

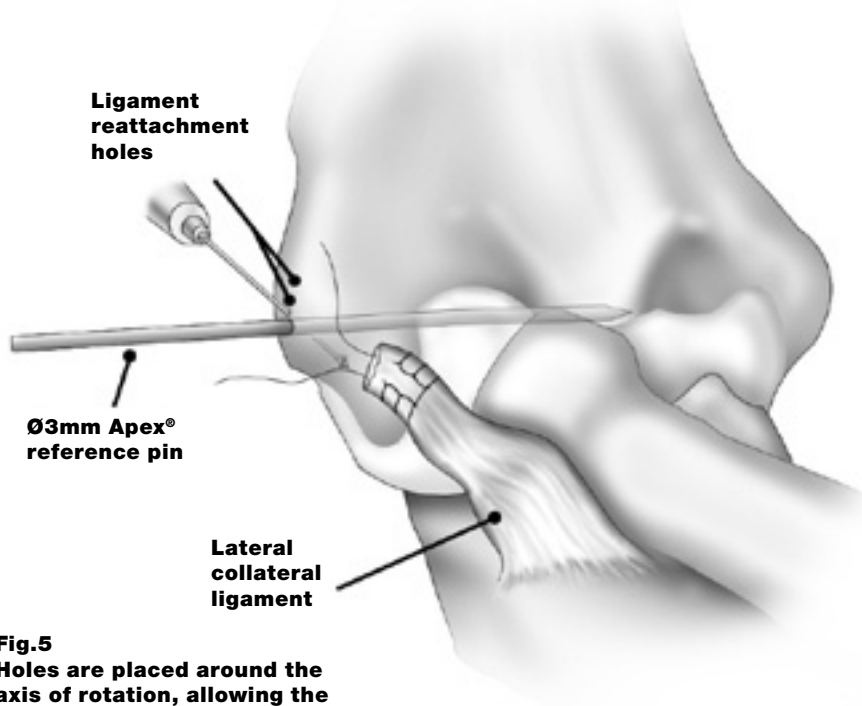


Fig.5
Holes are placed around the axis of rotation, allowing the ligament to be reattached.

Operative Technique

1. Axis of rotation

Determine the axis of rotation external landmarks and place the humeral (axis) reference pin guide in line with the axis of rotation (typically the pointed tip of the humeral axis guide is placed on the medial side with the pin guide on the lateral side) (Fig. 6).

Note:

Care should be taken to avoid injuring the ulnar nerve during placement of the humeral guide

2. Reference pin placement

The reference pin acts as a guide during frame construction. Insert laterally the ø3mm diameter Self Drilling/Self Tapping Apex® Pin through the humeral (axis) reference pin guide in the axis of rotation. For monolateral frame construction insert the pin to a depth of 15-20mm. For bilateral frames it is recommended to replace the ø3mm Apex® humeral reference pin by a ø3mm smooth Transfixing Apex® Pin which is inserted across the distal humerus (see Bilateral Frame Option).

Note:

The ø3mm pin is a reference pin and is the essential reference required to accurately assemble the DJD II frame and to properly insert the humeral and ulnar pins. It will be removed after frame construction.

3. Remove the humeral (axis) reference pin guide.

4. Placement of the DJD II frame on the reference pin.

The hollow bored hinge of the DJD II is placed over the reference pin so that its hinge is exactly in the same axis of rotation as the natural axis of rotation of the elbow. Verify that the distraction device is fully compressed before frame construction.

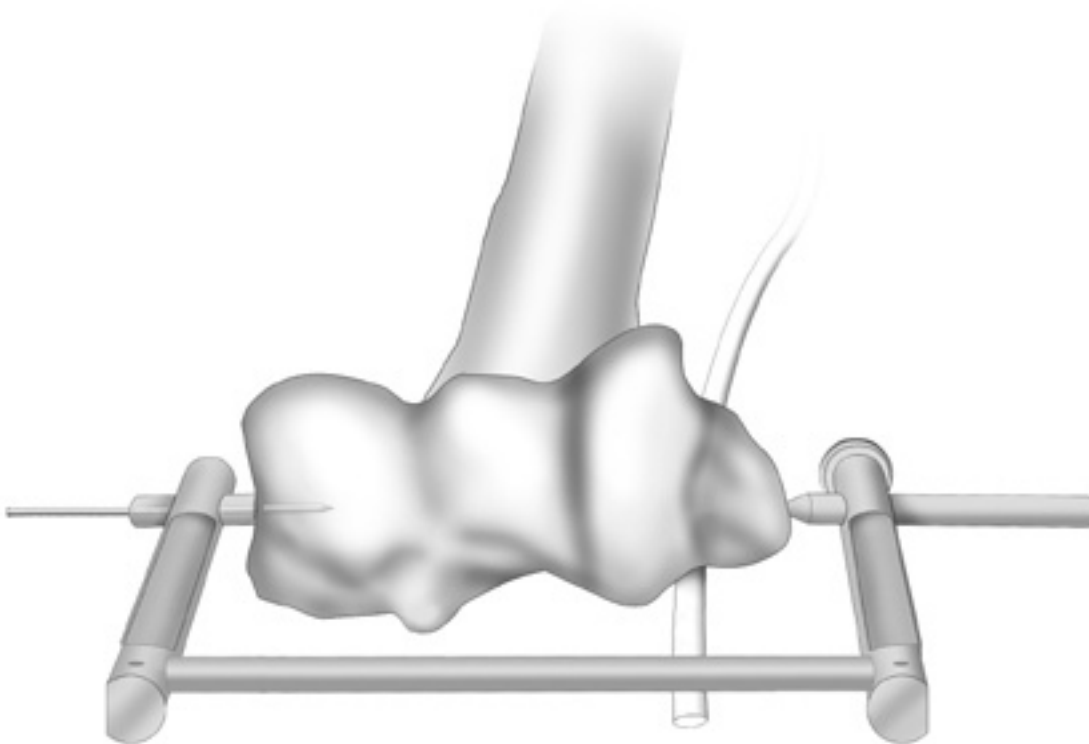


Fig.6
The pointed tip of the humeral axis guide is placed medially under direct vision, allowing accurate orientation of the axis reference pin.

Operative Technique

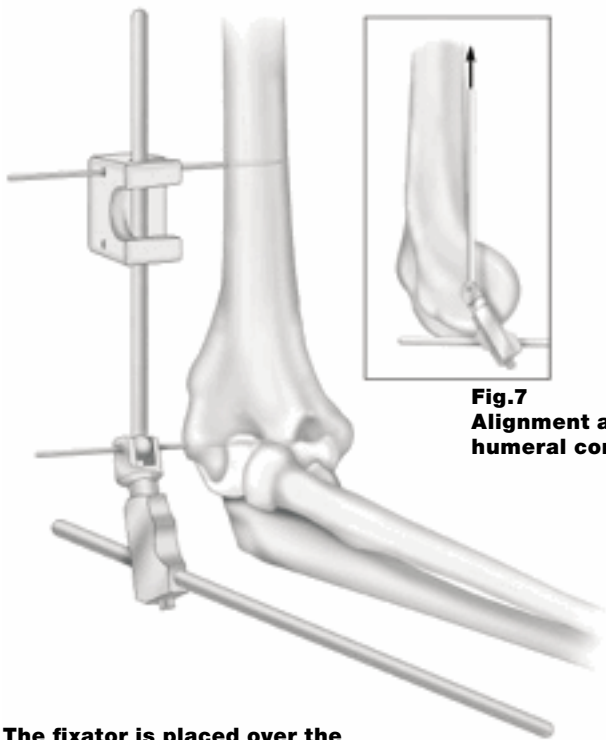


Fig.7
Alignment along the anterior humeral cortex

The fixator is placed over the reference pin and using the pin insertion guide a proximal half pin is placed through the lateral and medial humeral cortices.

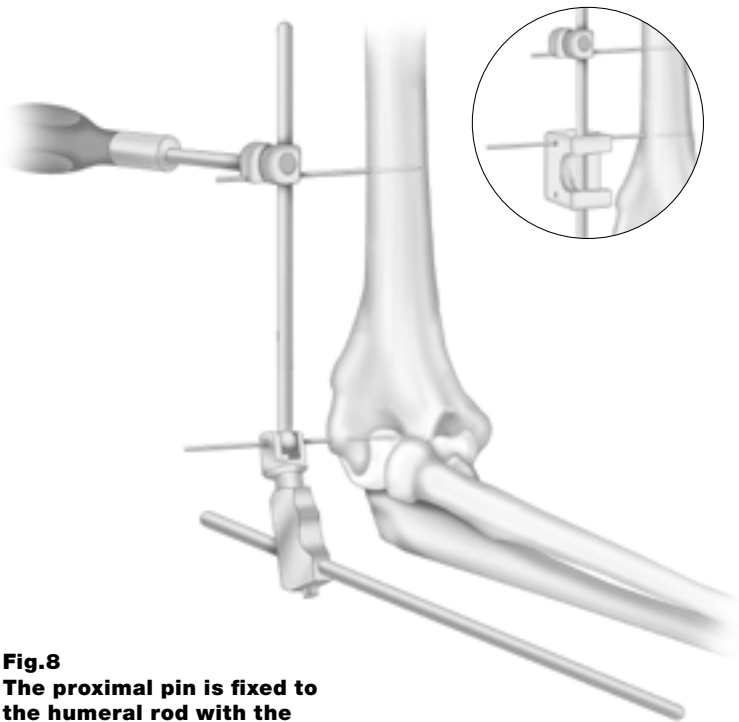


Fig.8
The proximal pin is fixed to the humeral rod with the Hoffmann® II Compact™ pin to rod coupling.

5. Pin insertion

At this stage, depending on surgeon preference or features of the case, one may insert either the humeral or the ulnar pins.

6. Humeral Pin Insertion

Note:

Care should be taken to avoid injuring the radial nerve during humeral pin insertions.

- 6.1 Insert the proximal pin first. According to the pin diameter ($\varnothing 3\text{mm}$ or $\varnothing 4\text{mm}$), place the appropriate pin insertion guide over the humeral rod so that the pin guide holes allow engagement of the lateral humerus (Fig. 7).

Note:

The $\varnothing 5\text{mm}$ humeral rod is aligned to the anterior cortex of the humerus (Insert).

- 6.2 The proximal humeral Self Drilling/Self Tapping Apex® $\varnothing 4\text{mm}$ (or $\varnothing 3\text{mm}$) Pin is inserted into the lateral cortex of the humerus through the pin guide and engaged in the opposite cortex.

Note:

The second hole of the pin insertion guide indicates the minimum distance between two pins. However, it is recommended to increase the distance between the pins by placing the pin guide further from the first pin as described in steps 6.5 and 7.5.

- 6.3 The pin guide is then removed.
- 6.4 The proximal pin is fixed to the humeral rod with a Hoffmann® II Compact™ Pin to Rod Coupling. This is then tightened using a Hoffmann® II Compact™ Wrench (Fig. 8).

Operative Technique

Note:

Hoffmann® II Compact™ Pin to Rod Couplings accept pins of both $\varnothing 3\text{mm}$ and $\varnothing 4\text{mm}$ diameter.

6.5 Place the pin guide over the humeral rod more distally (closer to the hinge).

6.6 The second Self Drilling/Self Tapping Apex® $\varnothing 4\text{mm}$ (or $\varnothing 3\text{mm}$) Pin is now inserted more distally through the pin guide (Fig. 9).

Note:

The pins need not necessarily be parallel.

If a different pin insertion angulation is required to access a more adequate area on the humerus, slightly rotate and/or incline the pin guide over the humeral rod until such a pin insertion area can be reached. By assuring proper pin-rod distance, the system allows an independent pin placement (Insert).

6.7 The pin guide is then removed.

6.8 The distal pin is fixed to the humeral rod with a Hoffmann® II Compact™ Pin to Rod Coupling which is then tightened using a Hoffmann® II Compact™ Wrench.

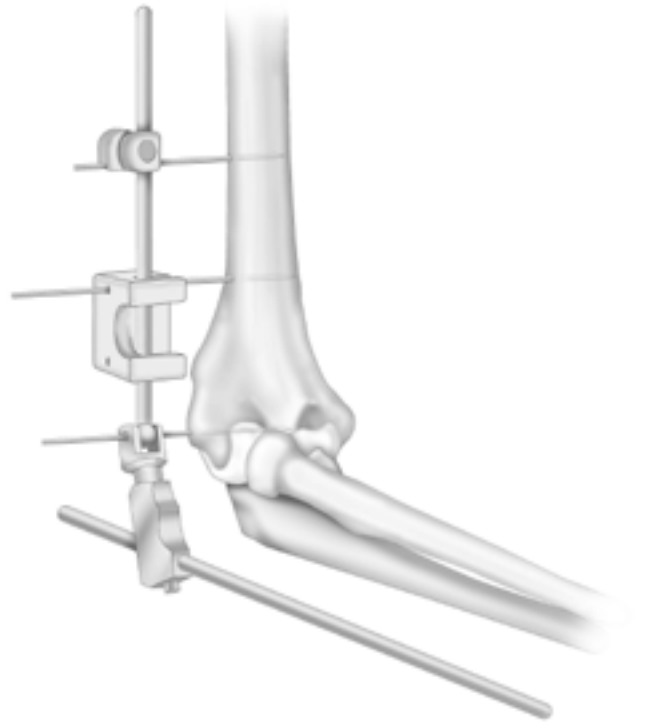
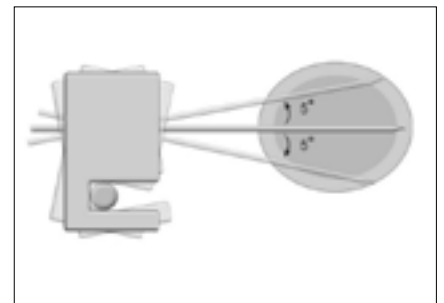
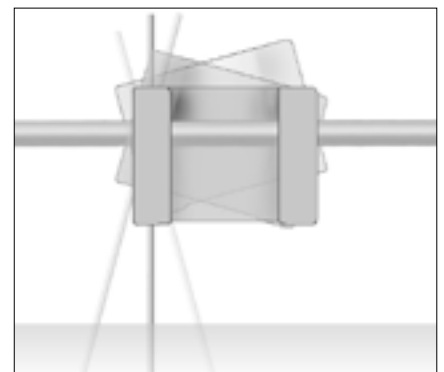


Fig.9
Using the pin insertion guide a second half pin is placed across the proximal humerus distal to the first.



Rotation over the rod allows precise pin placement



Inclination over the rod allows precise pin placement

Operative Technique

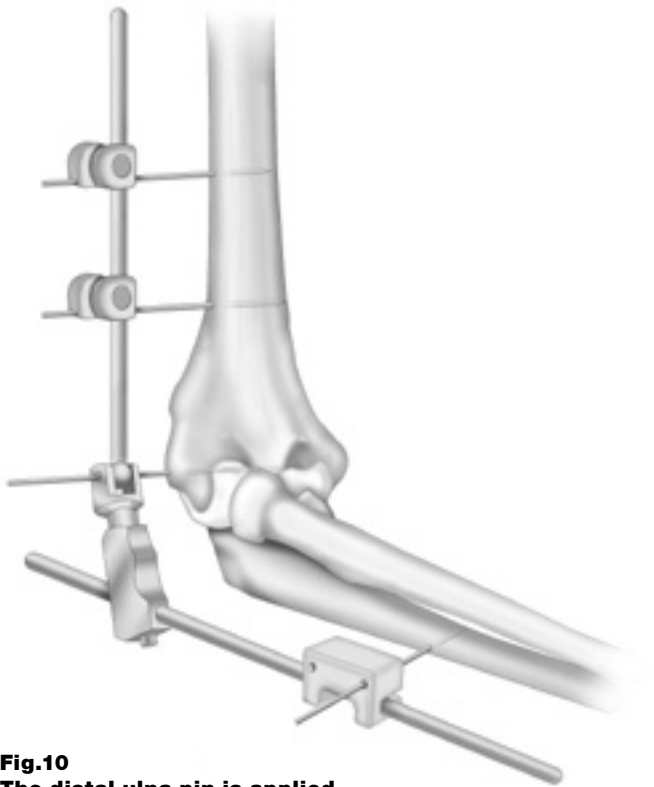


Fig.10
The distal ulna pin is applied with the use of the pin insertion guide.

7. Ulnar pin insertions

7.1 According to the pin diameter ($\varnothing 3\text{mm}$ or $\varnothing 4\text{mm}$), place the appropriate pin guide over the ulnar rod to access the lateral aspect of the ulna.

Note:

$\varnothing 3\text{mm}$ pins are usually preferred as the ulna diameter is smaller.

7.2 The distal ulnar Self Drilling/ Self Tapping Apex® $\varnothing 3\text{mm}$ (or $\varnothing 4\text{mm}$) Pin is inserted into the lateral cortex through the pin guide and pierces the medial ulnar cortex (Fig. 10).

7.3 The pin guide is then removed.

7.4 The distal pin is fixed to the ulnar rod with a Hoffmann® II Compact™ Pin to Rod Coupling which is then tightened using a Hoffmann® II Compact™ Wrench.

7.5 Place the pin guide over the ulnar rod more proximally i.e. between the distraction mechanism and the distal pin (Fig. 11).

7.6 The proximal Self Drilling/Self Tapping Apex® Pin can now be inserted through the pin guide.

Note:

As at the humerus, the pins are not necessarily parallel. If a different pin insertion angle is required to access a more adequate pin insertion area, slightly rotate the pin guide over the ulnar rod until such a pin insertion area can be reached. By providing proper pin-rod distance, the system allows an independent pin placement (see Fig. 9).

7.7 The pin guide is then removed.

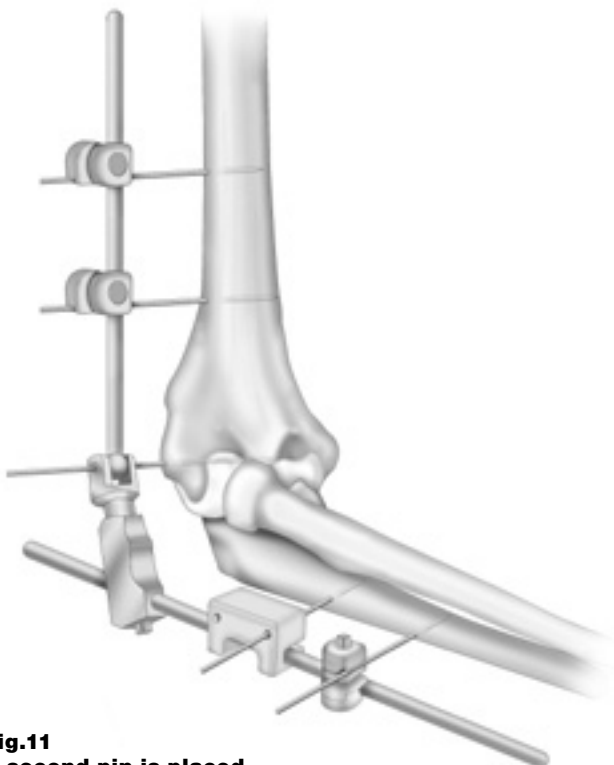


Fig.11
A second pin is placed proximally using the pin insertion guide.

Operative Technique

- 7.8 The proximal pin is fixed to the ulnar rod with a Hoffmann® II Compact™ Pin to Rod Coupling which is then tightened using a Hoffmann® II Compact™ Wrench.
- 7.9 If the indication requires the use of the proximal ulnar pin in the olecranon, it can be inserted through the pin guide. This pin will be once again attached to the ulnar rod with a Hoffmann® II Compact™ Pin to Rod Coupling, which is then tightened.

8. Axis reference pin removal

The ø3mm Apex® humeral reference pin is then removed (Fig. 12).

9. Distraction

The ulna is separated from the humerus by turning the distraction screw using a Hoffmann® II Compact™ Wrench. Typically 2-3mm distraction is sufficient to accomplish the goals of the procedure (Fig. 13). Skin closure is usually deferred until the distraction is applied.

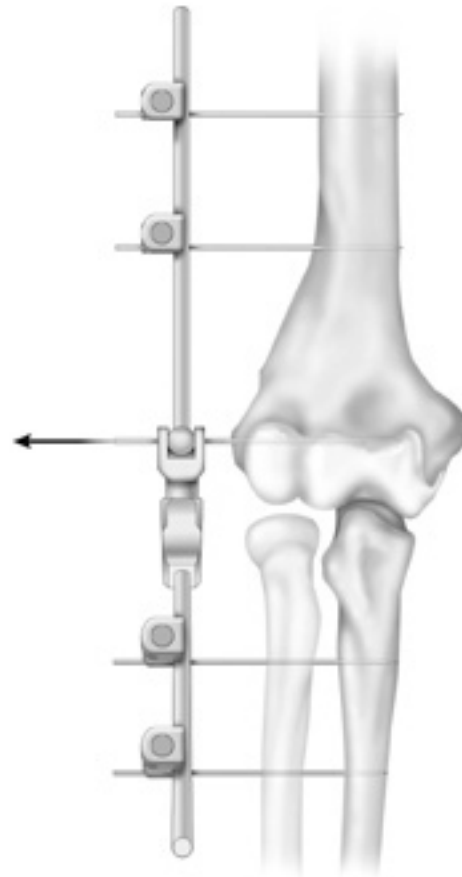


Fig.12
Apex® axis reference pin removal.

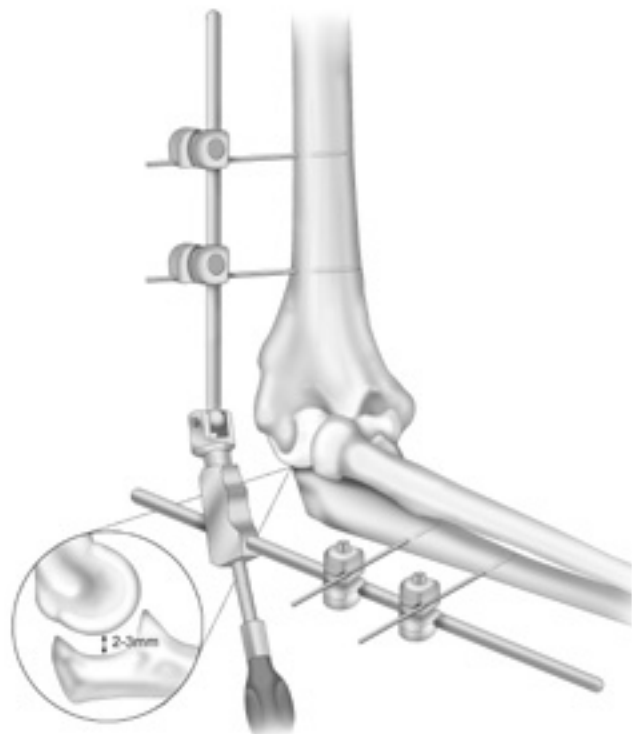
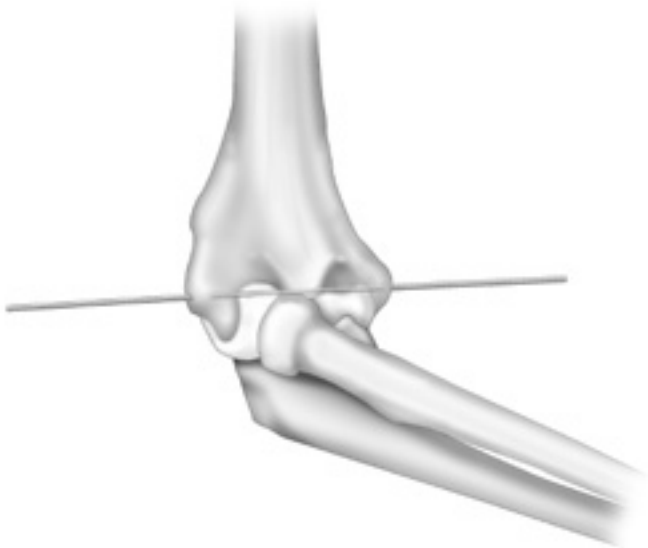


Fig.13
Using a Hoffmann® II Compact™ Wrench the elbow joint is distracted generally 2-3mm.

Operative Technique

Bilateral Frame Options

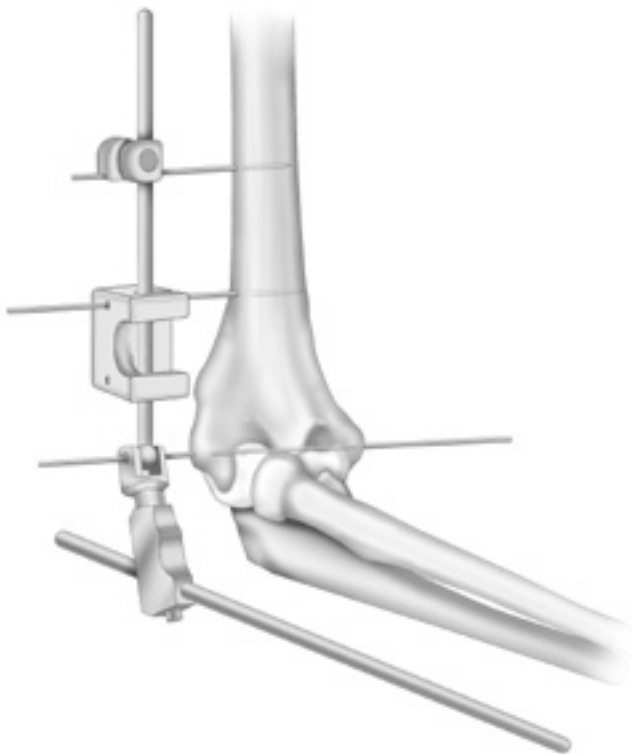
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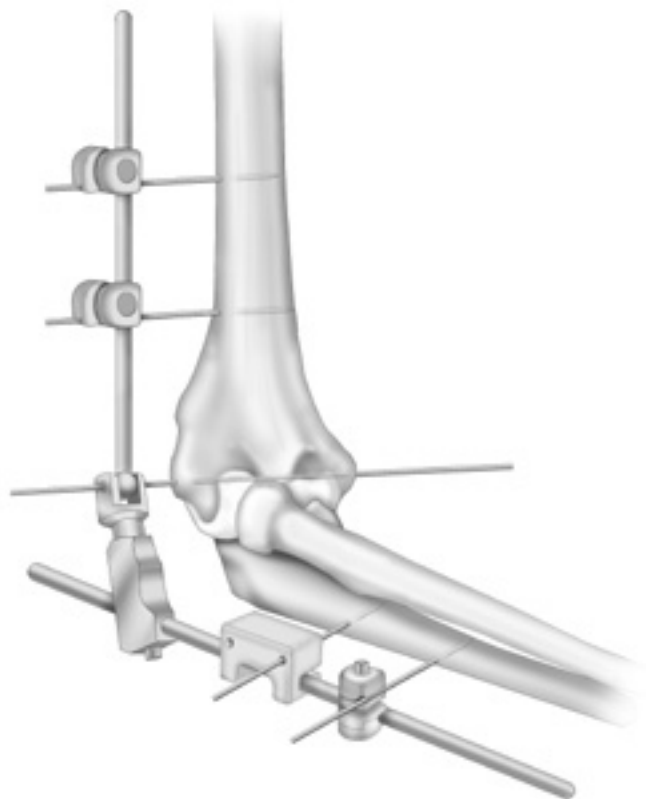
Axis of rotation is replicated through a $\varnothing 3\text{mm}$ smooth transfixing pin (half pins for separate lateral or medial applications are acceptable)

Lateral DJD II application

2



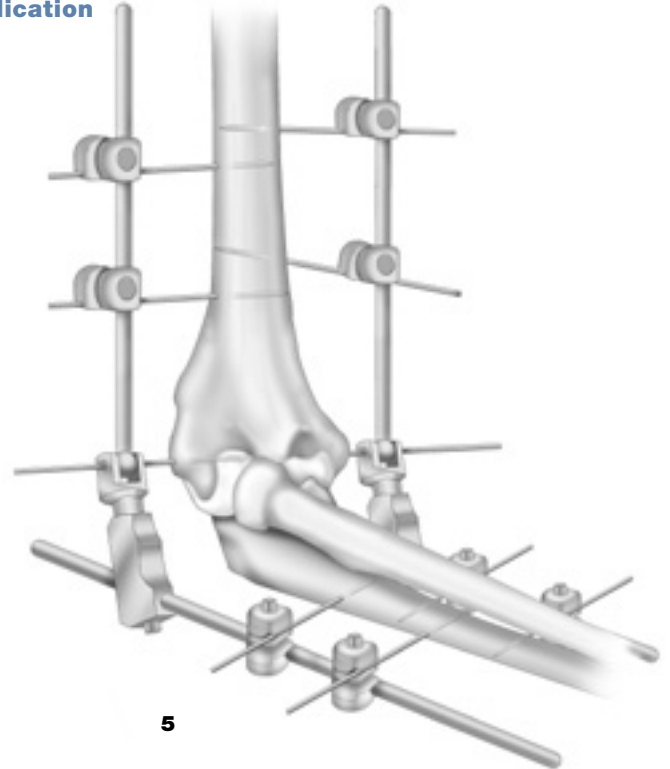
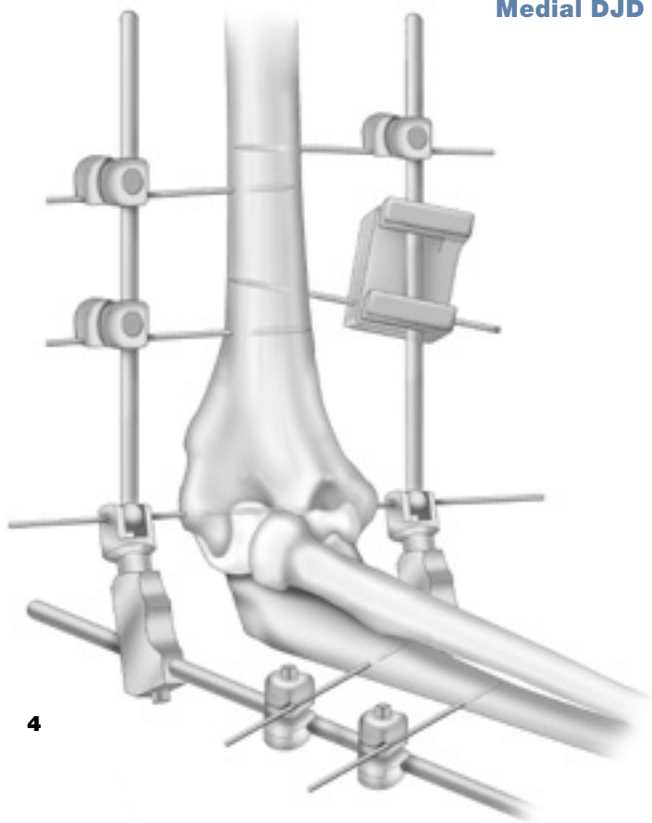
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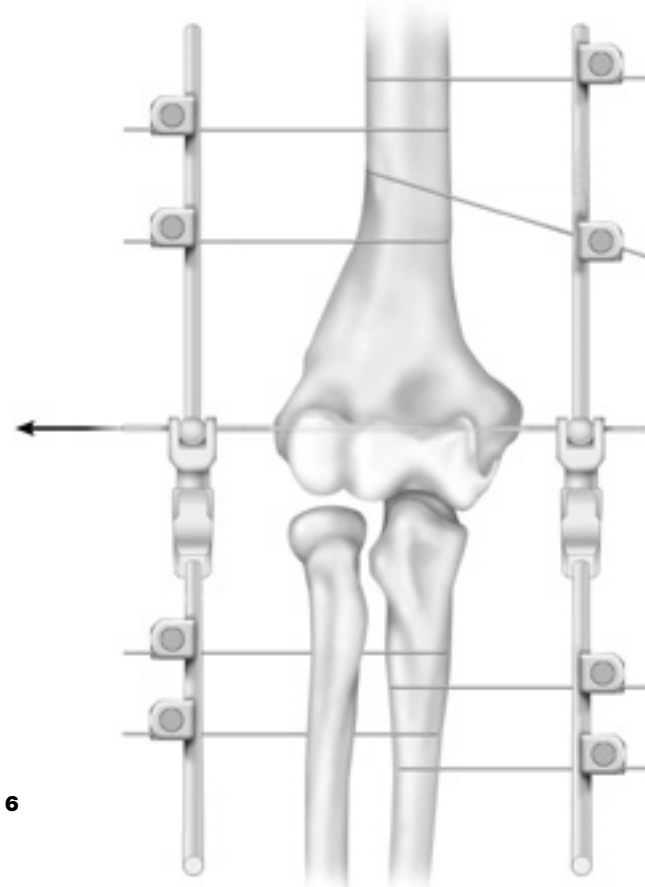
If greater stability of the external fixator is desired, a second half frame is applied over a $\varnothing 3\text{mm}$ smooth transfixing or over a medial reference half pin on the medial aspect. Independent medial half pins are then applied on both the humerus and the ulna as described in steps 6 and 7.

Operative Technique

Medial DJD II application



As with the unilateral frame configuration, the ø3mm smooth transfixing pin which replicates the axis of rotation of the elbow is removed at the end of the surgery to reduce the risk of joint infection.



ø3mm smooth transfixing pin removal

Operative Technique

Medial Frame Option

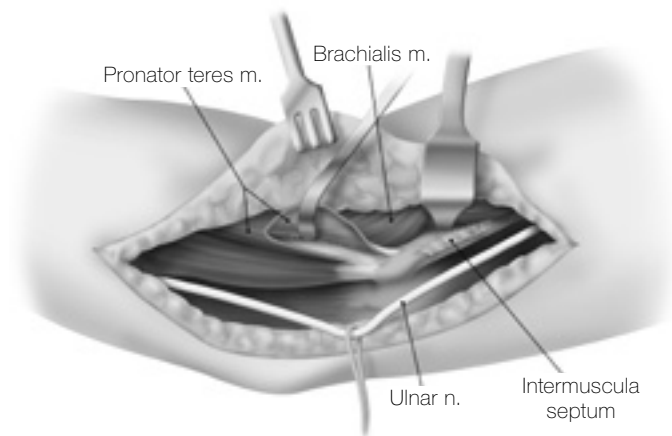


Fig.14
After identification of the medial intermuscular septum the brachialis and soft tissues are swept from the anterior aspect of the distal humerus.

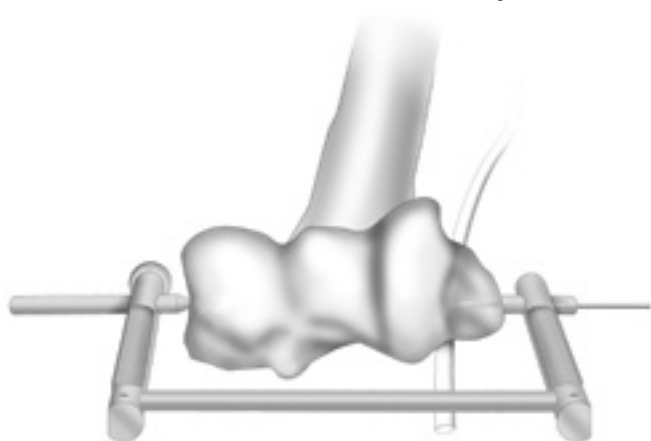


Fig.15
3mm Apex® reference pin medially insertion

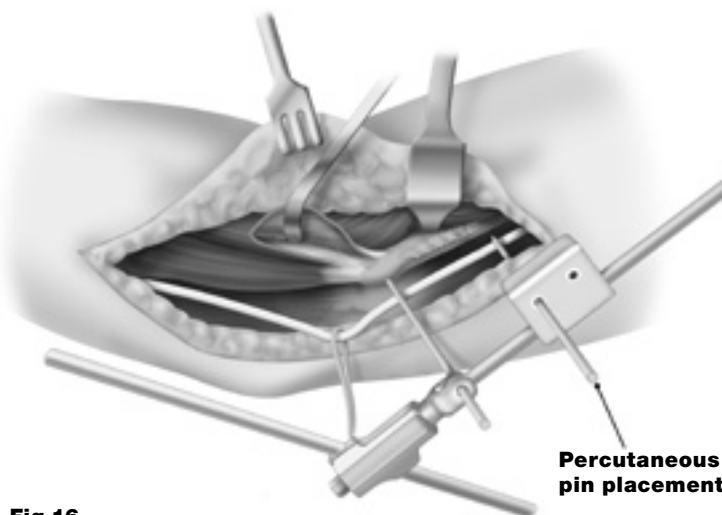


Fig.16
Percutaneous pin placement

The medial aspect of the triceps is identified along with the ulnar nerve. The nerve is not necessarily transposed unless appropriate for the case. The intermuscular septum is identified proximal to the epicondyle and followed anteriorly to the humerus. The soft tissues are elevated from the distal humerus and the pronator attachment is released from the anterior superior aspect of the medial epicondyle. Elevating the soft tissue sleeve allows exposure of the anterior medial capsule (Fig. 14). To apply the fixator, place the humeral (axis) reference pin guide in line with the axis of rotation.

The guide stylus is placed medially and the pointed tip is placed laterally at the axis site located at the lateral tubercle. Insert medially the 3mm Apex® humeral reference pin (Fig. 15). The application proceeds as with the lateral frame option (see page 7). However, care must be exercised to observe and protect the ulnar nerve and anterior neuromuscular bundle at the time of humeral pin insertion. This is best done by directly observing the entrance site of the pins at the humerus (Fig.16).

Operative Technique

Percutaneous Application

For some acute or subacute fractures in which the elbow is unstable, there is a tendency for the ulna to sublux posteriorly. In these cases, the DJD II may be applied to neutralize this tendency. The typical features of the application under these circumstances include:

- The use of fluoroscopy so that the pins may be inserted percutaneously
- Insertion of the pins distal to the coronoid to avoid any fracture fixation that may be present, but also to apply the correct distal displacement vector to accomplish elbow joint reduction.

The patient's extremity is draped free, and a C-arm fluoroscopic unit is also draped in a sterile fashion. It may be difficult to palpate the lateral epicondyle if there is a significant amount of swelling. Thus, the location in the midpoint of the lateral epicondyle is identified by A/P and lateral projections, using an hypodermic needle or Steinmann pin to identify the point of insertion.

Using the humeral guide, a $\varnothing 3\text{mm}$ Apex[®] reference pin is placed laterally and directed towards the point identified at the medial epicondyle (Fig. 17). The DJD II is then applied over the reference pin and the humeral half pins inserted percutaneously using the appropriate pin guide (see step 6 above). Hoffmann[®] II Compact[™] Pin to Rod Couplings are used to attach the humeral pins to the humeral rod of the DJD II. The joint is reduced as well as possible and the ulnar pins are then applied with the appropriate pin guide (see step 7 above). Ulnar pins are then attached to the ulnar rod with Hoffmann[®] II Compact[™] Pin to Rod Couplings (Fig. 18). The $\varnothing 3\text{mm}$ Apex[®] humeral reference pin is then removed.

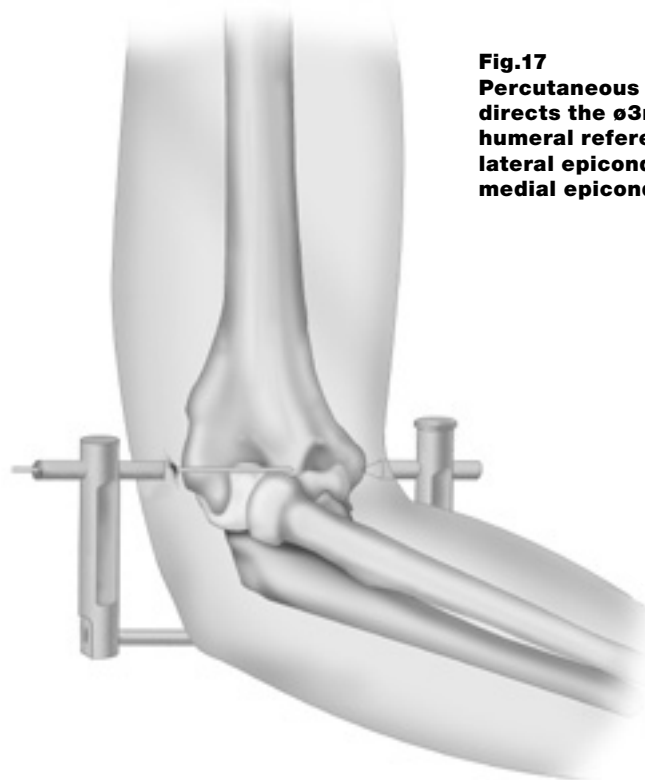
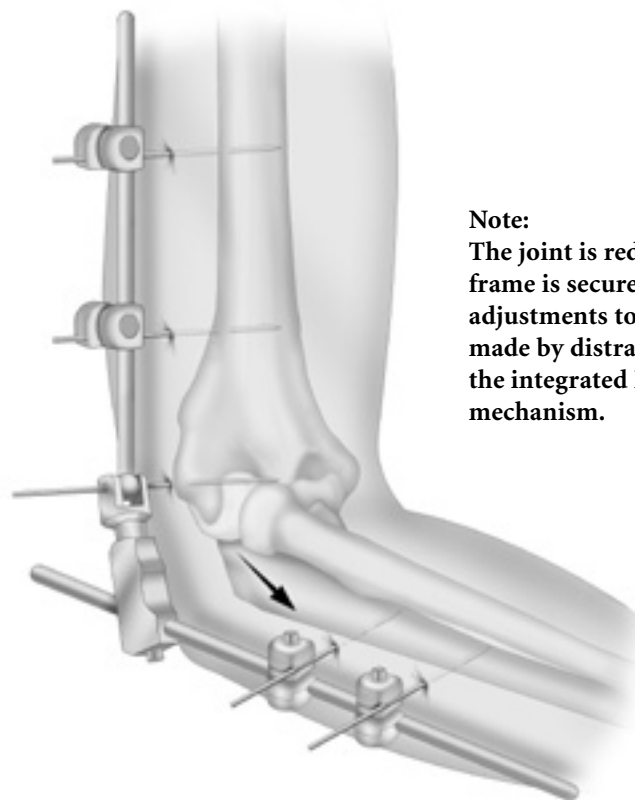


Fig.17
Percutaneous application directs the $\varnothing 3\text{mm}$ Apex[®] humeral reference pin from the lateral epicondyle towards the medial epicondyle.



Note:
The joint is reduced before the frame is secured, however, small adjustments to alignment can be made by distracting the joint using the integrated DJD II distraction mechanism.

Fig.18
Once the frame is applied the distraction device may sometimes be used to help reduce the glenohumeral joint.

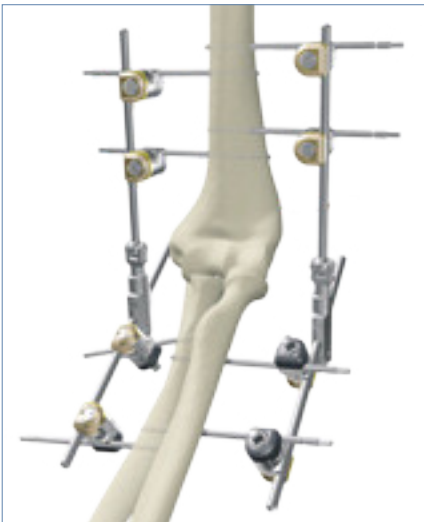
Operative Technique

DJD II Frame Reference Guide



A. Unilateral frame (Lateral)

	A	B	C
DJD II Body (Cat. No. 5195-0-010)	1	2	1
Pin to Rod Coupling (Cat. No. 4940-1-020)	4	8	4
Apex® Pins	4	8	4



B. Bilateral frame



C. Unilateral frame (Medial)

Postoperative Management Recommendations












The following steps are typically employed postoperatively:

- The patient is assessed in the recovery room to assure neurovascular competence.
- To avoid unwanted joint movement during the first 24 hours, the DJD II can be locked by using a Hoffmann® II Compact™ Rod and two rod to rod couplings. The rod is placed between the proximal humeral rod and the distal ulnar rod of the DJD II.
- If the procedure requires early motion and complete relief of pain, appropriate analgesia should be provided to attain this goal. A brachial plexus catheter may be appropriate for this purpose.
- The patient is encouraged to begin passive range of motion with the DJD II device during the first 24 to 48 hours.
- A careful inspection of the elbow is made to assess for swelling and to assure the device is not exerting pressure on the skin.
- Proper pin site care is necessary to reduce the risk of pin tract infection.
- If there is no evidence of infection and there has been adequate progress, the patient is dismissed upon surgeon's discretion with passive range of motion instructions.
- Approximately 3 weeks after the operative procedure for stiffness and 6 weeks for ORIF, the ulnar rod is freed from the ulnar pins and the elbow is examined for stability. Care is taken not to forcefully manipulate the elbow. If the elbow is found to be unstable, the ulnar rod is reattached to the ulnar pins. If the elbow is stable, the DJD II may be removed as well as the ulnar and humeral pins.

An A/P and lateral X-ray is taken to assure that the elbow is adequately reduced and stable. The patient is then treated with flexion and extension splints according to the merits of the case (see table below).




Post-op Management	Time Period
Analgesia	Recovery room to 48 hours
Continuous Passive Motion (CPM)	Day 1-21 for stiffness Day 1-42 for fracture
DJD II removal	3 weeks for stiffness 6 weeks for fracture
Flexion and extension splints program	12 weeks: 21 hr/day during 3 weeks 18 hr/day during 6 weeks 15 hr/day during 6 weeks
Long-term splints	Maintenance at night during 3 month (longer as needed)

Ordering Information - Components & Instruments

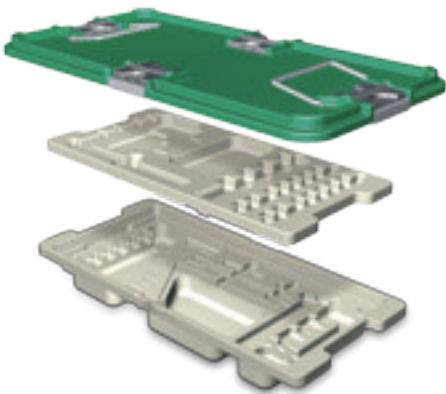
	REF	Description
DJD II Component		
	5195-0-010	DJD II body
Hoffmann® II Compact™ Couplings		
	4940-1-010	Rod to Rod Coupling
	4940-1-020	Pin to Rod Coupling
Hoffmann® II Compact™ Rods		
	5049-5-250	Stainless Steel Connecting Rod ø5mm x 250mm
	5049-5-525	Carbon Connecting Rod ø5mm x 250mm
DJD II Specific Instruments		
	5195-1-010	Humeral Guide
	5195-1-020	ø3mm Pin Insertion Guide
	5195-1-030	ø4mm Pin Insertion Guide
	4940-9-030	5mm Wrench/ø3 & 4mm Pin Driver
	5150-9-005	5mm Spanner Wrench
	4940-9-010	Stabilization/Reduction Wrench
	4920-9-020	Thumbwheel

Ordering Information - Implants & Case

Implants

	Stainless Steel REF	Diameter mm	Total Length mm	Thread Length mm
Apex® Self Drilling/Self Tapping				
	5038-5-080	3.0	80	20
	5038-2-110	3.0	110	25
	5023-2-090	4.0	90	20
	5023-3-120	4.0	120	30
	5023-5-150	4.0	150	40
Apex® Blunt Pins				
	5036-2-080	3.0	80	20
	5036-2-110	3.0	110	25
	5027-2-090	4.0	90	20
	5027-3-120	4.0	120	30
	5027-4-150	4.0	150	40
Apex® Smooth Transfixing Pin				
	5045-2-200	3.0	200	-

Case



REF	Description
5195-9-100	Storage Case

Joint Replacements

Trauma, Extremities & Deformities

Craniomaxillofacial

Spine

Biologics

Surgical Products

Neuro & ENT

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