stryker®

Trauma

Hoffmann® II MRI
External Fixation System

Operative Technique
- Long Bones
- Pelvis

Raising the Bar Once Again

Table of Contents

Introduction

In 1938, Raoul Hoffmann, a surgeon from Geneva, Switzerland, designed a revolutionary External Fixation System. The basic features of this system were its modular design and the ability to reduce fractures or to make post operative corrections to the alignment of fragments in three planes with the frame *in situ*.

The Hoffmann® II[1] has built upon these principles, and today is the gold standard in modular external fixation. Certainly, the Hoffmann® II family of products is unmatched in its ease-of-use, versatility, and patient comfort.

You will find in the following pages the benefits and advantages of the Hoffmann® II, and how the system will help patients heal and return to their normal lives.

1. Pin to Rod Coupling
2. Rod to Rod Coupling
3. 5-Hole Pin Clamp
4. 30°, 90° Angled Post & Straight Post
5. 8mm Connecting Rods
6. Semi-Circular Connecting Rod
7. Dynamization Tube
8. Compression/Distraction Tube
9. Tube to Rod Coupling
10. Apex® Self-Drilling Pin

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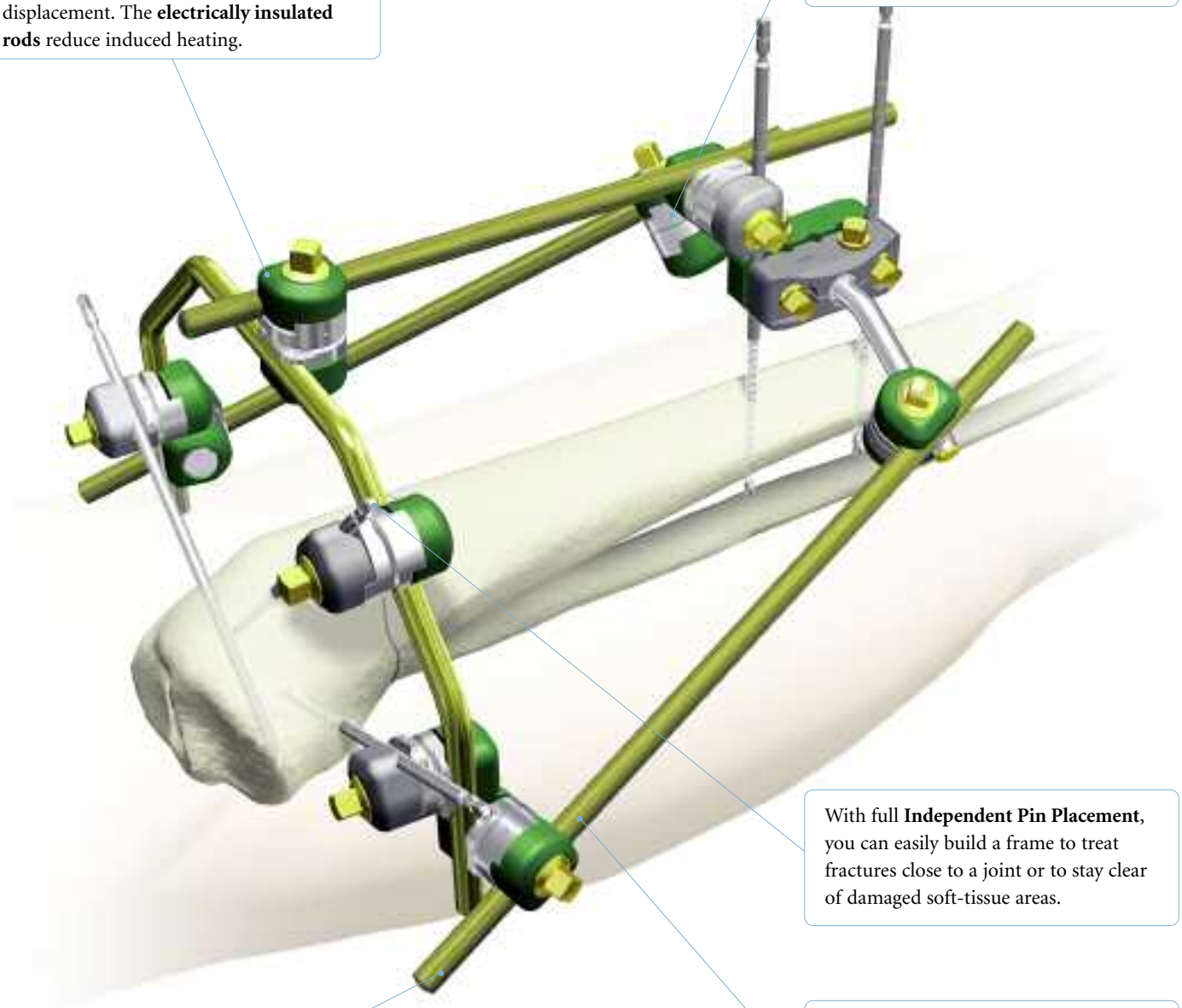
Features & Benefits

Speed, versatility and ease-of-use are the keys to an effective trauma fixator. Whether it is middle-of-the-night trauma, or a complicated fracture with associated soft-tissue damage, the Hoffmann® II MRI product family gives the surgeon the right tools to resolve even the most difficult cases.

Every system component is manufactured from **MRI-compatible materials**. Clamps and pins are made from non-ferromagnetic materials to help prevent component displacement. The **electrically insulated rods** reduce induced heating.

With the patented **"Snap-Fit" Technology**, stable frame building is simple. It is possible to reduce the fracture, make post-operative corrections, and treat soft-tissue damage with the frame *in situ*.



With full **Independent Pin Placement**, you can easily build a frame to treat fractures close to a joint or to stay clear of damaged soft-tissue areas.

Light-Weight and Advanced component materials create a strong rod for building **Low-Profile, Radiolucent Frames** which may enhance patient comfort and facilitates fracture management.

The components are **Color-Coded** for easy identification and there are just a handful of **multifunctional instruments** in the system. This makes the system very manageable in the operating room.

Relative Indications & Contraindications

Relative Indications

The Hoffmann® II MRI components are external fixation frame components for use with the components of the Hoffmann® External Fixation System, Hoffmann® II External Fixation System, Monotube® TRIAX™ External Fixation System and in conjunction with Apex® Pins. It is intended to provide stabilization of open and/or unstable fractures and where soft tissue injury precludes the use of other fracture treatments such as IM rodding or casting.

The specific indications for external fixation devices include, but are not limited to:

- Bone fracture fixation
- Osteotomy
- Arthrodesis
- Correction of deformity
- Revision procedure where other treatments or devices have been unsuccessful
- Bone reconstruction procedures

Relative Contraindications

See package insert for warnings, precautions and contraindications.

Frame Building Guidelines[1]

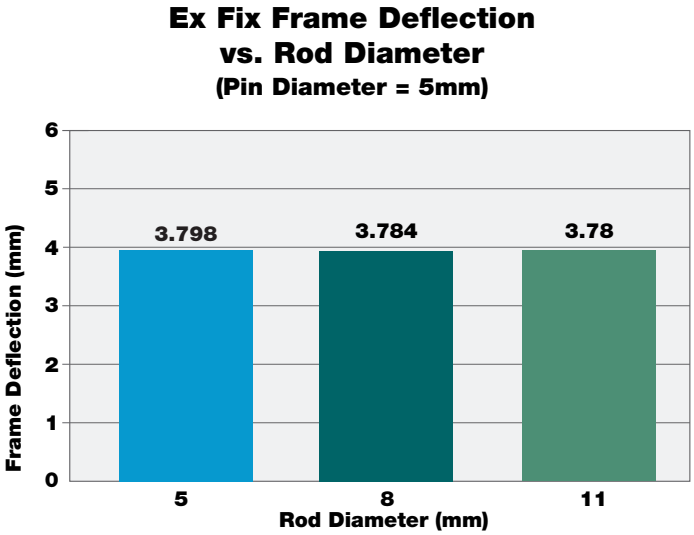
An understanding of external fixation principles requires a solid background in biomechanics. For years, research has shown that the biology of bone healing is significantly influenced by the biomechanics of fracture fixation.

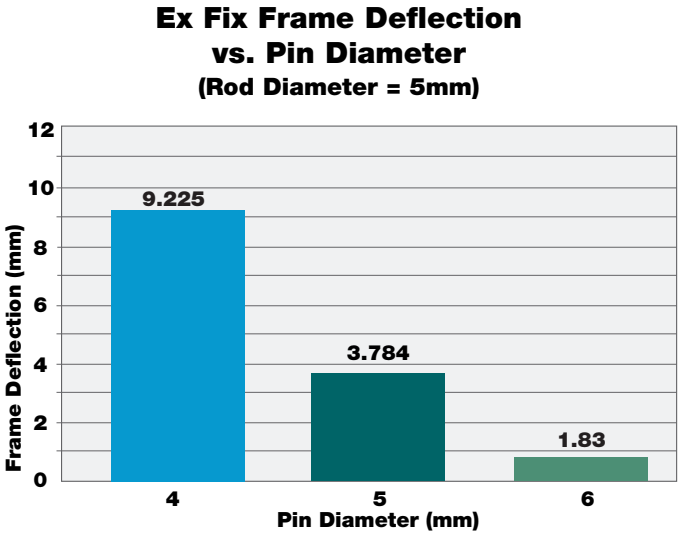
Two important properties to understand about the biomechanics of external fixation are stiffness and strength. Stiffness is defined as the measure of an external fixator's ability to resist deformation when loaded. Strength is defined as the measure of an external fixator's ability to resist failure under loads.

Not all frame components contribute equally to the overall strength and stiffness of a construct. **In general, external fixation pins are the most crucial elements of the fixator in creating successful external fixation frames.** An incremental change in connecting rod diameter or coupler properties will result in an insignificant change in frame stiffness and strength.

To help ensure strong, stiff, frames there are a few simple techniques that can be used when assembling an external fixator:

- increase the pin diameter
- increase the number of pins used
- keep the frame close to the bone
- space the pins far apart within a fragment





The effect of individual factors on frame stiffness:

Significant effect on improving frame stiffness	**Minimal effect** on improving frame stiffness
• Decreasing distance between frame and bone	• Increasing rod diameter
• Increasing pin diameter	• Employing stiffer rod materials
• Utilizing stiffer pin materials	• Applying stiffer clamp materials

1. Eric Ledet, PhD., Biomechanical Factors in External Fixation and Hybrid External Fixation. Stryker White Paper LSA48 2004

Frame Building Guidelines

The guidelines given here will help you build frames which have been proven to provide stability for sustained fracture reduction and elasticity for dynamic osteosynthesis. By using these simple biomechanical principles, you can build a frame suited to the indication at hand.

Pin clamps are designed to build a variety of frames. When using two half pins within a multi-clamp, use the hole positions furthest apart if the anatomy and soft tissues allow. This pin position is the most stable pin to clamp construct (*Figure 1*).

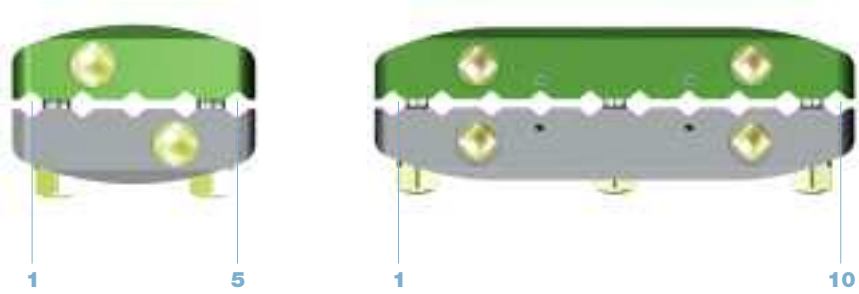


Figure 1

Pin clamps and couplings should be placed approximately 2.5cm away from the soft tissue to allow for post-operative swelling and proper pin site care (*Figure 2*).

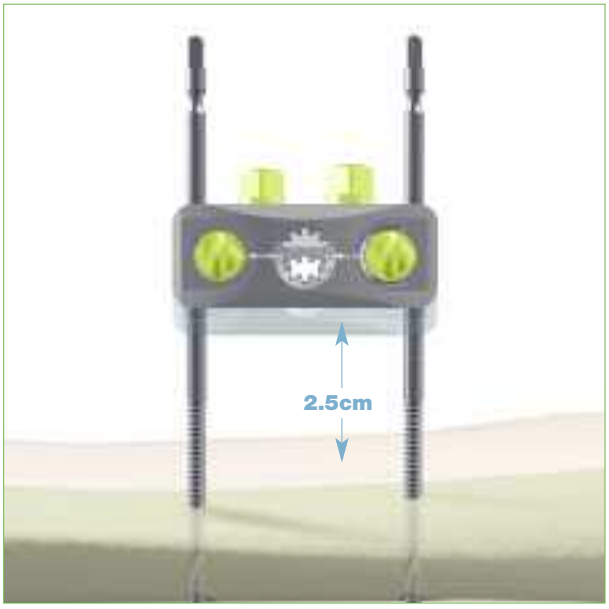


Figure 2

When tightening the clamps and couplings, it is important to apply sufficient torque to fully tighten the frame. It also is important to provide sufficient counter torque so that the tightening of the frame does not damage the pin/bone interface or disturb the fracture site. Make sure to hold the clamp or coupling to be tightened. This can be facilitated by using the Stabilization/Reduction Wrench as shown here. This wrench also is helpful during the reduction process. Use a wrench on either side of the fracture to manipulate and reduce. The wrenches will also keep your hands out of the operative site and will prevent blocking the C-arm (*Figure 3*).

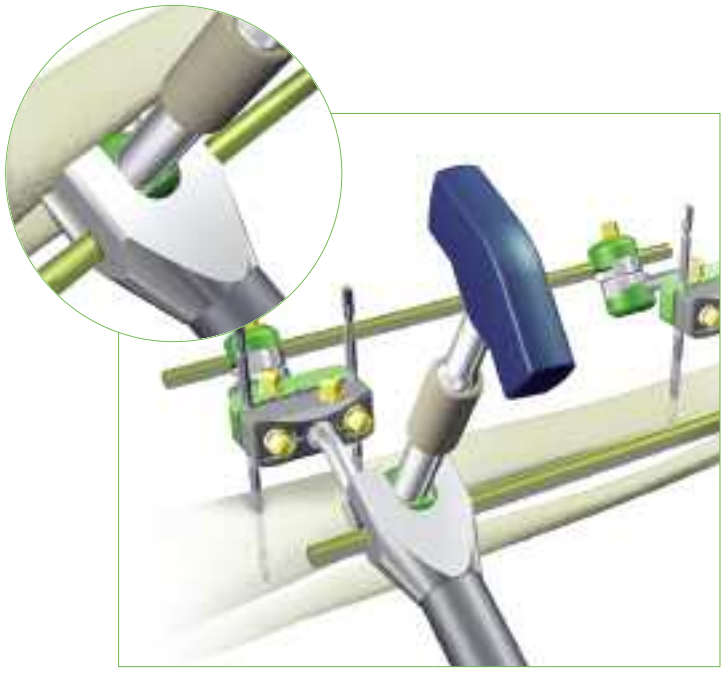


Figure 3

Frame Recommendations

1. Fully open the Rod to Rod and Pin to Rod Couplings prior to attachment of the component to the frame.
2. All 5mm Square Head Screws should be positioned facing away from the patient and other frame components to make tightening more accessible.
3. When possible, place the Rod to Rod and Pin to Pin Clamps on the inside of the frame and facing the fracture to increase stability.
4. Connecting Rods should always be kept as short as possible in order to maximize frame stability.
5. Placing 30° posts facing downward will create a lower-profile frame.
6. As with all external fixation frames, the frame must be adapted to the weight and fracture patterns of the patient.
7. Precise reduction is not required prior to pin insertion. The frame can be assembled and the final reduction performed with the frame *in situ* before all components are locked in place.
8. During frame removal, turn the pin a quarter turn forward before backing the pins out to engage the cutting edge of the pin and facilitate pin removal.
9. Do not place Rod to Rod or Pin to Rod Couplings on the curved portions of the Curved Rod or 30° Angled Post.

Pin Selection/Insertion Guidelines

Four types of half pins are offered in the system: Blunt/Self-Tapping Half Pins, Blunt/Cancellous Half Pins, Self-Drilling/Self-Tapping Half Pins, and Self-Drilling Transfixing Pins. Pre-drilling is necessary when using blunt pins. It is optional to pre-drill when using self-drilling pins.

- Use a 3.2mm drill to pre-drill a 4mm pin
- Use a 4.0mm drill to pre-drill a 5mm pin
- Use a 4.5mm drill to pre-drill a 6mm pin or a Cancellous Half Pin

Choose a pin diameter that is approximately one third of the diameter of the bone in which it will be inserted.

It is important to have a stable pin to bone interface. To ensure this, make sure to obtain bi-cortical purchase with the pin. When using self-drilling pins, it is recommended that you pre-drill manually rather than using power. This will help reduce heating.

Due to the high versatility of the Hoffmann® II System, an unlimited number of frame configurations can be constructed, thus providing surgeons the ease-of-use to treat a variety of indications.

This Technical Guide provides step by step surgical techniques for four standard frame assemblies. These assemblies can then be adapted to other indications.

Self-Drilling Pin

Blunt Pin

Cancellous Pin

Transfixing Pin

Due to the high versatility of the Hoffmann II® System, an unlimited number of frame configurations can be constructed, thus providing surgeons the ease of use to treat a variety of indications.

This Technical Guide provides step by step surgical techniques for four standard frame assemblies. These assemblies can then be adapted to other indications.

Operative Technique – Tibia Shaft Frame

Half Pin Insertion Guidelines

The safe zone of the tibia shaft is the medial side. For maximum bi-cortical bone purchase and patient comfort, it is suggested to insert pins 15° to 20° anterior to the coronal plane.

Step 1

The surgical technique utilizes a limited open approach for half pin insertion. Make an incision at least 2cm proximal to the fracture site on the medial face of the tibia.

Using soft-tissue protection, manually insert the first half pin making sure to obtain bi-cortical purchase.

Step 2

Insert a second half pin parallel to the first half pin using the 5-Hole Pin Clamp as a guide. Place the pins as far apart as possible.

Step 3

Position the 5-Hole Pin Clamps approximately 2-2.5cm away from the skin. Tighten Bolts A to secure the clamps to the half pins. Repeat Steps 1, 2 and 3 for the distal half pin groups making an incision at least 2cm distal to the fracture site.

Operative Technique – Tibia Shaft Frame

Step 4

Insert two Posts into the mating holes on both lateral and medial sides of each of the 5-Hole Pin Clamps. Tighten Bolts B to secure the posts.

Note:
The posts may be placed in twelve different positions. It also is possible to use straight or 90° posts. These post options give flexibility to build frame configurations as needed.

Step 5

Connect a Rod to Rod Coupling to each of the posts. Attach 8mm Connecting Rods aligning them with the long axis of the tibia. This will connect the two 5-Hole Pin Clamps together. Unrestricted multi-planar motion of the components allows for the manipulation of the fracture fragments with the fixator in place.

Step 6

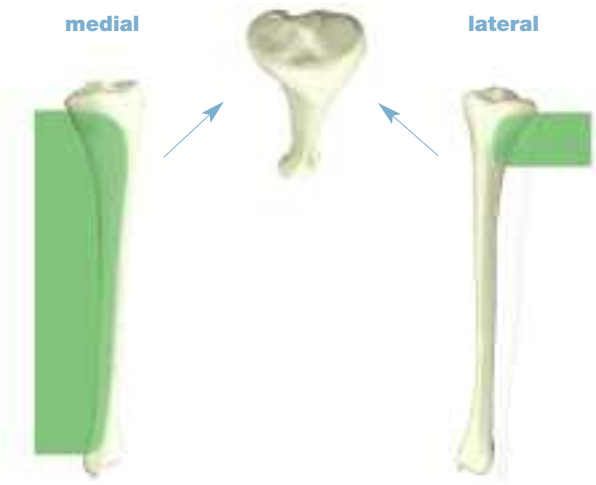
Reduce the fracture. Tighten Bolts C on the Rod to Rod Couplings. Also, ensure that all of the bolts of the frame are securely tightened.

For proper alignment, check the final reduction with x-ray.

Operative Technique – Tibia Plateau Frame

Half Pin Insertion Guidelines

For this frame, 3 half pins are inserted into the metaphyseal region of the proximal tibia at least 1.5 centimeters distal to the plateau under x-ray control. Also, 2 half pins are inserted antero-medially in the shaft of the tibia, approximately 90° to the long axis of the bone. The safe zones are illustrated here.



Step 1

Using soft-tissue protection, manually insert the medial and lateral half pins in the metaphyseal region of the tibia. Ensure that the half pins do not compromise the joint capsule. Also these pins should be inserted in slightly different axial planes to avoid impinging each other within the bone.

Step 2

Connect a Pin to Rod Coupling to each half pin, and connect the couplings to a Curved Rod. Make sure to maintain at least 2-2.5cm clearance between all frame components and the soft tissue.

Operative Technique – Tibia Shaft Frame

Step 3

Attach an Inverted Pin to Rod Coupling to the antero-medial aspect of the Curved Rod. Use this coupling as a guide for placing the antero-medial half pin.

Note:
In this frame, an Inverted Pin to Rod Coupling is chosen due to its ease-of-use. A standard Pin to Rod Coupling also may be used if desired.

Step 4

Using soft-tissue protection, manually insert the half pin. Then tighten the Pin to Rod Couplings with Bolt A in order to secure the Curved Rod to the half pins.

Step 5

At least 2cm distal to the fracture site, insert a half pin in the medial face of the tibia. Attach the 5-Hole Pin Clamp to the pin in the first hole of the clamp. Using the clamp as a guide, insert a second half pin through the fifth hole in the clamp. Secure the clamp to the pins by tightening the bolts on the lateral side of the clamp. Insert a 30° post in each of the star-shaped holes on the lateral and medial side of the clamp. Tighten the bolts on the anterior side of the clamp to secure the posts.

Operative Technique – Tibia Plateau Frame

Step 6

Attach a Rod to Rod Coupling to the curved ring just lateral to the medial pin. Attach a Pin to Rod clamp to the most proximal pin. Insert a connecting rod into these two clamps (**A**).

Attach Rod to Rod Couplings on the posterior sides of the curved rod. Attach Rod to Rod Couplings to both of the 30° posts in the 5-Hole Pin Clamp. Connect the rod to the clamps on both lateral and medial sides (**B**).

Unrestricted multi-planar motion of the components allows for reduction of the fracture with the frame in place.

Step 7

After final adjustments and satisfactory alignment has been restored, ensure that all bolts are securely tightened. For proper alignment, check the final reduction with x-ray.

Note:
A half pin may be added to the frame to capture a bone fragment to add further stability.

Operative Technique – Ankle Stabilization Frame

Half Pin Insertion Guidelines

The safe zone for the tibia is the medial face of the tibia. For the calcaneus, pins should be inserted at least 2cm anterior to the posterior aspect of the calcaneus and 2cm superior to the plantar aspect of the calaneus.[1]

Step 1

Using soft tissue protection, insert the most posterior transfixing pin in the calcaneus. Make sure to allow at least 2cm distal clearance so that the frame will not protrude past the base of the calcaneus. Insert this pin until the threads in the mid shaft of the pin are fully engaged in the bone.

Place the 5-Hole Pin Clamp on the medial side with the pin in the first hole of the clamp. Using the clamp as a guide, insert a second transfixing pin through the fifth hole of the clamp if the anatomy will allow. Holes 3 or 4 may also be used if more appropriate for the anatomy.

Step 2

Insert a half pin in the mid shaft of the tibia. Attach a 5-Hole Pin Clamp to the pin in hole 1. Insert a second half pin through hole 5.

1 External Fixation of the Pelvis and Extremities. Samir Mehta, M.D., Wudbhav N. Sankar, M.D., Christopher T. Born, M.D. Lippincott Williams & Wilkins, 2005

Operative Technique – Ankle Stabilization Frame

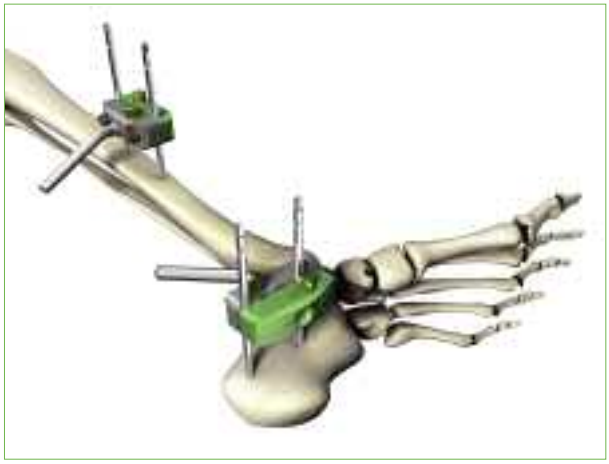
Step 3

Position the two 5-Hole Pin Clamps approximately 2-2.5cm away from the skin. Tighten Bolts A to secure the clamps to the half pins.

Step 4

Insert a 30° Post to each of the 5-Hole Pin Clamps as illustrated. Tighten Bolts B to secure the posts.

Note:
Do not over torque the Bolt B which does not contain a post.



Step 5

Attach Rod to Rod couplings to each of the posts. Insert an 8mm connecting rod to each of the couplings.

Step 6

Repeat Steps 4-5 for the lateral side of the frame.

Operative Technique – Ankle Stabilization Frame

Step 7

After final adjustments and satisfactory alignment have been restored, tighten Bolts C on the Rod to Rod Couplings. Also, ensure that all of the bolts of the frame are securely tightened.

For proper alignment, check the final reduction with x-ray.

The construct shown here is an alternative ankle bridging frame. Two 5mm half pins are placed in the tibia, one 5mm half pin is placed in the calcaneus, and one 4mm half pin is placed in the first metatarsal.

Operative Technique – Pelvic Frame

Half Pin Insertion Guidelines

The pelvic frame described in this technique uses three half pins placed in each iliac crest. The first half pin should be positioned 2.5cm posterior to the anterior superior iliac crest. The second and third half pins should be inserted following the natural mid-line of the iliac crest with a distance of 1.5cm to 2.0cm between each of the pins.

Take care to insert the pins between the cortices of the iliac crest.

Step 1

Make a 1-2cm incision for each pin over the iliac crest toward the umbilicus. Blunt dissect to the bone after cutting through the skin.

Using soft-tissue protection, manually insert a half pin between the inner and outer tables of the iliac crest toward the acetabulum. After initial penetration of the cortex, continue inserting the half pin while taking care not to penetrate the inner or outer tables.

When using blunt pins, the outer cortex of the iliac crest must be pre-drilled.

Step 2

Place the second and third half pins in the same manner and check to ensure each has adequate purchase. Repeat Steps 1 and 2 for the opposite side of the pelvis.

Operative Technique – Pelvic Frame

Step 3

Place a Pelvic Clamp over the three half pins on each side of the pelvis. Tighten the clamps 2-2.5cm away from the skin.

Step 4

Connect four Rod to Rod Couplings to the Pelvic Clamp Posts. From this base, build a "double cross bar" frame as shown here by placing appropriate length Connecting Rods to the Rod to Rod Couplings.

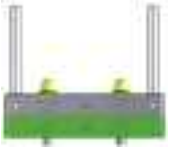
Step 5

While holding the reduced pelvis, properly adjust and stabilize the frame and fully tighten all bolts on the Pelvic Clamps and Rod to Rod Couplings.

To verify alignment, obtain an AP x-ray of the pelvis.

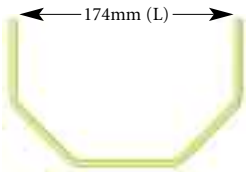
Note:
If necessary, increase or decrease the distance between the bars for better access to the abdomen.

Ordering Information – Components

	REF	Description
Hoffmann® II MRI Components		
	4921-2-020	5-Hole Pin Clamp for 4, 5, and 6mm pins
	4921-2-060	10-Hole Pin Clamp for 4, 5, and 6mm pins
	4921-2-080	Pelvic Clamp for 4, 5, and 6mm pins
	4921-1-010	Rod to Rod Coupling for 8mm rods or posts
	4921-1-020	Pin to Rod Coupling for 4-5mm pins/8mm rods or posts
	4921-1-030	Inverted Pin to Rod Coupling for 8mm rods or posts/4-5mm pins
	4921-1-100	Tube to Rod Coupling for 20mm tubes/8mm rods or posts
	4921-2-120	Straight Post 8mm
	4921-2-140	30° Angled Post 8mm
	4921-2-160	90° Angled Post 8mm

Ordering Information – Components

REF	Description	Length
Hoffmann® II MRI 8mm Rods and 20mm Tubes		
5028-8-065	MRI Carbon Connecting Rod	65mm
5028-8-100	MRI Carbon Connecting Rod	100mm
5028-8-150	MRI Carbon Connecting Rod	150mm
5028-8-200	MRI Carbon Connecting Rod	200mm
5028-8-250	MRI Carbon Connecting Rod	250mm
5028-8-300	MRI Carbon Connecting Rod	300mm
5028-8-350	MRI Carbon Connecting Rod	350mm
5028-8-400	MRI Carbon Connecting Rod	400mm
5028-8-450	MRI Carbon Connecting Rod	450mm
5028-8-500	MRI Carbon Connecting Rod	500mm



5028-7-030	MRI Semi-Circular Carbon Rod	174mm (L)

Hoffmann® II MRI 20mm Tube

4921-0-000	Dynamization/Distraction Tube	

4921-0-015	Compression/Distraction Tube	

Ordering Information – Instruments

	REF	Description
		Hoffmann® II Instruments for MRI System
		(not for use in the MRI suite)
	4920-9-010	Stabilization/Reduction Wrench
	4920-9-020	Thumbwheel
	4920-9-030	7mm T-Wrench/5-6mm Pin Inserter
	5054-8-009	7mm Spanner Wrench
	4921-9-984	Storage Case Lid
	4921-9-983	Storage Case Upper Insert
	4921-9-985	Storage Case Lower Insert
	4921-9-986	Storage Case Base

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