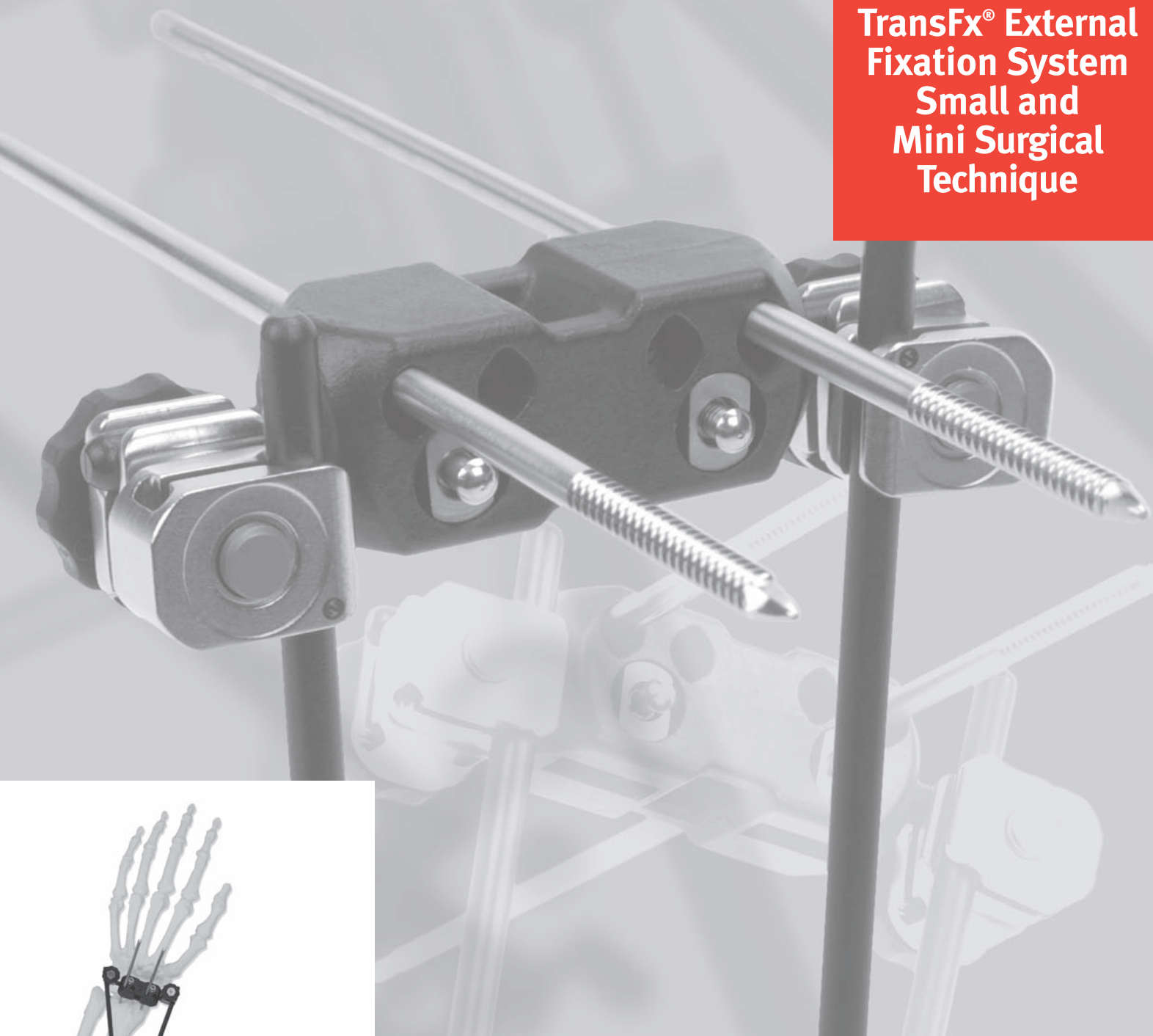




**TransFx® External
Fixation System
Small and
Mini Surgical
Technique**



Surgical Technique For TransFx External Fixation System Small - Mini

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Introduction

In 1897, Dr. Clayton Parkhill of Denver, Colorado, reported on the first successful use of an external fixation device in fracture treatment. Five years later, Dr. Albin Lambotte of Belgium developed a unilateral fixator that allowed active motion without splinting. Lambotte's more rigid device was made of better materials, and used more pins in combination with steel rods.

The use of smaller external fixation systems on upper extremity fractures without plaster began in the 1930s with Dr. Roger Anderson of Seattle, Washington. He developed the concept of independent pin and wire placement with individual pin-to-rod clamps.

These small, modular-type frames were initially developed for Colles and other types of fractures in the distal radius. These same techniques and their variations are the basic technology used today by orthopaedic surgeons in the treatment of these fractures.

The *TransFx*® External Fixation System is a modular system that offers the surgeon advances in design technology and materials. The system philosophy is to provide the surgeon with choices in frame construction, simplicity in frame components, and ease of transition from one frame size to another. The *TransFx* External Fixation System is indicated for fractures of the long bones and pelvis, joint fusion, limb lengthening, osteotomies, and periarticular fractures.



Design Rationale

Design Goals

The most important functional design goal of an external fixation system is to provide the necessary stability to the fracture. Stability is affected by a number of factors, including:

- **Material Strength** – An external fixation device must be able to withstand the loads applied by an active patient.
- **Pin Spacing** – The rigidity of a frame is increased when pins within the same fragment are spaced farther apart.
- **Proximity of Rod to Bone** – Rigidity is also increased when the rod is placed closer to the bone.
- **Diameter of Rods and Pins** – The greater the cross-sectional area of the rods and pins, the stronger the frame.
- **Number of Pins, Rods, and Frames** – Adding pins, stacking rods, and/or creating an additional frame in a different plane (Delta Frame) can enhance the rigidity of the construct.
- **Pin Angles** – Pins must be inserted at angles that allow optimal bone purchase and fracture reduction.

In addition to providing the desired functional stability, the general goals of an external fixation system design are to provide a wide choice of frame construction options, flexibility in pin placement and orientation, simple application of the construct, and easy transition among frame sizes to accommodate specific patient anatomy and fracture type.

Frame Construction Options

The *TransFx* External Fixation System is designed to provide multiple frame construction options by offering a variety of clamp designs, including rod-to-rod clamps, transition clamps, and single and multi-pin clamps. These options allow flexible pin positioning and flexible placement on the rods.

Pin Placement and Orientation

Pin orientation should be dictated by patient anatomy and the characteristics of the fracture fragments. The clamps in the *TransFx* External Fixation System are universally adjustable to allow independent pin placement in three planes. This allows flexible configuration and positioning of the construct. Multi-pin clamps are available in single-, mid-, and end-connect options with choices of pin separation to further accommodate independent pin placement. Components are available in a wide selection of pin and rod diameters and lengths.

Construct Stability

The pins and some clamps of the *TransFx* System are made from high strength stainless steel. Rods are made from carbon fiber, while multi-pin clamps are made primarily of carbon fiber and aluminum.

Dynamization

By decreasing the rigidity of a frame, axial movement of the fragments can take place, which may create increased callous stimulation at the fracture site.

Basic Frame Configurations

Two basic frame configurations are commonly used: unilateral frames, and modular frames. These two configurations may be used in spanning (crossing a joint) or nonspanning applications.

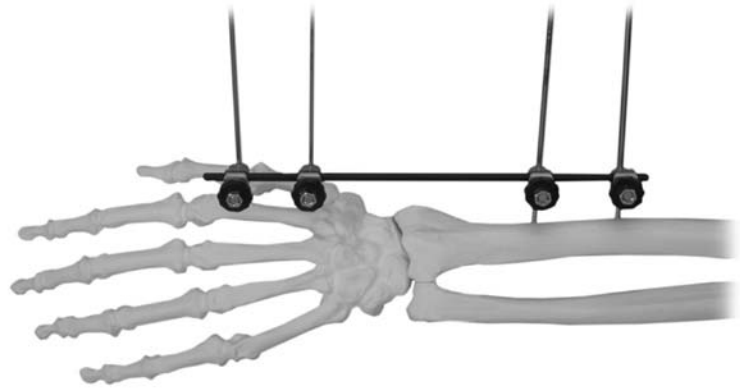
Unilateral Frames

When a single rod is attached with pins above and below a fracture site, the frame is considered to be unilateral. However, a unilateral frame does not allow for multiplanar manipulation of the fracture after the frame is applied. It can be adjusted only axially. The rigidity of a unilateral frame can be increased by adding additional pins, or by adding a second rod in a stacked configuration.

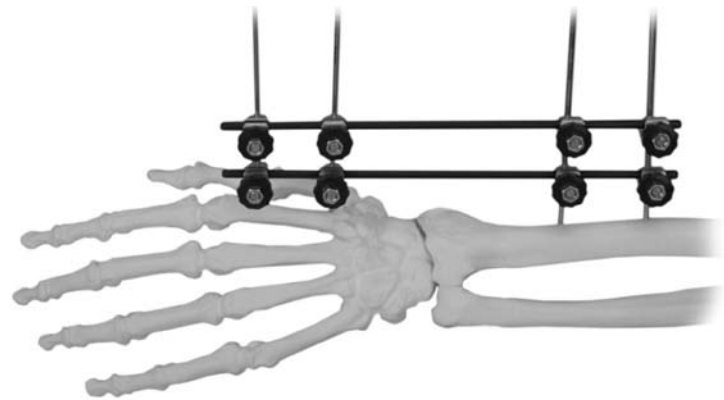
Modular Frames

Frames where pins and rods are individually attached to the fragments (fracture units) are known as modular frames. The pins are then connected through the use of multiple single-pin clamps and rods to achieve reduction and stability. Alternatively, the pins may be connected in pairs, using multi-pin clamps with a single rod. Modular frame configurations allow manipulation of the fracture in more planes to facilitate fracture reduction.

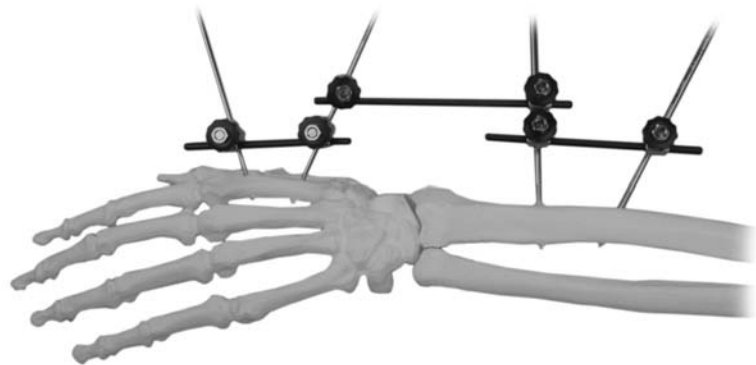
NOTE: A unilateral frame can be converted to a modular frame by changing the rod and clamp configuration as long as the inside pins are not spaced too close.



Unilateral frame



Stacked frame



Modular frame

System Components

Small/Mini Components

Pins



Self Drilling (Small Only)



Self Tapping (Small Only)



Trocar Tip (Small Only)



Threaded Trocar Tip (Mini Only)

Carbon Fiber Rods



3mm diameter



4mm diameter



Clamps



Pin to Rod (Small Only)



Open Rod to Rod (Small Only)



Closed Rod to Rod (Mini Only)



Transitional Rod
(Mini: 3mm-4mm/Small: 4mm-8mm)

Multipin Clamps



End Connect



Mid Connect



Single Connect

Pins (Small)

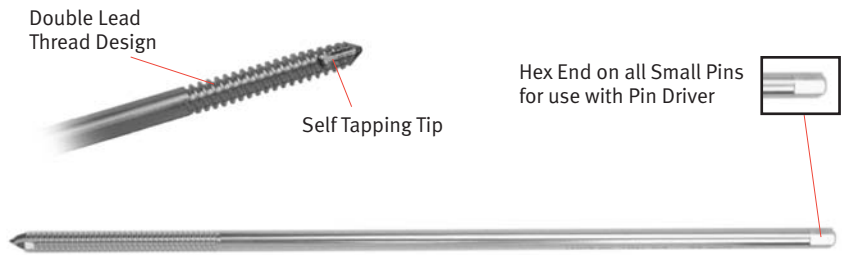
All pins are made from stainless steel.

Self-Tapping

Available in small only.

Double Lead Threads:

Pin advances into the bone at a rate of two threads per revolution



Pin Dia.	Material Grade	Thread Dia.	Lengths	Thread Type	Minor Dia.	Drill Required
4.0mm	22-13-5	4.0	80, 100, 120, 150	Dbl. Lead	3.2	3.0
3.5mm	316L	3.5	80, 100, 150	Dbl. Lead	2.7	2.5
3.0mm	316L	3.0	3.080, 150	Sngl. Lead	2.25	2.0

Self-Drilling/Self-Tapping



Pin Dia.	Material Grade	Thread Dia.	Length	Minor Dia.
4.0mm	22-13-5	4.0	80, 150	3.4
3.5mm	22-13-5	3.5	80, 150	2.9
3.0/4.0mm	22-13-5	3.0	80, 100	2.4
3.0mm	22-13-5	3.0	80, 150	2.4

Trocar Tip

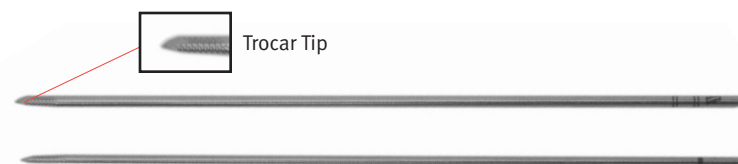


Pin Dia.	Material Grade	Thread Dia.	Length	Minor Dia.
3.0/4.0mm	22-13-5	3.0	80	1.8
2.5mm	316L	2.5	150, 200	1.75

- For use with Trocar Device

Pins (Mini)

Threaded Trocar Tip Pins (Self-Drilling)



Pin Dia.	Material Grade	Thread Dia.	Length	Minor Dia.
1.6mm	316L	1.6mm	100mm	1.15mm
1.25mm	316L	1.25mm	100mm	.75mm

Clamps

Pin-to-Rod Clamp (Small Only)

- Universally adjustable
- Independent pin placement in three planes
- Open clamp design for snap fit
- Speed nuts for initial finger tightening
- Spring action
- 2.5mm-4mm pins/4mm rods



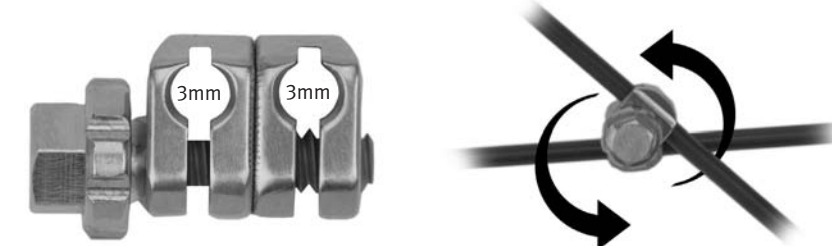
Open Rod-to-Rod Clamp (Small Only)

- Universally adjustable
- Open clamp design
- Speed nuts for initial finger tightening
- 4mm rods



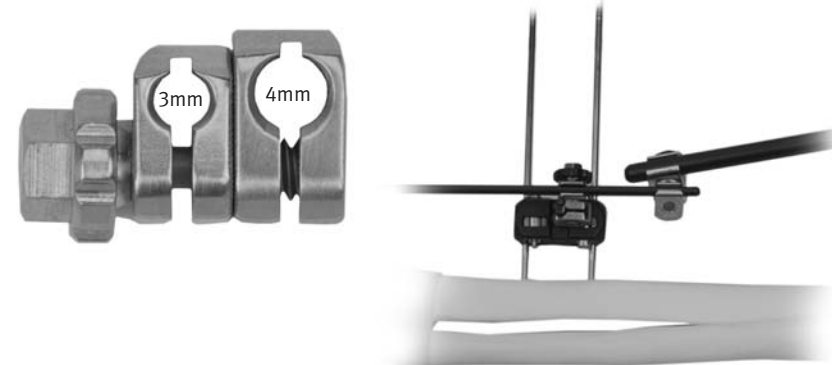
Closed Rod-to-Rod Clamp (Mini Only)

- Universally adjustable
- Closed design
- Speed nuts for initial finger tightening
- 3mm rods



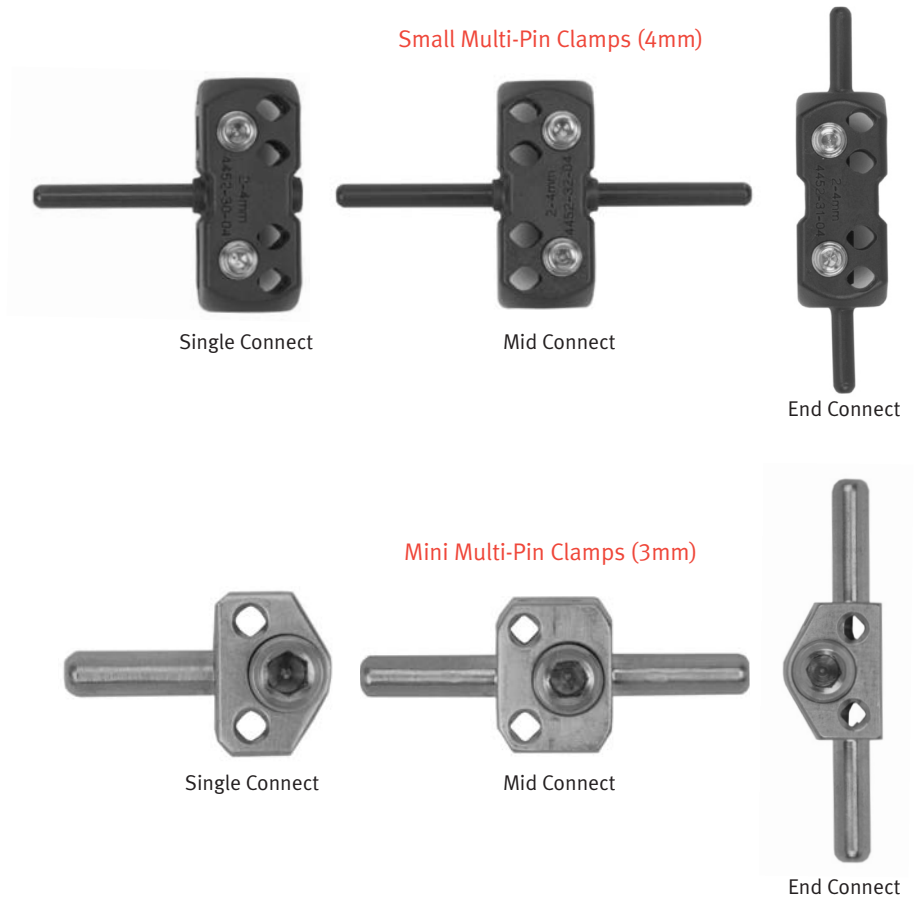
Transition Clamp (3mm-4mm / Small: 4mm-8mm)

- Ability to connect from mini to small or small to intermediate systems
- Three-dimensional clamp rotation
- Open clamp design for snap fit in 4mm to 8mm
- Closed clamp design in 3mm to 4mm



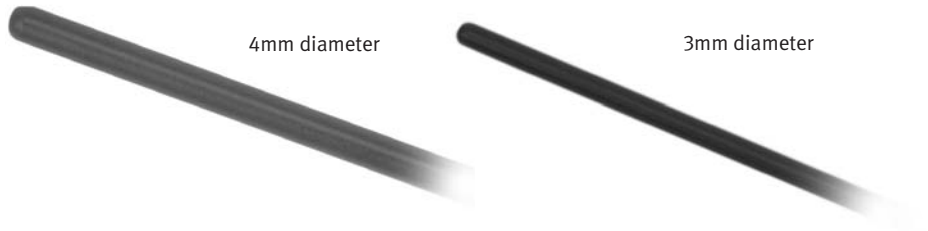
Multi-Pin Clamp

- Always use pins of same diameter in clamps
- Single-connect, mid-connect, and end-connect options
- Cam locking feature on pin tightens with Hex Screwdriver
- Small clamps accept 2.5mm to 4mm pins
- Mini clamps accept 1.25mm, or 1.6mm pins



Rods

- Carbon fiber
- Rounded ends reduce sharp edges
- 4mm (Small) available in 60/80/100/120/140/160/180/200/250/300mm lengths
- 3mm (Mini) available in 25/45/60/75/90/105mm lengths



Instruments

Hex Pin Driver (Small Only)

- Interference-fit design
- Hex Pin Driver inserts three pin diameters
- Used on intermediate and small systems
- 3mm, 3.5mm, and 4mm



Multi-Pin Drill Guide (Small Only)

- Five-position setting
- Four-hole drill guide with drill sleeve that corresponds to small multi-pin clamps
- Threaded drill sleeve locks into position



Drill Guide (Mini Only)

- Dual purpose for pin sizes 1.6mm & 1.25mm
- Serrated tip
- Corresponds to multi-pin clamp separation



Screwdriver

- Driver used for intermediate, small, and mini systems
- 2.5mm hex drive

**Socket Wrench**

- Small: 7mm
- Mini: 5.5mm

**Combination Wrench**

- Small: 7mm
- Mini: 5.5mm

**Universal Chuck with T-Handle**

- For use with all pin sizes (1.25mm to 6.0mm)

**Clamp Holder – Mini**

- Stabilizes Multipin clamps for tightening



Pathways for Pin Insertion

Forearm Zone A

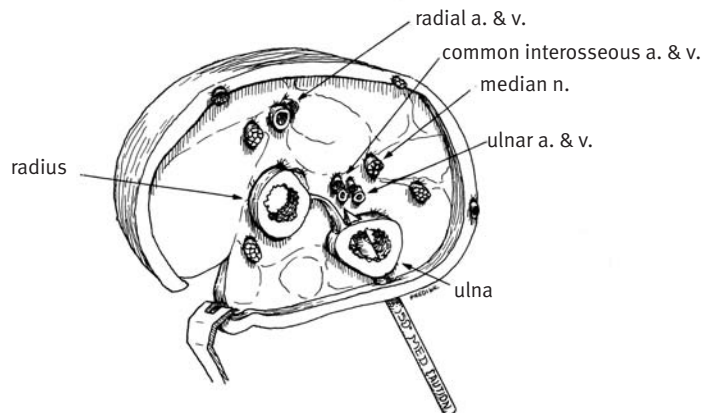
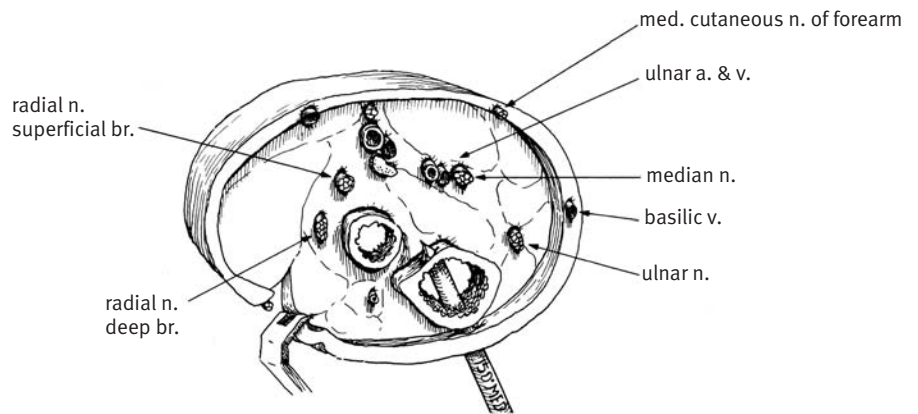
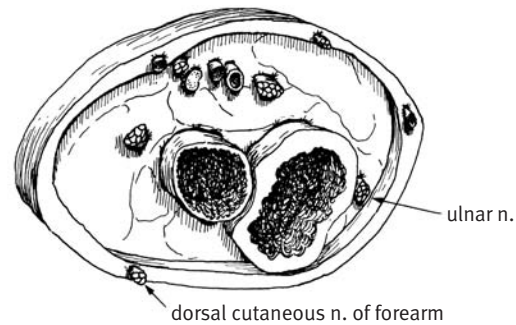
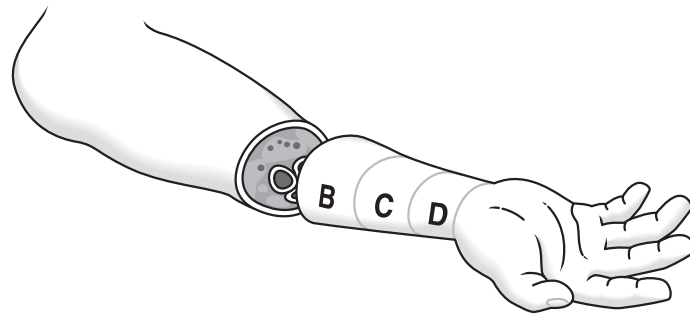
Anatomic Considerations

1. The deep branch of the radial nerve winds around the lateral side of the humerus within the substance of the supinator muscle.
2. The brachial artery divides into its terminal branches in Zone A, the common interosseous artery and the ulnar artery, with associated veins, are anterior to the proximal ulna in distal Zone A.

Pin Placement

1. Half-pins can be inserted into the proximal ulna from the 150° medial direction. Image intensification fluoroscopy is recommended.
2. Pin placement into the proximal radius is dangerous because of the location of the deep branch of the radial nerve. If it is necessary to stabilize the proximal radius with external fixation, it is wise to identify this structure surgically before pin insertion.
3. In distal Zone A, pins may be placed into the ulna from the 150° lateral position (not shown).

Green SA. *Complications of External Skeletal Fixation—Causes, Prevention, and Treatment*. Charles C. Thomas Publisher; 1981 (used with permission).



Forearm Zone B

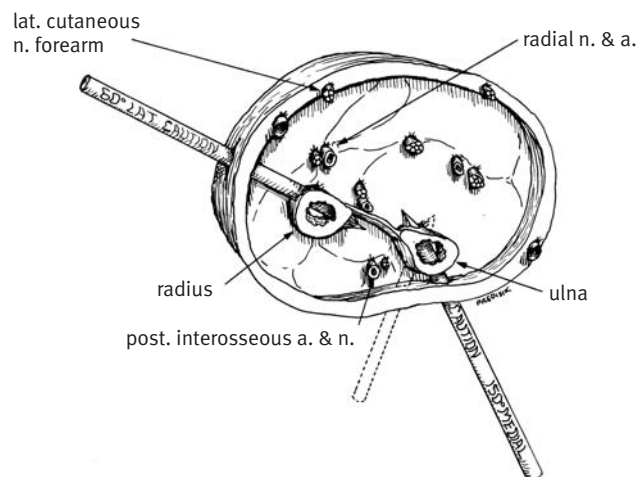
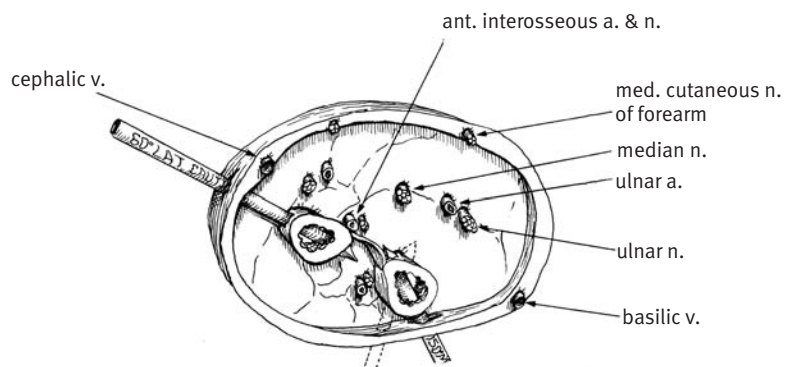
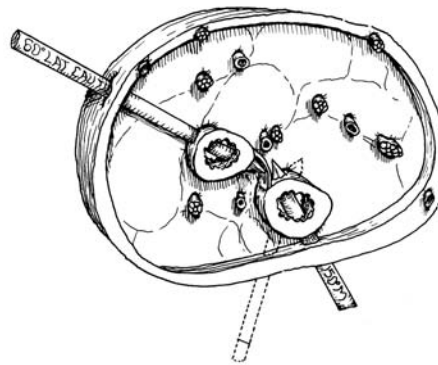
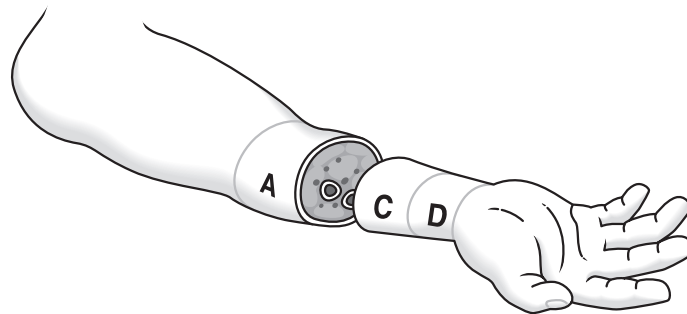
Anatomic Considerations

1. The radial, ulnar, and median nerves remain in relatively constant position throughout Zone B.
2. The anterior interosseous artery and nerve lie on the anterior surface of the interosseous membrane.
3. The deep branch of the radial nerve lies adjacent to the posterior interosseous artery, posterior to the interosseous membrane and separated from it by muscle.

Pin Placement

1. Half-pins can be inserted into the ulna from the 150° medial position. Depth can be assessed with fluoroscopy.
2. Half-pins can be inserted (employing considerable caution) into the radius via the 60° lateral position. As with half-pin insertion into the ulna, fluoroscopy control is recommended.

Green SA. *Complications of External Skeletal Fixation—Causes, Prevention, and Treatment*. Charles C. Thomas Publisher; 1981 (used with permission).



Forearm Zone C

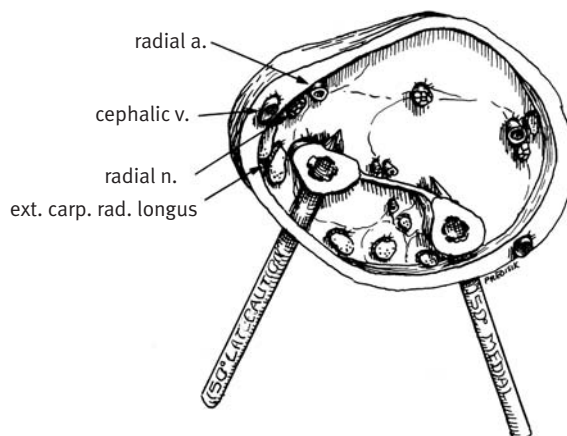
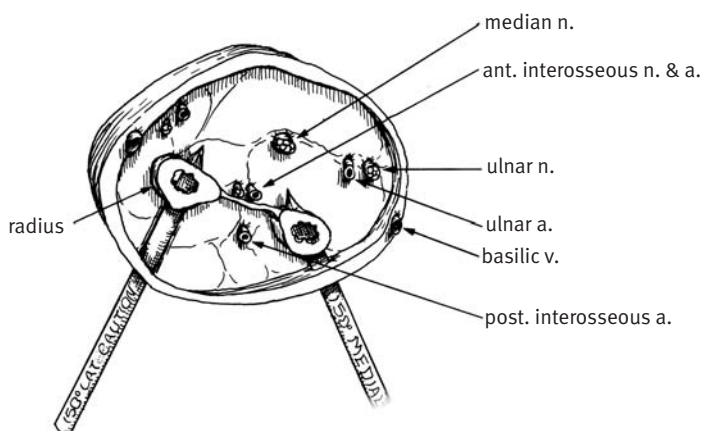
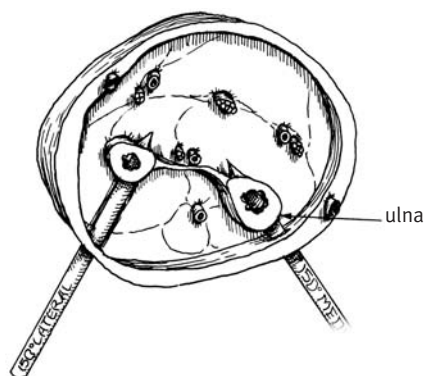
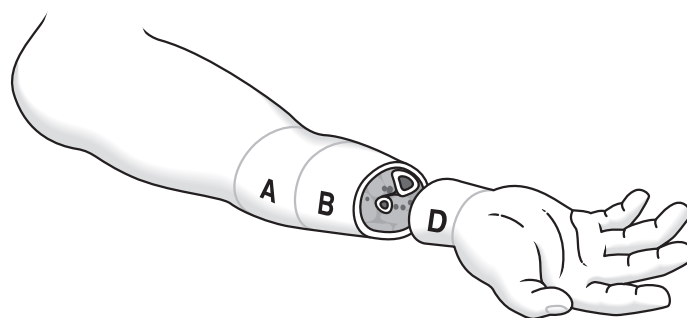
Anatomic Considerations

1. The superficial branch of the radial nerve and radial artery are anterior to the radius in Zone C, becoming more lateral and superficial in the distal part of this zone.
2. The median nerve maintains its position in the middle of the forearm, surrounded by muscle.
3. The ulnar nerve and ulnar artery remain anterior and medial to the ulna throughout Zone C.

Pin Placement

1. Half-pins may be placed with caution into the ulna from the 150° medial direction. They can be placed in the 180° posterior position and the 150° lateral position as well, being mindful of the position of the extensor tendon as illustrated in distal Zone C.
2. Half-pins may be placed into the radius from the 150° lateral position. Pins may also be placed into the radius from the 180° posterior position if care is taken to avoid impalement of extensor tendons.

Green SA. *Complications of External Skeletal Fixation—Causes, Prevention, and Treatment*. Charles C. Thomas Publisher; 1981 (used with permission).



Forearm Zone D

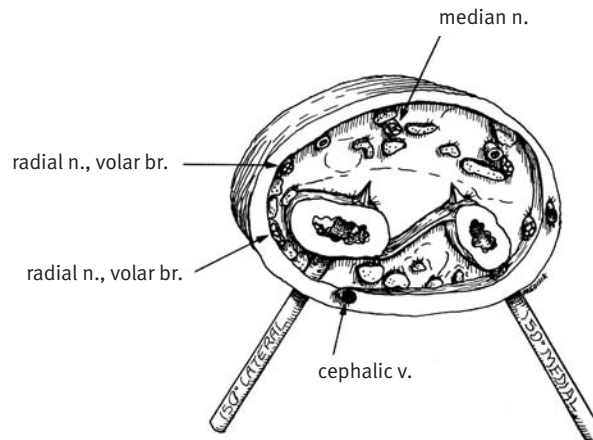
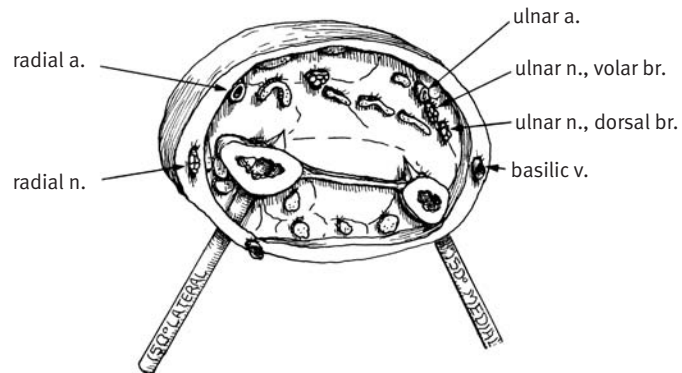
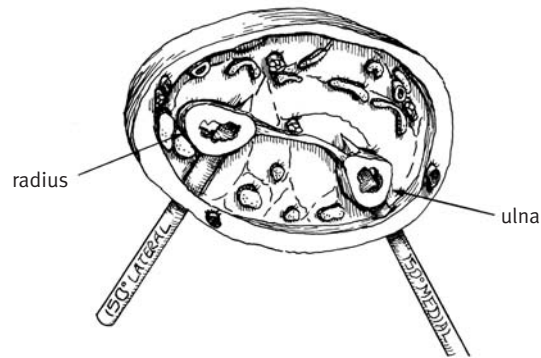
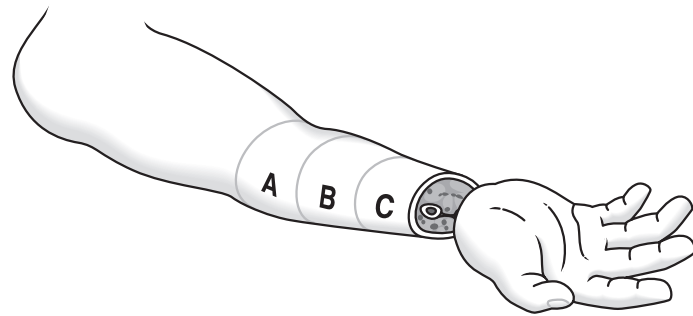
Anatomic Considerations

1. The radius and ulna are posteriorly located in the cross section of the forearm.
2. The radial nerve is lateral to the shaft of the radius, dividing into dorsal and volar branches in Zone D.
3. The median nerve remains within the volar muscle mass.
4. The ulnar nerve divides into dorsal and volar branches, the dorsal branch passing to the posterior aspect of the distal forearm.
5. The extensor and flexor muscles become tendinous in Zone D.

Pin Placement

1. Half-pins may be inserted with caution from the 150° medial direction into the ulna.
2. Half-pins may be placed into the distal radius from the 150° lateral direction. Note the relative position of the extensor tendons so they are not impaled by a pin.

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Hand

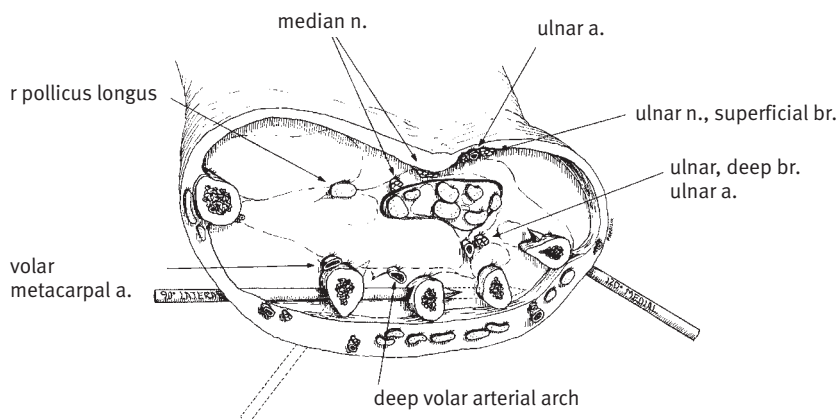
Anatomic Considerations

1. A cross section through the metacarpal shafts demonstrates the close relationship of the radialis indicis artery to the volar surface of the second metacarpal.
2. The palmar metacarpal artery to the second web space is adjacent to the radial volar surface of the third metacarpal shaft.
3. The ulnar artery and deep branch of the ulnar nerve are volar to the fourth metacarpal shaft, separated from it by muscle, a distance equal to the width of the bone.



Pin Placement

1. Full- or half-pin placement from the 90° lateral position can be safely passed through the shafts of the second, third, and fourth metacarpals. Extensor tendon impalement may occur as the pin passes through the skin on the medial side of the dorsum of the hand. The oblique lateral surface of the second metacarpal makes pin insertion difficult because the tip of the pin tends to slide on the bone.
2. Half-pin insertion into the second metacarpal from the 150° lateral position can be safely accomplished if done carefully.
3. Half-pin placement into the fifth metacarpal shaft from the 120° medial position can be done with caution, although the curved surface of the bone makes pin insertion difficult.



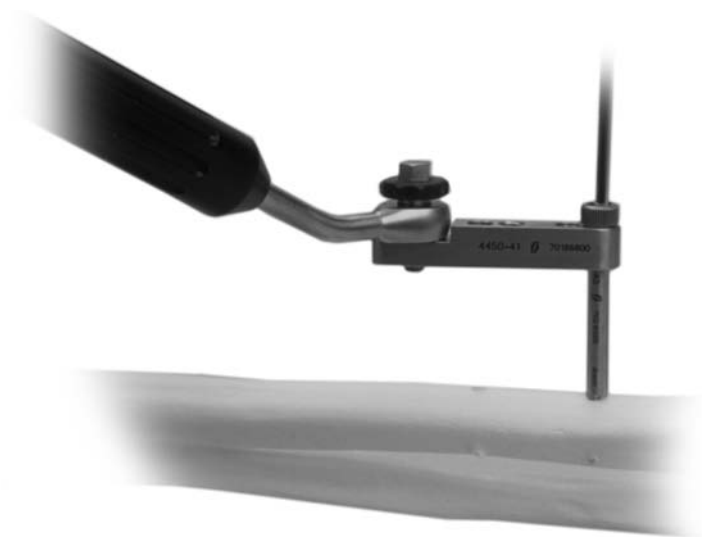
Green SA. *Complications of External Skeletal Fixation—Causes, Prevention, and Treatment*. Charles C. Thomas Publisher; 1981 (used with permission).

Techniques

Pin Insertion

Multi-Pin Drill Guide (4mm)

1. Identify first pin position using Drill Sleeve w/Trocar inserted into Multi-Pin Drill Guide.
 - Dissect down to bone.
 - If using self-drilling pins, insert pin after removing Trocar.
 - If using self-tapping pins, remove Trocar and drill first hole.
 - Disconnect Drill Bit from Universal Cannulated Chuck. (This will maintain Drill Sleeve position, which is especially important when inserting through deep soft tissue.)
2. Identify second pin position and insert appropriate sleeve through Multi-Pin Drill Guide.
 - If using self-drilling pins, insert pin after removing Trocar.
 - If using self-tapping pins, remove Trocar and drill second hole.
 - Use depth gauge to determine proper pin length.
 - Insert pin through sleeve.
 - Remove Drill Bit from first hole.
 - Use depth gauge to determine proper pin length.
 - Insert pin.



Multi-Pin Clamp Used as Drill Guide (small)

1. Insert the first pin through the appropriate sleeve.
 - Place *TransFx* Multi-Pin Clamp onto pin.
2. Insert a sleeve into the second hole of the clamp.
 - Pre-drill or insert a self-drilling pin.

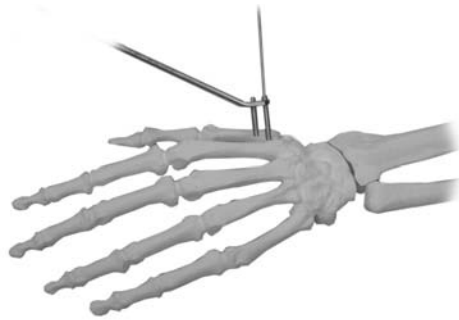


3. Insert a self-tapping pin by hand through the clamp or sleeve.



Multi-Pin Drill Guide (mini)

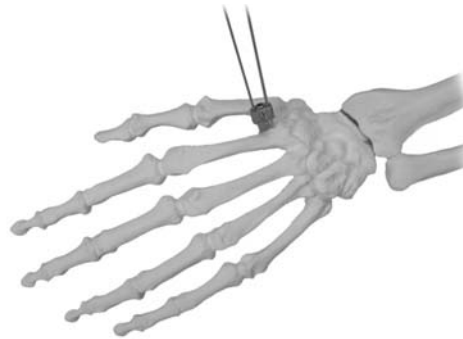
1. Identify first pin position and insert 1.25mm or 1.6mm pin through Multi-Pin Drill Guide.



2. Insert second pin.



3. Slide multi-pin clamp over pins.



4. Use Mini Clamp Holder and Hex Screwdriver to tighten clamp.



5. Attach rods.



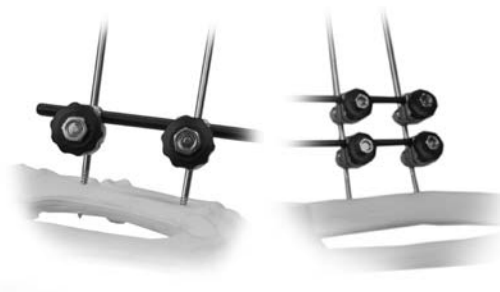
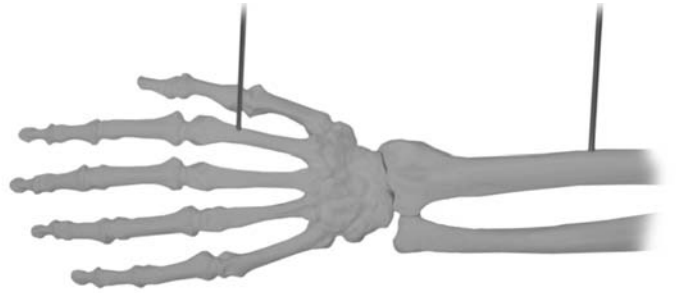
Frame Construction

Unilateral Frame (Small) (Pin Sizes 2.5mm-4mm)

1. Reduce fracture and stabilize with bone clamps, if possible (once applied, unilateral frames cannot be adjusted to further reduce fracture).
2. Insert most proximal and most distal pins using appropriate Drill Sleeve w/Trocar. In unilateral frames, it is best to leave adequate space for insertion of inner pins.
3. Place four pin-to-rod clamps on carbon fiber rod.
 - Place end caps on end of rods and apply outer clamps to pins.
 - Reduce fracture and tighten end clamps.
4. Insert Drill Sleeves through inner clamps and drill, maintaining safe distance from fracture site. **NOTE: Pins do not have to be parallel to each other.**
 - Insert final pins and tighten clamps.

NOTE: If stacking a frame, the second rod must be placed on end pins prior to drilling inside pins. Drill Sleeve must be passed through both clamps to maintain proper alignment of pins and clamps.

5. To further increase rigidity, additional pins with *TransFx* Open Pin-to-Rod Clamps may be added at any position on the rod.

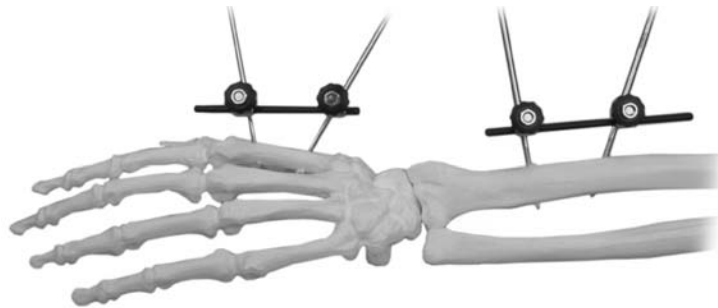


Modular Frame

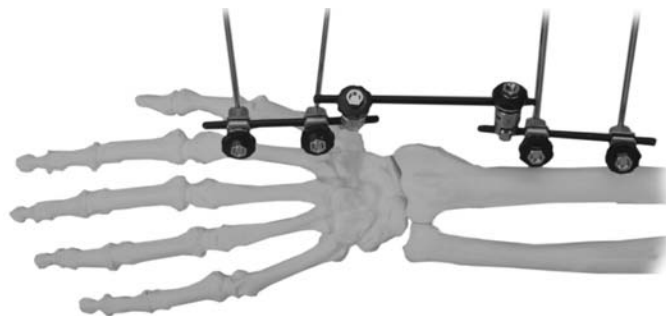
1. Insert two pins in proximal or distal fragment and attach appropriate clamps and rod, creating a fracture unit.
 - Pins may be placed in any plane; however, the pin closest to the fracture should not be so close or angled in such a way that it interferes with the fracture site or causes difficulty in attaching additional connecting rods to the unit.
 - Single-tightening *TransFx* Open Pin-to-Rod Clamps may be used on modular frames.



2. Repeat step one for second fracture unit.



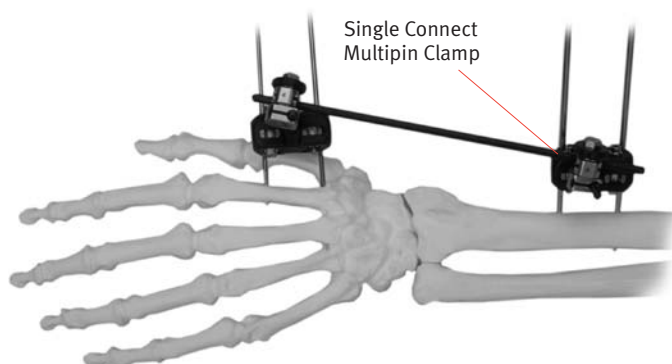
3. Reduce fracture and connect units with appropriate length rods and rod-to-rod clamps.



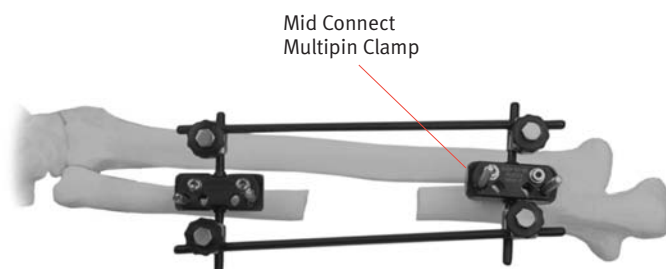
4. Stacking or reinforcing can be accomplished using inside pins with pin-to-rod clamps and appropriate rods.

Multi-Pin Modular Frame

1. See multi-pin insertion technique on page 16.
2. Select appropriate *TransFx* Multi-Pin Clamp (side-, end-, or mid-connect).
3. Utilize first multi-pin clamp and then the second on opposite fragment.
4. Connect appropriate rod-to-rod clamps and then reduce fracture and tighten clamps.



5. Add second rod to increase stability.



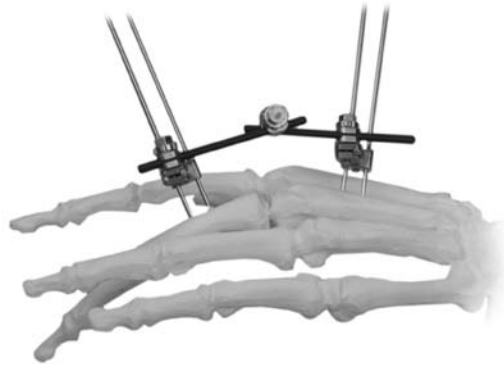
6. For variations, add additional pins to other locations.



Mini Frame Variations

By using side- or end-connect *TransFx* Mini Multi-Pin Clamps, you may increase the rigidity by adding an additional rod.

When tightening two rods, tighten first rod on the clamp. Then connect a rod-to-rod clamp and second multi-pin clamp.



Postoperative Care

Patient compliance is important to prevent complications at pin sites. Thoroughly instruct the patient or caregiver on how to clean and protect pin sites.



Contact your Zimmer representative or visit us at www.zimmer.com

The CE mark is valid only if it is also printed on the product label.

