stryker

Hoffmann® LRF

Circular External Fixation

Operative Technique





Table of contents

Disclaimer 4
Indications and contraindications 5
Indications for use 5
Contraindications 5
Precautions 6
Information for the patient 6
MR safety information 6
System Overview 8
Introduction 8
Compatibility 8
Key instruments 9
Ring template 9
Drill bits for half pins 9
Wrenches 11
Wire guides 12
Wire tensioner 12
Universal components 15
Half pins 15
Wires 17
Rings 18
Nuts, bolts and washers 26
Plates 28
Fixation components 30
Wire fixation 30
Pin fixation 32
Rods, struts and couplings 35
Hoffmann LRF - Operative Technique 38
General information 39
Ring selection 39
Half pin and wire insertion 39
Circular fixation with clickers 47
Circular fixation with telescopic struts 48
Frame assembly methods 49
Fracture reduction with telescopic struts 52
Telescopic strut removal 55
Telescopic strut frame construct example 56
Gradual correction 57
Hinged telescopic struts 58
Telescopic motor struts 61
Technique for equinus foot correction using gradual correction struts 62
Tibial ring-block-first approach 63
Guide-wire-first approach 66
Attaching the foot ring 67
Foot ring wire fixation 68

Using a threaded rod assembly as an alternative construct . . . 70
Telescopic motor strut attachment . . . 71
Final distraction . . . 73
Post operative adjustments . . . 74
Bone transport . . . 78
Bone transport overview . . . 79
Transport strut overview . . . 80
Frame configuration . . . 81
Distal ring mounting arm adjustment . . . 82
Moving ring mounting arm adjustment . . . 83
Ring and transport strut orientation . . . 84
Mounting considerations . . . 85
Ring spacing: distal ring . . . 86
Technique for tibial defect . . . 89
Safety clip removal . . . 92
Post-transport lengthening . . . 93
Distraction and transport . . . 94
Lengthening frame . . . 96

Hoffmann LRF smartHEX - Operative Technique . . . 97

smartHEX Strut overview . . . 98
Strut sizes and adjustments . . . 99
Strut directional markings . . . 100
Strut cleaning and maintenance . . . 101
Strut identification . . . 102
Rings and mounting locations . . . 103
Ring markings . . . 103
Ring default mounting locations . . . 104
Ring non-default mounting locations . . . 105
Ring default mounting locations for double-stacked frames . . . 106
Strut offsetting . . . 107
Applying the smartHEX construct . . . 109
Mounting the frame . . . 109
Pre-built frame approach . . . 109
Rings first approach . . . 111
Strut controller trials . . . 114
Strut identification post frame build . . . 115
Performing a corticotomy . . . 116
smartHEX web application users . . . 116
Post-operative strut adjustments . . . 117
Gradual manual adjustments . . . 117
Strut adjustment, repositioning and change-out procedure . . . 118
smartHEX controller-assisted strut adjustments (optional) . . . 121
Attach the strut controllers . . . 121
Battery changes . . . 122
Strut controller removal . . . 122

Appendix A: Pre-built frame sterilization guidelines . . . 124

Appendix B: Hoffmann LRF system components . . . 125

Appendix C: Minimum required system components . . . 136

Disclaimer

This publication sets forth detailed recommended procedures for using Stryker devices and instruments. It offers guidance you should heed, but as with any such technical guide, each surgeon must consider each patient's particular needs and make appropriate adjustments when and as required.

A workshop training is recommended prior to performing your first surgery.

WARNING

Follow the instructions provided in our cleaning and sterilization guide (OT-RG-1). All non-sterile devices must be cleaned and sterilized before use.

WARNING

Multicomponent instruments must be disassembled for cleaning. Please refer to the corresponding assembly/disassembly instructions.

Please remember that the compatibility of different product systems has not been tested unless specified otherwise in the product labeling.

Consult the Instructions for Use (www.ifu.stryker.com) for a complete list of potential adverse effects, contraindications, warnings, and precautions.

WARNING

The surgeon must warn patients of surgical risks and make them aware of possible adverse effects.

The patient should be warned that the device cannot and does not replicate a normal healthy bone and that the device can break or become damaged as a result of strenuous activity or trauma, malunion, or nonunion.

The surgeon must warn the patient that the device has a finite expected service life and may need to be removed at some time in the future.

For a complete overview of the entire Hoffmann LRF System, it is recommended that the user also references the Instructions for Use (700001224590), the smartHEX Web Application User Manual (700004267604), the smartHEX Strut Controller and Mobile Application User Manual (700004267606), the smartHEX Patient Guide (700004308965), and the Hole Offset Worksheet (FA-HLHX-SURGP-3210081).

Indications and contraindications

Indications for use

The Hoffmann LRF System is indicated in pediatric (2 through 21 years of age) and adult patients for the treatment and fixation of:

- Open and closed fractures
- Post-traumatic joint contracture which has resulted in loss of range of motion
- Fractures and disease which generally may result in joint contractures or loss of range of motion and fractures requiring distraction
- Pseudoarthrosis or non-union of long bones
- Limb lengthening by epiphyseal, diaphyseal, or metaphyseal distraction
- Correction of bony or soft tissue deformity
- Correction of segmental bony or soft tissue defects
- Joint arthrodesis
- Management of comminuted intra-articular fractures of the distal radius
- Bone transport

The Hoffmann LRF System is indicated in adults for:

- Osteotomy
- Revision procedure where other treatments or devices have been unsuccessful
- Bone reconstruction procedures
- Fusions and replantations of the foot
- Charcot foot reconstruction
- Lisfranc dislocations

Contraindications

Since external fixation devices are often used in emergency situations to treat patients with acute injuries, there are no absolute contraindications for use. The surgeon's education, training and professional judgment must be relied upon to choose the most appropriate device and treatment for each individual patient. Whenever possible, the device chosen should be of a type indicated for the fracture being treated and/or for the procedure being utilized.

Conditions presenting an increased risk of failure include:

- Insufficient quantity or quality of bone which would inhibit appropriate fixation of the device
- Compromised vascularity that would inhibit adequate blood supply to the fracture or operative site
- Previous history of infections
- Any neuromuscular deficit which could interfere with the patient's ability to limit weight bearing
- Any neuromuscular deficit which places an unusually heavy load on the device during the healing period
- Malignancy in the fracture area
- Mental, physical or neurological conditions which may impair the patient's ability to cooperate with the postoperative regimen

Indications and contraindications

Precautions

Information for the patient

CAUTION

Surgeons must instruct the patients to report any unusual changes of the operated site to their physician. Surgeon should immediately evaluate the patient if a change at the fracture or osteotomy site has been detected. The surgeon should evaluate the possibility of subsequent clinical failure and discuss with the patient the need for reduced activity levels, and/or possible revision surgery in order to aid fracture healing.

CAUTION

The surgeon should discuss all physical and psychological limitations inherent in the use of external fixation appliances with the patient. Particular attention should be given to premature weight bearing, activity levels and the necessity for periodic medical follow-up.

MR safety information

WARNING

The Hoffmann LRF System is MR unsafe.

WARNING

Do not reuse single-use external fixator components. Single use devices cannot be reused, as they are not designed to perform as intended after the first usage. Mechanical, physical, or chemical properties may be compromised after first usage. In this case, the safety and performance of the devices is not supported by the manufacturer, and compliance with relevant specifications cannot be ensured. External fixator devices have been designed for single patient use. Reuse of single-use external fixators may lead to reduced biomechanical properties and/or fatigue breakage of the devices. Please refer to the device label to identify single or multiple use and/or re-sterilization release.

Hoffmann® LRF

System Overview

Introduction

Key instruments

Universal components

System Overview

Introduction

Hoffmann Limb Reconstruction Frame (LRF) is a circular external fixation system designed for simple construction and application. A reconstruction frame construct is comprised of wires and/or half pins that are attached to rings using a variety of fixation components. The rings are connected by struts to create a frame construct that surrounds the affected limb. **(Figure 1)**

The basic components of the system are half pin and K-wire implants, fixation components, rings and struts. The diverse selection of hardware components offered with the system is designed to facilitate the construction of versatile frames to treat various indications.

A list of minimum required system components can be found in **Appendix C: Minimum required system components**.

Compatibility

The Hoffmann LRF is mechanically compatible with Hoffmann II MRI, and Hoffmann 3 Modular Fixation.



Figure 1

System Overview

Key instruments

This list of instruments is not comprehensive. For a full list, refer to **Appendix B: Hoffmann LRF system components**.

Ring template

The Ring Template is designed to assist in selecting the appropriate ring size: 155mm, 180mm, or 205mm. The ring templates are non-sterile and are intended for pre-operative use. Sterilized aluminum or carbon rings may be used for sizing purposes intraoperatively. **(Figure 2)**



Figure 2

NOTICE

Ring templates must not be sterilized or reprocessed.

Tissue sleeves: Available in two sizes: short (5057-2-601) and long (5057-2-602). **(Figure 3)**



Figure 3

Drill bits for half pins

The Hoffmann LRF system offers short and long drill bits to use with 4, 5, and 6mm pin sizes. **(Figures 4-5)**

- Color-coded by diameter
- "Pilot tip" designed to help prevent skiving and support efficient drilling
- 6mm shaft diameter across all sizes
- Designed with an AO connection for reduced instrumentation

All drill bits are laser-marked for the surgeon to determine the appropriate half pin thread length when drilling through the tissue protection sleeve assembly.

Each drill bit is calibrated to be used to identify the required threaded length of the half pin. The appropriate thread length will help to achieve the desired amount of half pin protrusion beyond the far cortex.

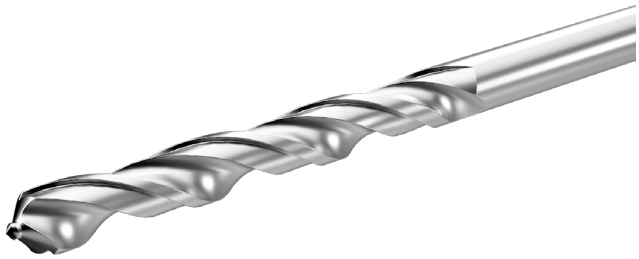


Figure 4

System Overview - Key instruments



Figure 5

Table 1: Drill specifications

Drill color	Compatible pin size diameter (mm)	Drill diameter (mm)	Max drill depth (mm)	Total drill depth (mm)	Compatible sleeve size
Short drill					
Yellow	4	3.05	50	170	Short
Blue	5	4.05			
Red	6	5.05			
Long drill					
Yellow	4	3.05	90	250	Long
Blue	5	4.05			
Red	6	5.05			

System Overview - Key instruments

Wrenches

Wire Bolt Wrench (4933-9-201) **(Figure 6A)**

- Features a counter-torque nose that fits into the cannulated heads of the wire bolts
- Designed to protect the surgeon's hand from the wire

L-Socket Wrench (4933-9-206) (Figure 6B)

- 10mm wrench used to tighten connection bolts, M8 and M6 connecting nuts

Spanner Wrench

- **7/10mm** (4933-9-204) Dual-sided design used for tightening 7mm or 10mm components **(Figure 7A)**
- **5mm** (4933-9-205) Designed to adjust the ball joint of the telescopic struts when working space is limited **(Figure 7B)**

Ratchet Wrench (4933-9-202) **(Figure 8)**

- **10mm wrench** used to tighten connection bolts, M8 and M6 connecting nuts
- Dual-sided design with color markers for loosening and tightening.

Thumbwheels (Figure 9)

- **7mm/5mm** (4920-9-020)
- **Hex 10mm** (4933-9-203) Used for provisional tightening or as an extension for the ratchet wrench

5mm Wrench / 3-4mm Pin Inserter (4940-9-030) **(Figure 10)**

- Locks and unlock the ball joints of the telescopic struts
- Designed to fit in tight places and to limit the torque applied while locking the ball joint

Hex Key 5mm (200343) **(Figure 11)**
Used to tighten the hardware connection bolts as well as the half pin bolts in tight spaces.

T-Handles
Used to manually drive half pins

- **702430:** features a positive locking mechanism **(Figure 12A)**
- SEF90002: features a ratcheting mechanism; does not lock the half pin **(Figure 12B)**

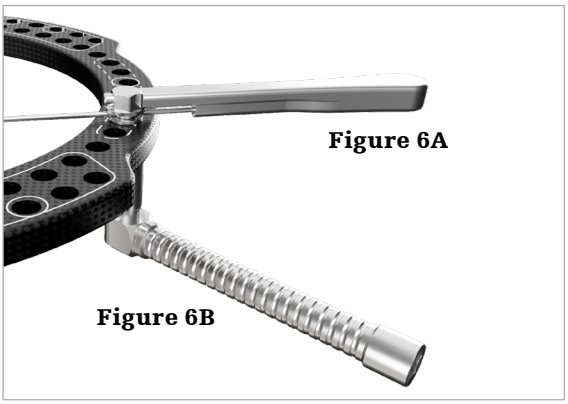
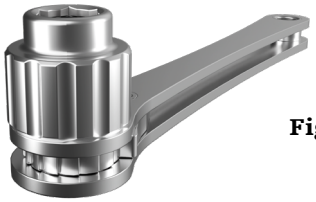

Figure 6A

Figure 6B


Figure 7A

Figure 7B


Figure 8

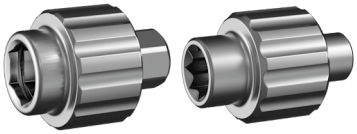
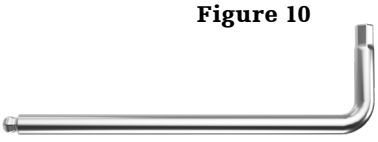
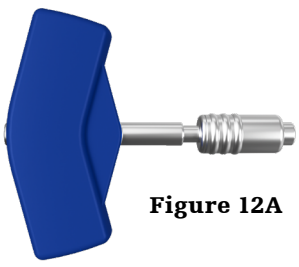
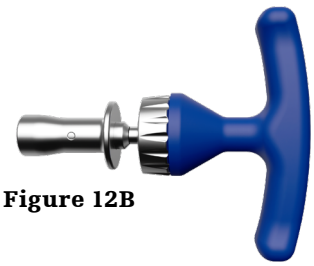

Figure 9


Figure 10


Figure 11


Figure 12A


Figure 12B

System Overview - Key instruments

Wire guides

The Hoffmann LRF system offers two wire guides that are designed to aid with wire placement directly on the ring. Each wire guide is compatible with 1.5mm, 1.8mm, and 2mm smooth and olive K-wires.

Two designs to accommodate each ring material type:

- aluminum (4938-0-537) **(Figure 13A)**
- carbon fiber (4938-0-538) **(Figure 13B)**

Each guide is marked with the compatible ring type.

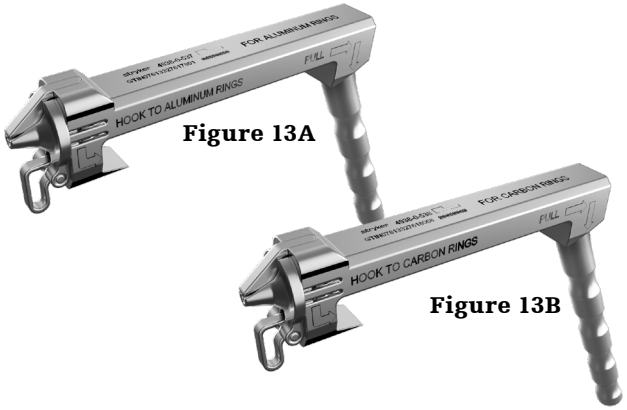


Figure 13A

Figure 13B

Wire tensioner

The Hoffmann LRF system offers a wire tensioner design (4933-9-100) to aid with tensioning of 1.5mm, 1.8mm, and 2.0mm K-wires. **(Figure 14)**

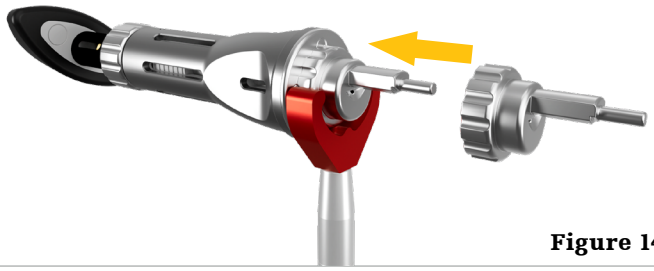


Figure 14

Key features

- Modular counter-torque nose in two interchangeable length options: short (4933-9-110) and long (4933-9-111)
- Ergonomic, light-weight design
- Rotating handle with simple tension scale

Tips for use

- Use the 25mm biocompression wrench (5150-9-125) to firmly attach a tensioner nose to the handle **(Figure 15)**
- Before loading a wire into the tensioner, ensure that the tensioner is unlocked. To unlock the device, rotate the black handle counterclockwise until the stop is reached. The unlocked position can be confirmed when the gold indicator on the handle's shaft aligns with the open padlock icon **(Figure 15B)**
- Load the wire through small opening underneath the tensioner nose. Smooth wires may be tensioned from either the sharp or blunt end. Olive wires must be tensioned from the sharp end. **(Figure 16)**
- Three lines on the handle's shaft indicate the tension levels: 50kg, 90kg, and 130kg. To tension the wire, turn the black handle clockwise until it covers the line marking the desired tension level. **(Figure 16B)**



Figure 15

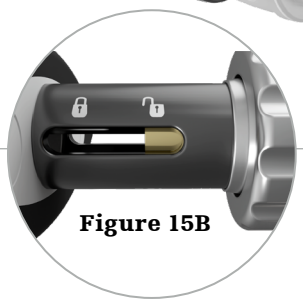


Figure 15B



Figure 16

Figure 16B

System Overview - Key instruments

- Wire tension is preserved when the corresponding nut on the fixation component is fully tightened **(Figure 17)**
- To remove the tensioner, turn the black handle counterclockwise until the tensioner is completely unlocked again. If successfully unlocked, the tensioner should slide off the wire.

NOTICE

Olive wires must be tensioned from the sharp end so that the olive bead is pulled toward the bone surface.

NOTICE

Do not trim or bend the excess wire until tensioning is complete. If the tensioner fails to grip the wire during tensioning, repeat the procedure: Turn the black handle counterclockwise until the gold indicator is in the open padlock position. Re-insert the wire and proceed with clockwise turns.

Recommended tension levels

Recommended tension levels vary by fixation component type and are laser-marked on each fixation component for user reference. Surgeons should use their best clinical judgment when applying tension to wires.

Recommended tension levels for a non-exhaustive list of example component combinations are outlined in Table 2.

Table 2: Examples of maximum recommended tension levels

Tension	Example
50 kg	Long wire bolt adaptor used with short wire bolt
	Short wire bolt used wire post 3rd, 4th, 5th holes
90 kg	Short wire bolt adaptor used with short wire bolt
	Short wire bolt used with wire post 2nd hole
130 kg	Short wire bolt
	Medium wire bolt
	Long wire bolt
	Short wire bolt used with wire post 1st hole



Figure 17

NOTICE

Excessive tensioning on the wires may compromise the ring integrity.

NOTICE

For wires fixed to foot rings and u-plates that are not closed with a foot arch or half ring and are considered “open”, the maximum recommended tension level is 90kg.

System Overview - Key instruments

Disassembly for cleaning and maintenance (Figure 18)

- Align the gold indicator with the open padlock symbol
- Using the biocompression wrench (5150-9-125), remove the wire tensioner nose.
- Using the biocompression wrench, remove the wire tensioner wheel

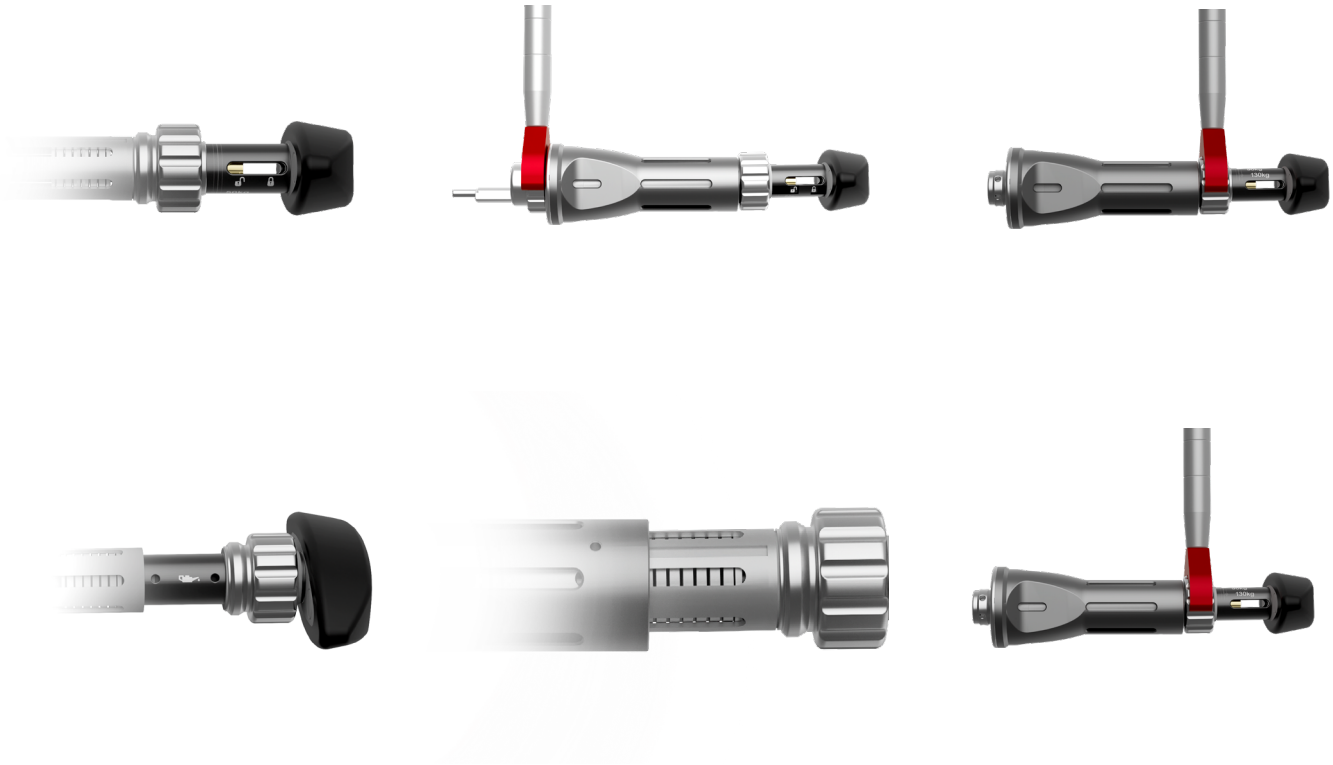


Figure 18

System Overview

Universal components

Half pins

Solid pin fixation and appropriate half pin sizing are essential for effective external fixator devices.[1]

Half pin design

The Hoffmann LRF half pins **(Figure 19)** are made of stainless steel and have a standard 6mm shaft diameter that accommodates a universal centering sleeve. They are outfitted with an AO connection.

The half pins include a self-tapping thread feature designed to make the insertion process efficient.

The double helical flute design creates a homogeneous thread profile that transports bone chips out of the drill hole, which potentially allows for reduced insertion temperature.[2]

NOTICE

All standard Blunt Half pins and HA Coated Blunt Half pins require pre-drilling.



Figure 19

System Overview - Universal components

Half pin selection

Both the standard and hydroxyapatite (HA) coated blunt half pins are offered in a broad range of diameters, lengths, and thread lengths. **(Table 3)**

- **Blunt half pins**
- **HA coated blunt half pins**

Hydroxyapetite is a material that supports bone ingrowth and osteoinegration.[3,4,5]

Half pin markings

Each half pin features etchings that indicate its position relative to the tissue sleeve.

- **175mm half pins:** must be used with the short tissue sleeve; contain one etching **(Figure 20)**
- **225 and 250mm half pins:** may be used with the short or long tissue sleeve; contain two etchings **(Figure 21)**

Refer to the **Tissue sleeve selection section** of the operative technique for more details about drill and half pin use with the tissue sleeves.

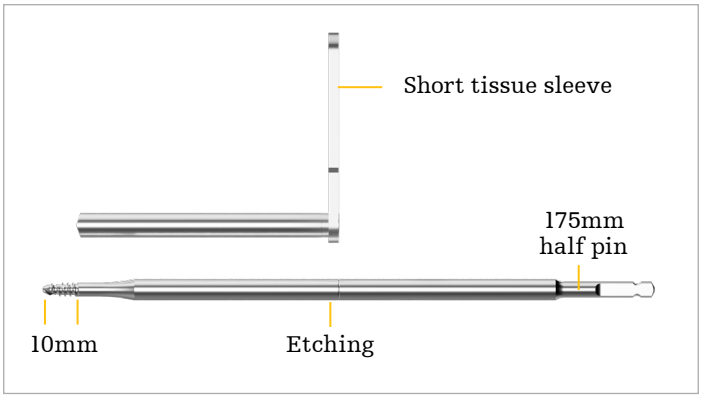


Figure 20

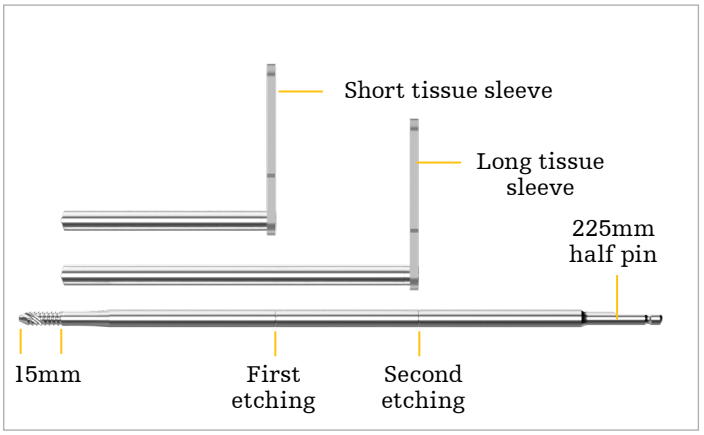


Figure 21

Table 3: Half pin size chart

Diameter (mm)	Diameter - threaded end (mm)	Total length (mm)	Thread lengths (mm)	Sleeve compatibility	Drill compatibility
6	4	175	10, 15, 20, 25, 30, 35, 40, 45, 50	Short	Short
	5	225	15, 20, 25, 30, 35, 40, 45, 50	Short, Long	Short, Long
			60	Long	Long
		250	70, 80, 90	Long	Long
	6	175	20, 25, 30, 35, 40, 45, 50	Short	Short
		225	20, 25, 30, 35, 40, 45, 50	Short, Long	Short, Long
			60	Long	Long
		250	70, 80, 90	Long	Long

System Overview - Universal components

Disposable end caps (4938-1-050)

These 6mm plastic end caps are designed to be compatible with the size range of half pins within the Hoffmann LRF system. They may be used to buffer the sharp edges of the pins after cutting. **(Figure 22)**

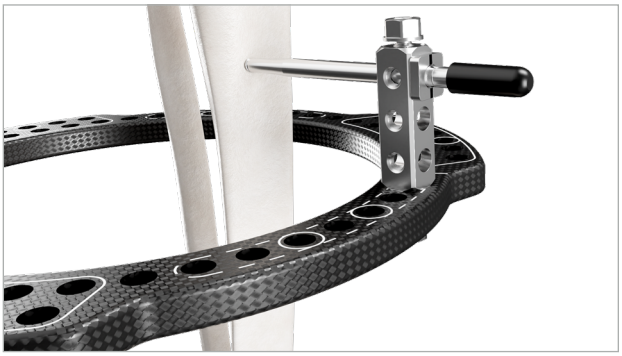


Figure 22

Wires

The Hoffmann LRF system offers Kirshner wires (K-wires) with a smooth or olive design in multiple sizes to best meet surgeon needs. **(Table 4)** The Ø1.8mm and Ø2mm wires are commonly used for adult patients, while Ø1.5mm wires may be used for pediatric patients.

The Hoffmann LRF K-wires have a "diamond tip" **(Figure 23)** that aids in reducing skiving during insertion.



Figure 23

An olive wire features an olive "bead". **(Figure 24)** When an olive wire is tensioned, the olive is pulled against the relative bone fragment; consequently, olive wires tensioned in opposite directions may produce interfragmentary compression. The olive wires feature a striped end **(Figure 25)** that's designed to quickly identify the side of the wire that should be pulled during replacement or removal.



Figure 24



Figure 25

Table 4: Wire selection

Item #	Sizes
Smooth K-wire	
5101-1-450	1.5 × 450mm
4933-8-010	1.8 × 450mm
5101-2-450	2.0 × 450mm

Item #	Sizes
K-wire with olive	
4933-8-020	1.5 × 450mm
4933-8-030	1.8 × 450mm
4933-8-040	2.0 × 450mm

System Overview - Universal components

Rings

The Hoffmann LRF rings are available in aluminum or a radiolucent carbon-fiber reinforced polymer. The tabbed ring design features two rows of holes for additional locations to place struts and fixation components. **(Figure 26)**

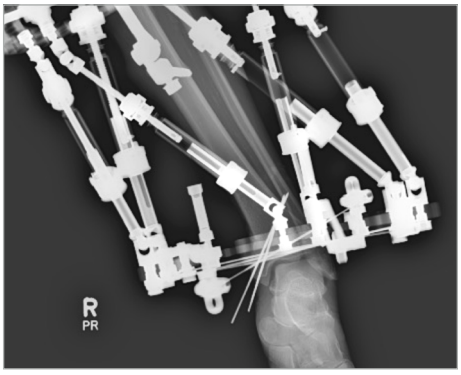
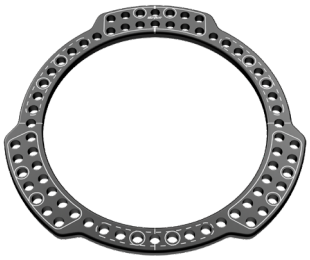
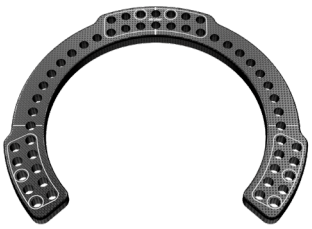


Figure 26

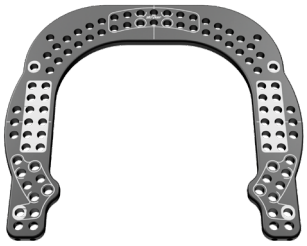
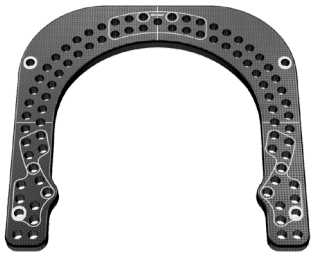
Ring options

Ring diameters range from 80mm to 305mm and are offered in full, open, and half-ring designs. A full list of ring offerings is outlined in **Table 5**.

Table 5: Ring selection

Aluminum		Carbon fiber	
Full ring			
	Ø80mm, Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm, Ø230mm, Ø255mm, Ø280mm, Ø305mm	Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm	
2/3 ring			
	Ø80mm, Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm, Ø230mm, Ø255mm, Ø280mm	Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm	
Half ring			
	Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm, Ø230mm, Ø255mm		

System Overview - Universal components

Aluminum		Carbon fiber	
U-plate			
	Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm		
Foot Ring (Long)			
	Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm	Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm	
		Foot Ring (Short)	
		Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm	
		Foot Arch	
		Ø105mm, Ø130mm, Ø155mm, Ø180mm, Ø205mm	

System Overview - Universal components

Ring sizes increase by 25mm. Within both the circular region of the rings and the arms of the foot ring and U-plate, the outer row of the smaller size ring overlaps the inner row of the next size ring. **(Figure 27)**

The angular values between two adjacent holes within the inner and outer rows of the circular portion of the rings **(Figure 28)** are outlined in **Table 6**. This is applicable to all types of rings.

Table 6: Ring selection

Ring Size	Inner Row (X°)	Outer Row (Y°)
80mm	15°	12°
105mm	12°	10°
130mm	10°	8.5°
155mm	8.5°	7.5°
180mm	7.5°	6.6°
205mm	6.6°	6°
230mm	6°	5.4°
255mm	5.4°	5°
280mm	5°	4.6°
305mm	4.6°	4.2°

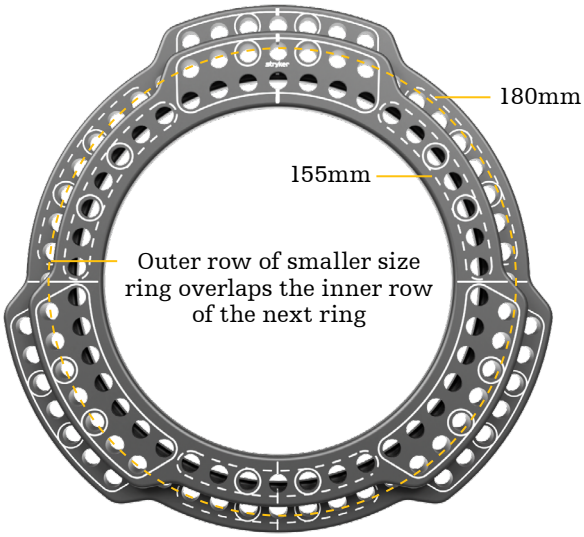


Figure 27

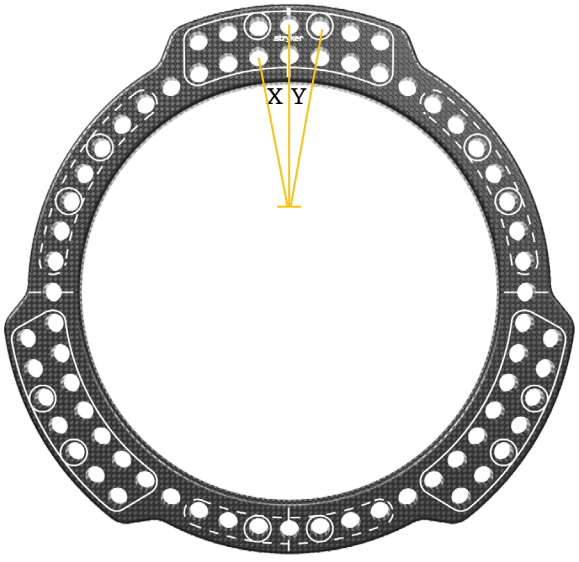


Figure 28

System Overview - Universal components

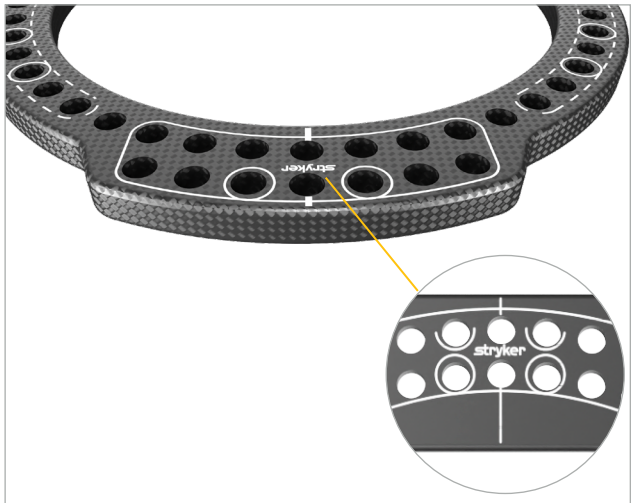
Ring markings

The ring's master marker, indicated by the Stryker logo **(Figure 29)**, is important for hexapod configurations.

The Hoffmann LRF rings feature markings that indicate the ring size, equator lines, rocker shoes attachment sites, and the dedicated areas for assembling certain complex configurations.

For three-strut constructs, the tabbed and non-tabbed regions of the circular rings are angularly equal in order to provide a visual indication for even strut spacing. For four-strut constructs, the equator lines are symmetrical to provide a visual indication for even strut spacing.

For more information about ring markings and specific instructions for using the rings in a hexapod configuration, refer to **smartHEX section of the Operative Technique**.



Master marker

Figure 29

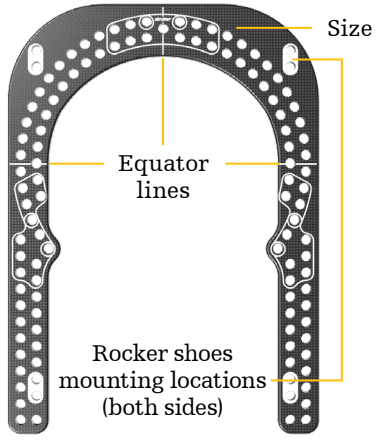


Figure 29A: Long foot ring

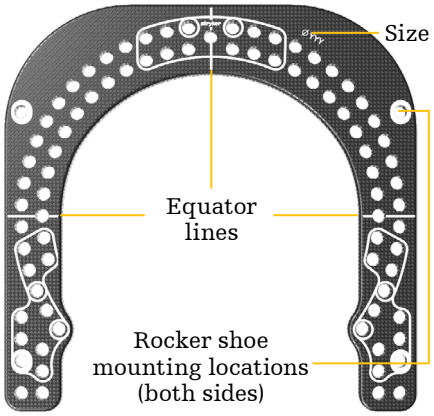


Figure 29B: Short foot ring

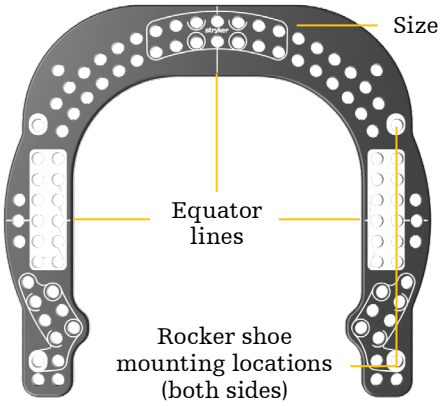


Figure 29C: U-plate

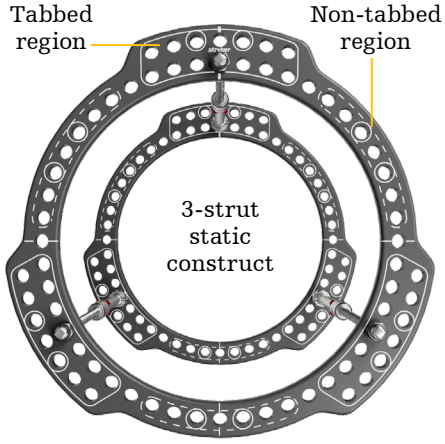


Figure 29D: Three-strut construct

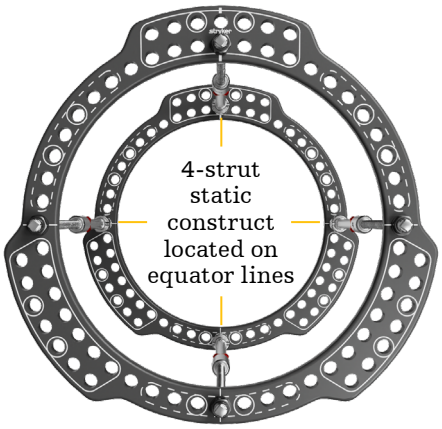


Figure 29D: Four-strut construct

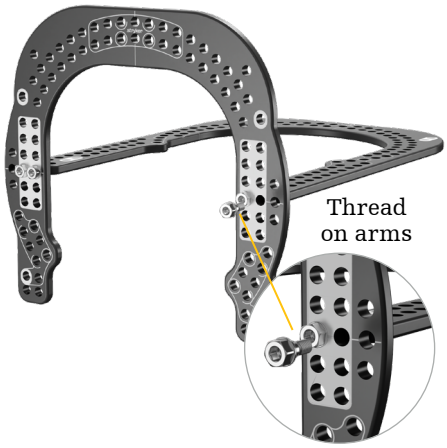


Figure 29E: Buttress frame construct

System Overview - Universal components

Ring formations

Half rings may be assembled to form a full ring, using the hardware connection bolts and M6 connecting nuts. **(Figure 30)** Foot rings and U-plates are also available with corresponding variable-angle foot arches for closure. If desired, half rings can also be used for closure by using hardware connection bolts and the threads on the arms of the aluminum long foot ring or U-plate. **(Figures 30A-31)**

A full list of ring offerings is outlined in **Table 5**.



Figure 30

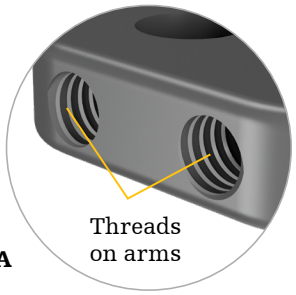


Figure 30A

⚠ CAUTION

A blue 4mm washer (4933-1-712) must be utilized between the hardware connection bolt head and half ring, when the half ring is used in a 90° orientation on the aluminum foot ring or u-plate for closure. **(Figure 32)**

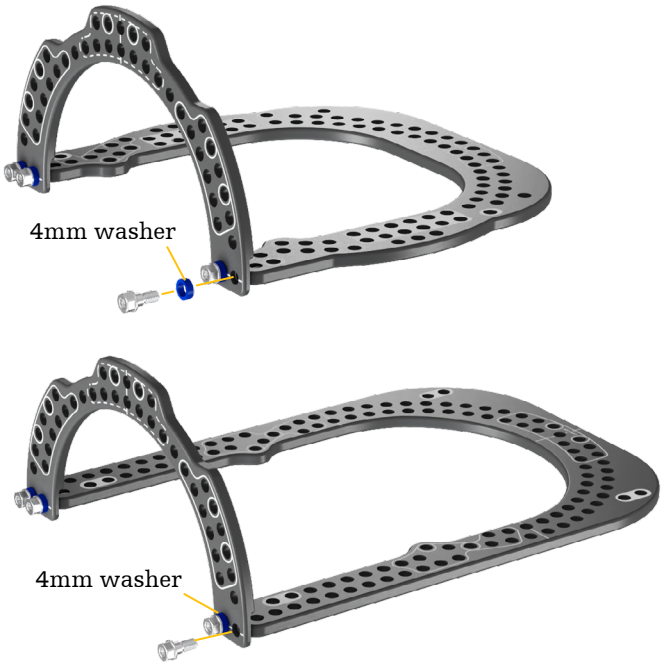
⚠ CAUTION

Carbon fiber rings should not be re-sterilized beyond fifty (50) autoclave cycles to maintain the intended performance.



0° Half ring closing option

Figure 31



90° Half ring closing option

Figure 32

System Overview - Universal components

Foot arches

The Hoffmann LRF Foot Arch is made of radiolucent carbon fiber reinforced polymer. It offers a fully assembled design with built-in hinged connection bolts for angular arch adjustment.

Foot arches are attached to rings using the M8 connection nuts (4933-1-010).

NOTICE

Because the open end of the foot ring or U-plate can bend under the wire tension, it is recommended that the foot arch be connected prior to tensioning.

The foot arch is designed to occupy the inner row holes of the arms on the foot rings and U-plate. **(Figure 33)** If rocker shoes and a foot arch are used together, avoid occupying the holes required for rocker shoe attachment.

Once desired angulating of the foot arch is achieved, the 5mm square bolts on either side can be tightened with a 5mm wrench. **(Figure 34)**

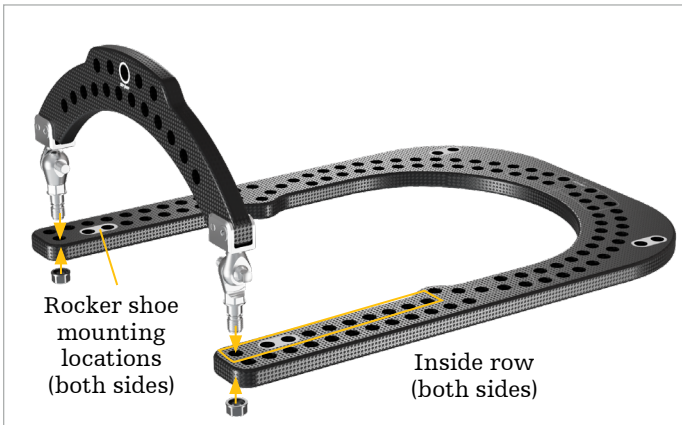


Figure 33

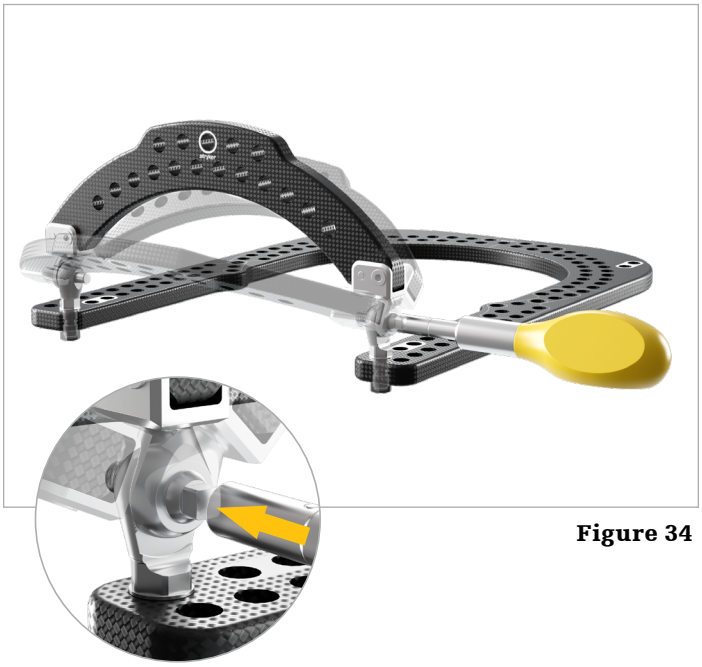


Figure 34

System Overview - Universal components

Rocker shoes

The rocker shoes' independent design allows side-specific height adjustment to compensate for an angled distal foot ring. **(Figure 35)** The anterior and posterior ends of the shoe feature a 15° slope and a treaded rubber sole is designed for traction during ambulation. The rocker shoes are available in six sizes and have dedicated posterior mounting holes on the foot rings and U-plate. The maximum clearance of each shoe is 23mm, including a 7mm washer. **(Figures 36-37)** The rocker shoe size compatibility with each ring type is outlined in **Table 7.**



Figure 35

⚠CAUTION

Rocker shoes are non-sterile and must be applied post-operatively.

NOTICE

Encourage patients to use caution when walking on wet or slippery surfaces.

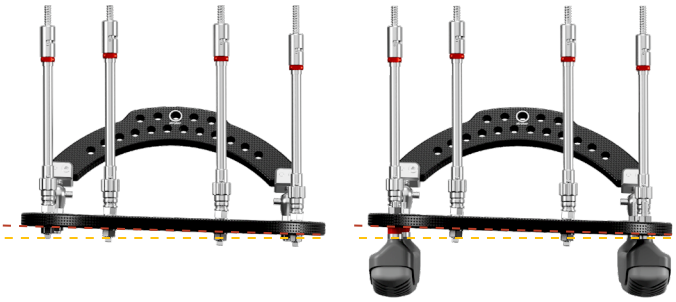


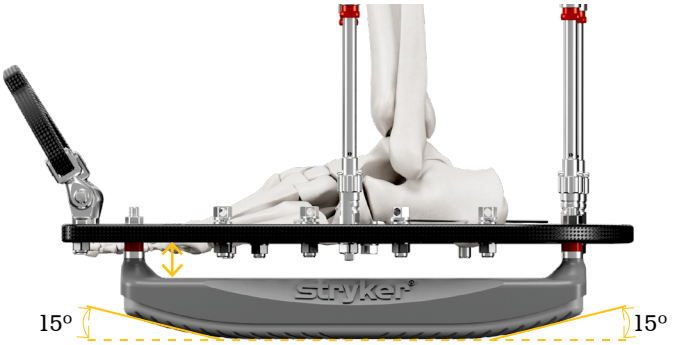
Figure 36

⚠CAUTION

Rocker shoes are attached to rings using the M6 connecting nuts (4933-1-701).

⚠CAUTION

If rocker shoes will be utilized, the dedicated mounting holes should not be occupied with other frame components. The location of the dedicated mounting holes varies by ring type.



Max clearance = 23mm (inlc. washer red 7mm)

Figure 37

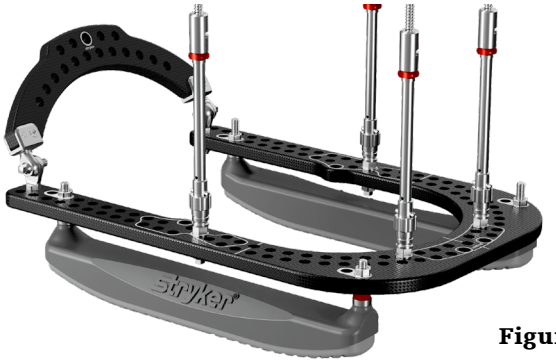
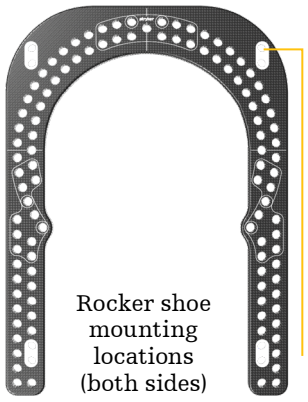
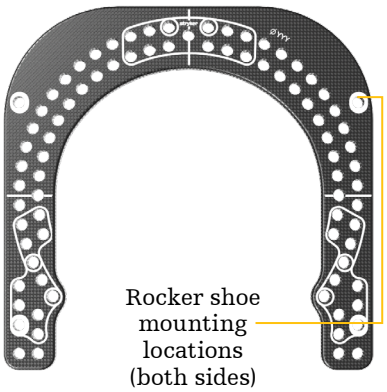
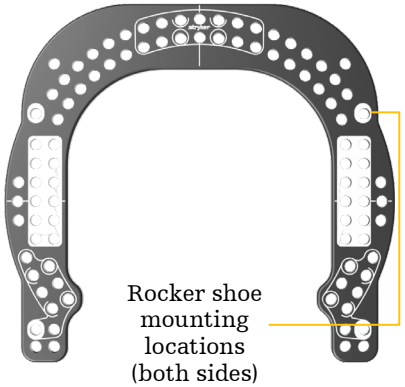


Figure 38

System Overview - Universal components

Table 7: Rocker shoe sizing by ring size and type

Ring size	Long Foot Ring	Short Foot Ring	U-Plate
			
	Rocker Shoe Size		
105	Small Rocker Shoe Long	Medium Rocker Shoe Short	Large Rocker Shoe Short
130	Medium Rocker Shoe Long		
155		Large Rocker Shoe Short	
180	Large Rocker Shoe Long		
205			Large Rocker Shoe Long

System Overview - Universal components

Nuts, bolts and washers

Hardware connection bolts (Figure 39)

Hardware connection bolts may be used to connect struts and fixation components with female connections to the rings. The bolt is available in a short (4938-1-300) or long (4938-1-310) option.

The bolt's recessed hex head is designed to accommodate a 5mm hex key (200343) as well as the insertion of the smartHEX ID Caps (4938-1-051) when used with a Hexapod strut. The bolt's outer head is designed for use with a 10mm wrench.

NOTICE

Struts, clickers, pin cubes, wire posts, MG connection plates and twisted plates are attached to rings using a hardware connection bolt.

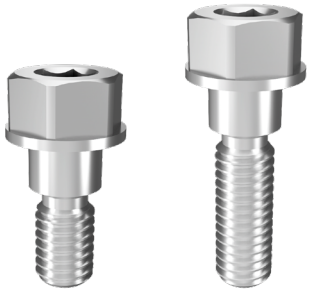


Figure 39



Figure 40



Figure 41

Half pin bolts (4938-1-100) (Figure 40)

- The bolt's hexagon head design allows use of an L-socket wrench.
- The cupped end increases contact with the pin shaft when locking it into place.
- The bolt also has a hex recess feature that is compatible with a 5mm hex key.

Connecting nuts

M8 connecting nuts (Figure 41)

- Designed with a built-in washer that provides more surface area for contact with the ring
- Available in sizes short (4933-1-010) and long (4933-1-011)
- Long nuts may allow for easier wrench access when space is limited between components on the ring. **(Figure 42)**



Figure 42

M6 connecting nuts (4933-1-701) (Figure 43)

- Designed with a built-in washer that provides more surface area for contact with the ring
- Utilized to connect threaded rods, rocker shoes, and male hinge posts.



Figure 43

Dice nuts (4938-9-100) (Figure 44)

- Designed to be used with threaded rods
- Markings on the four sides of the square nut are designed to aid in manual distraction or compression by patients in ¼mm increments
- May be used in lieu of an M6 nut for easier wrench access when space is limited between two components

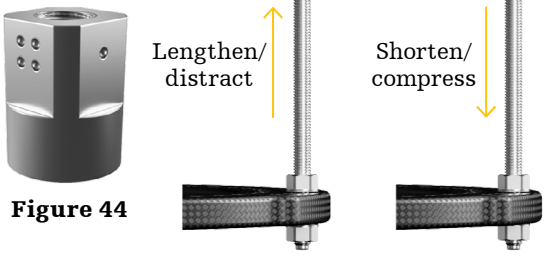


Figure 44

System Overview - Universal components

Spherical washers (4933-1-720) (Figure 45)

Spherical washers are designed to allow angulation of the threaded rod components within the ring. This allows threaded rods to span to rings that are not parallel or have different diameters. The angulation is achieved by adding the cup-and-cone-shaped washer assembly to both sides of the ring/threaded rod interface. **(Figure 46)**

NOTICE

Spherical washers are attached using the M6 connecting nuts only. The female half of the washer is applied first, with the grooved surface facing the ring. The male half of the washer is applied second, followed by the M6 nut.

The spherical washers can be used with both aluminum and carbon fiber rings. With aluminum rings, the threaded rods can be angulated 12° from neutral. Since the carbon rings are slightly thicker, 10° of rod angulation from neutral is possible. **(Figures 47-48)**

Standard color washers (Figure 49)

A set of standard color-coded washers may be used to offset the height of fixation components.

- 4933-1-710: 1mm, black
- 4933-1-711: 2mm, yellow
- 4933-1-712: 4mm, blue
- 4933-1-713: 7mm, red

The blue washers (4933-1-712) must be utilized in special circumstances:

- Between the hardware connection bolt head and half ring, when the half ring is used in a 90° orientation on the aluminum foot ring or u-plate.
- When connecting a short hardware connection bolt to an aluminum ring

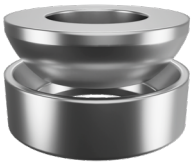


Figure 45

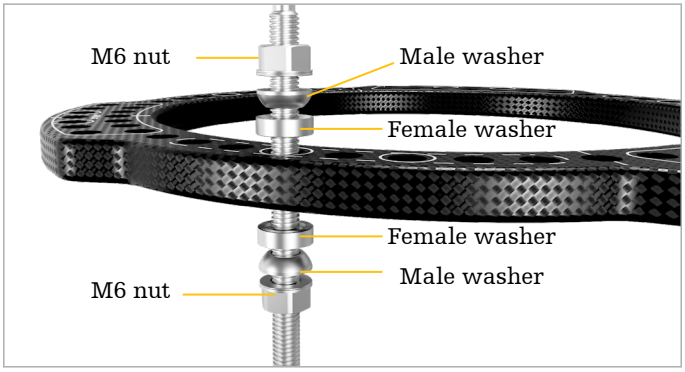


Figure 46

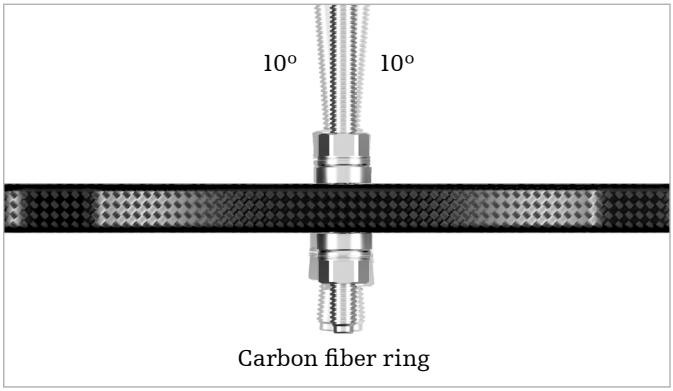


Figure 47

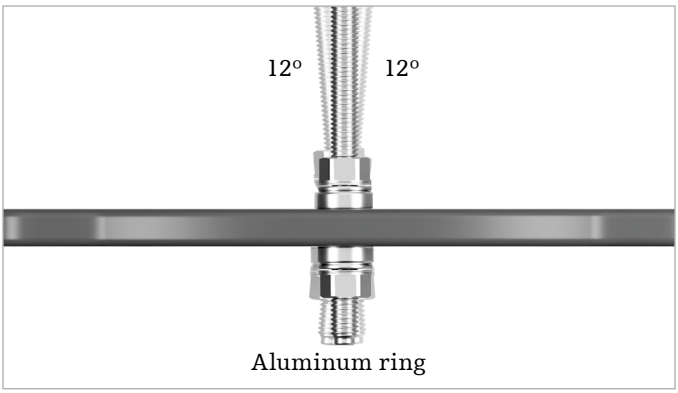


Figure 48



Figure 49

System Overview - Universal components

Plates

Slotted plates

Slotted plates (4934-1-060) **(Figure 50)** may be used to build a variety of offset component assemblies. Slotted plates are commonly used as modular ring "tabs" to capture threaded rods or struts that do not directly align with the ring holes. **(Figure 51)**

Slotted plates are designed to accommodate both 6mm and 8mm diameter components.

In addition to offsetting 6mm threaded rods, slotted plates can be used to attach telescopic struts and gradual correction struts.

NOTICE

Slotted plates are connected to rings using medium M6 connection bolts and M6 connecting nuts.

⚠CAUTION

Do not use slotted plates to mount hexapod struts.

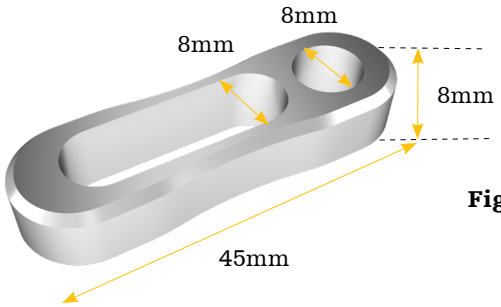


Figure 50

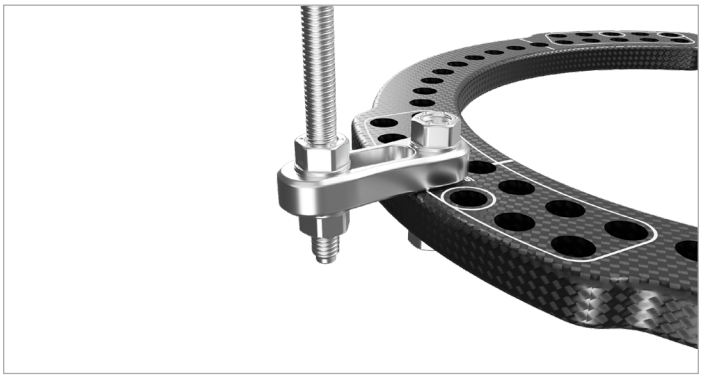


Figure 51

MG connection plates

MG connection plates* **(Figure 52)** may be used to mount fixation components off the ring or to catch broken wires.

Offered in four variations:

- 2 holes (4938-3-102)
- 1 hole +1 slot (4938-3-103)
- 2 holes +1 slot (4938-3-104)
- 3 holes +1 slot (4938-3-105)

The slots provide four locations for placing fixation components. Some slots and holes intentionally overlap across plate sizes to allow for connection of different sized rings. **(Figures 53-53A)**

Built-in teeth on either end of the plate increase the rotation resistance of the of the plates on both aluminum and carbon fiber ring surfaces.

Strategic cutouts along the outer profile of each plate are designed to allow adjacent placement of other components.



Figure 52

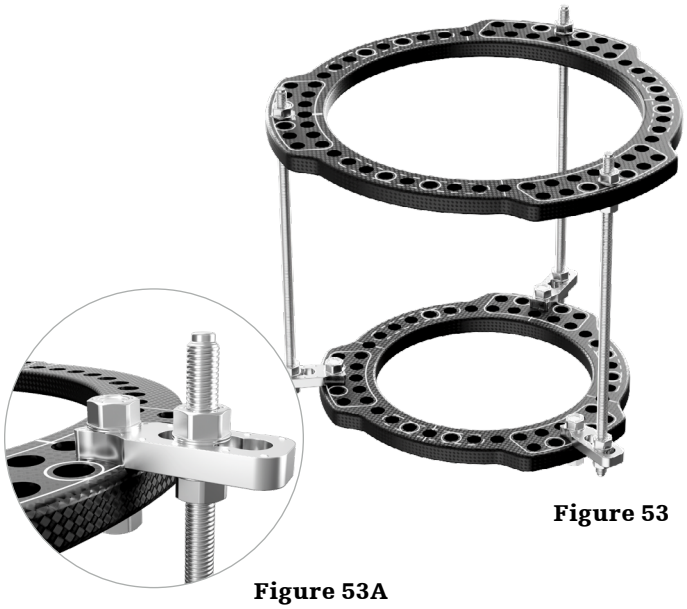


Figure 53

Figure 53A

*The MG Connection Plate is named in honor of Mayank Gupta, one of our talented engineers who tragically lost his life, along with much of his family, during the peak of COVID. This product stands as a heartfelt tribute to his memory and contributions.

System Overview - Universal components

Twisted plates (4938-3-002)

Twisted plates have connection points oriented 90o apart and may be used to mount components rotationally offset to the ring surface. **(Figure 54)**

- Built-in teeth on either end of the plate are designed to minimize slippage on both aluminum and carbon fiber ring surfaces
- Strategic cutouts around each hole are designed to allow adjacent placement of other components

NOTICE

MG connection plates and twisted plates are connected to the ring using long hardware connection bolts (4938-1-310) and M6 nuts.



Figure 54

System Overview - Universal components

Fixation components

Wire fixation

Wire bolts

- The Hoffmann LRF wire bolts feature a built-in grooved stainless-steel washer
- The cannulated head is designed to accept the counter-torque nose of the wire bolt wrench
- The bolts fit 1.5mm, 1.8mm, and 2.0mm K-wires
- Offered in two unique designs

Hex slotted wire bolt

- Designed with an offset wire slot
- The wide side of the flange of the wire bolt head **(Figure 55)** indicates the location of the wire slot
- Designed to catch wires offset from the center of the wire bolt body
- Offered in sizes short (4938-9-011), medium (4938-9-012), and long (4938-9-013)

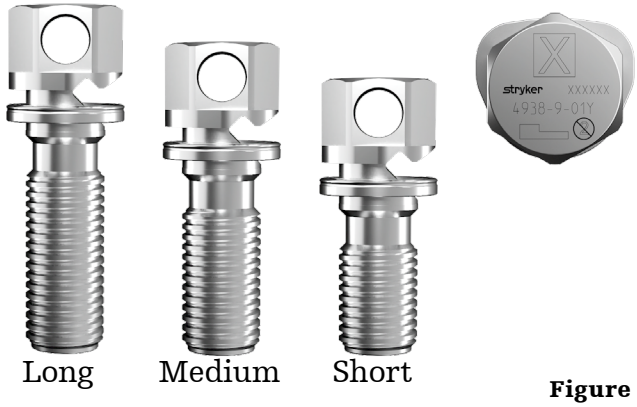


Figure 55

Cannulated wire bolt

- Wire cannulation is located at the center of the wire bolt body **(Figure 56)**
- Offered in sizes short (4938-9-001) and medium (4938-9-002)

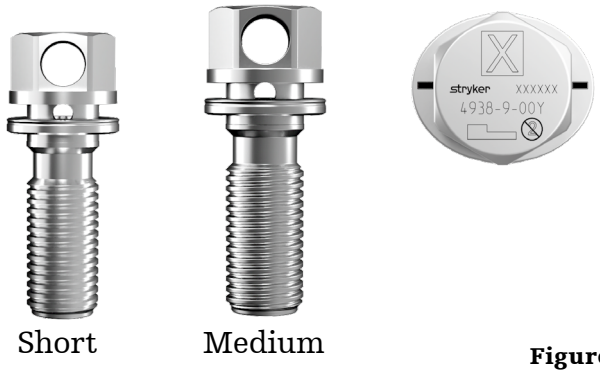


Figure 56

Wire bolt offset adapter

- Used with wire bolts to capture obliquely inserted wires **(Figure 57A)** or wires placed above or below the ring surface **(Figure 57)**
- The threaded post is designed to allow micro-adjustments in height to capture the wire without incidental bending.
- Offered in sizes short (4933-1-004) and long (4933-1-005)

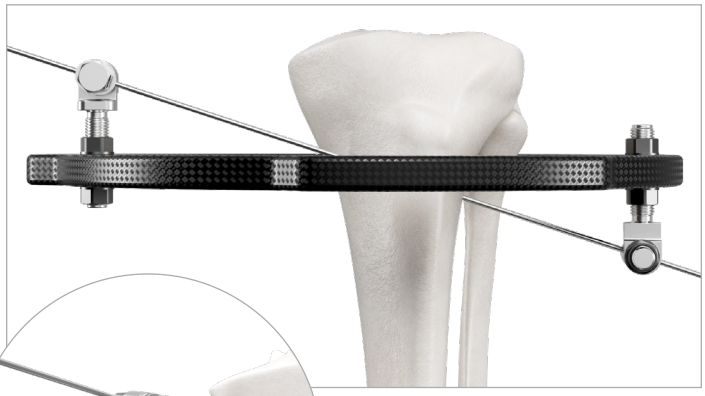


Figure 57

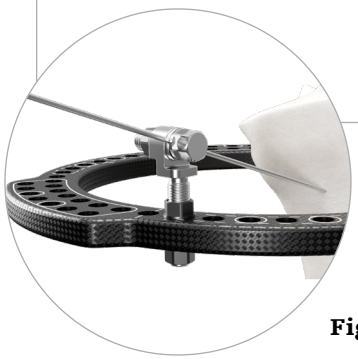


Figure 57A

NOTICE

Wire bolts and wire bolt adaptors are attached to rings using the M8 connecting nuts (4933-1-010 or 4933-1-011).

System Overview - Universal components

Wire post

Wire posts are used to capture wires inserted at an offset of up to 51.5mm above or below the ring surface.

- The wire post base is designed with a flat surface for a wrench to provide counter-torque
- Available with multiple hole variations:
  - 2-hole: 4938-2-002 **(Figure 58A)**
  - 3-hole: 4938-2-003 **(Figure 58B)**
  - 4-hole: 4938-2-004 **(Figure 58C)**
  - 5-hole: 4938-2-005 **(Figure 58D)**
- Compatible with the slotted and cannulated wire bolts
- Built-in teeth on the base increase the rotation resistance of the wire posts when tightened on aluminum and carbon fiber ring surfaces. **(Figure 59)**
- The female connection is designed for easier adjustment and removal of components
- Attached to the ring with a hardware connection bolt

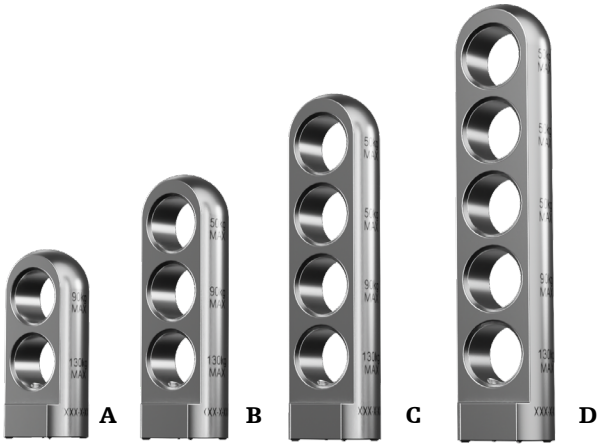


Figure 58

NOTICE

Use the short hardware connection bolt only when the first hole is selected. For larger offsets, the use of long hardware connection bolt is recommended.

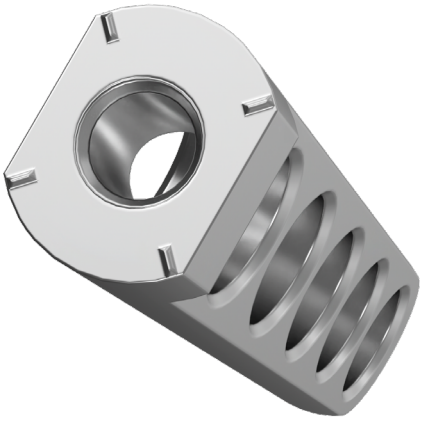


Figure 59

NOTICE

Utilize counter-torque instrumentation to minimize wire bending during final tightening. **(Figure 60)**

NOTICE

Tensioning information for each offset hole is marked adjacent to the hole on either side of the component. **(Figure 60A)**

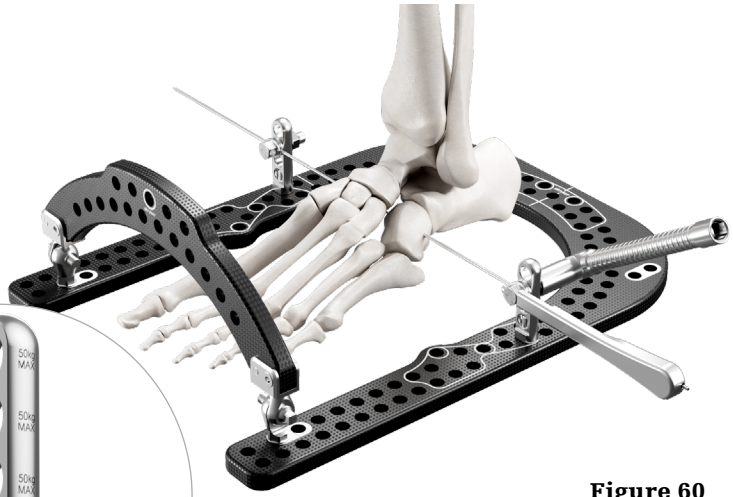


Figure 60



Figure 60A

System Overview - Universal components

Pin fixation

Pin cubes

Pin cubes are alternative fixation components that allow for orthogonal half pin placement up to 58.5mm above or below the ring. **(Figure 61)**

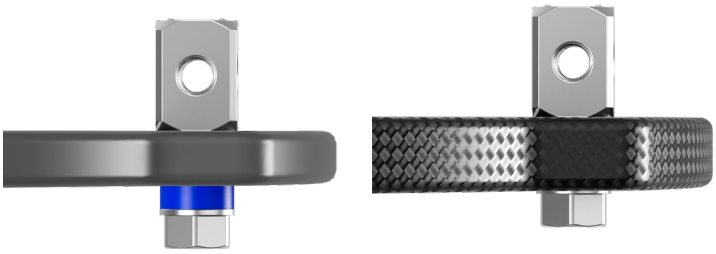
- Available in 1, 2, 3, 4 and 5-hole variations
- Compatible with HA-coated blunt half pins and standard blunt half pins
- Built-in teeth on the base increase the rotation resistance of the pin cubes when tightened on aluminum and carbon fiber ring surfaces.
- Using the half pin bolt, the half pin may be locked into place from either side or from the top, which may provide flexibility when working in tight spaces.



Figure 61

NOTICE

Use only the short hardware connection bolt (4938-1-300) with a 1-hole cube (4938-1-001). In addition, with an aluminum ring, a 4mm washer (4933-1-712) must be utilized between the bolt head and the ring. **(Figure 62)**



Aluminum Carbon fiber

Figure 62

Centering Sleeve

The centering sleeve (4938-1-200) is designed to restrict the movement of the half pin within the pin cube upon insertion. **(Figure 63)**

The laser marking on the centering sleeve indicates the intended half pin bolt engagement location and must be aligned with the planned top or side bolt insertion point to facilitate proper fixation and prevent interference during tightening.

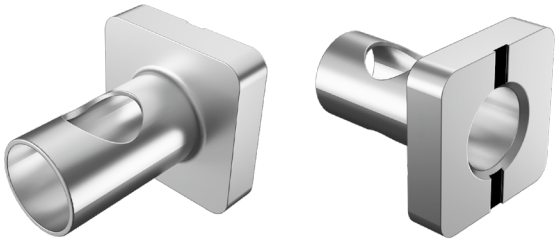


Figure 63

System Overview - Universal components

Pin bolts
Apex pin bolt (4933-1-022) (Figure 64)

The apex pin bolt may be used for fixation of half pins orthogonally to the ring. The one-piece adjustable design is compatible with 4, 5, and 6mm HA coated or standard half pins.

Low profile pin bolt (4939-9-022) (Figure 65)

The low-profile pin bolt may be used for pin placement closest to the top or bottom ring surface. **(Figure 66)**

- Positions the pin 2.75mm from the ring surface
- Compatible with 4, 5, and 6mm half pins and tissue protection sleeves
- When the pin bolt is tightened to the ring, the half pin is also locked into place, eliminating the need for an additional bolt and centering sleeve

⚠CAUTION

When using a soft tissue sleeve with pin bolts, provisional tightening should be done using fingers or a thumbwheel wrench because deformation and/or unwanted spinning of the sleeve is possible with over-tightening.



Figure 64



Figure 65

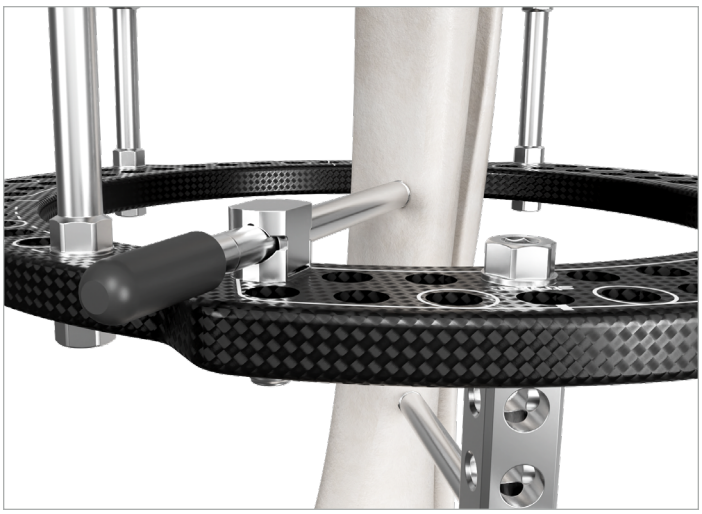


Figure 66

System Overview - Universal components

Pin adaptors

Angled pin adaptor

The angled pin adaptor has an adjustable design that may be used to capture half pins inserted at various angles for multiplanar fixation. **(Figure 67)**

- Available in sizes short (4938-1-021), medium (4938-1-022), and long (4938-1-023)
- Compatible with 4, 5, and 6mm half pins and tissue protection sleeves
- The half pin locking feature is designed to accommodate a centering sleeve and half pin bolt from any of three sides
- Laser markings on the side of the adaptor provide a visual aid for pin placement. When the markings are aligned, pin placement is orthogonal. **(Figure 68)**
- Interdigitating counter-torque serrations are designed to mechanically lock the angulation by tightening the built-in bolt on the adaptor head.
- A built-in hex-nut is designed to accept a 10mm wrench or 5mm hex key for counter-torque during tightening
- The female connection design may allow for easier removal of the component while the pin remains inserted.

Low profile angled pin adaptor (4938-1-024)

The low-profile design provides an option that is one size shorter than the short-angled pin adaptor. It may be used for multiplanar pin fixation closest to the ring. **(Figure 69)**

When the low-profile angled pin adaptor is fixed to the ring, it locks the angulation of the pin, eliminating the need for additional tightening steps.

The low-profile design allows for fixation component assembly in adjacent holes, and the male post can accommodate all washer sizes available to attain the desired offset from the ring.

NOTICE

Pin fixation components including angled pin adaptors and half pin bolts are attached to rings using M8 connecting nuts (4933-1-010 or 4933-1-011).



Figure 67



Figure 68

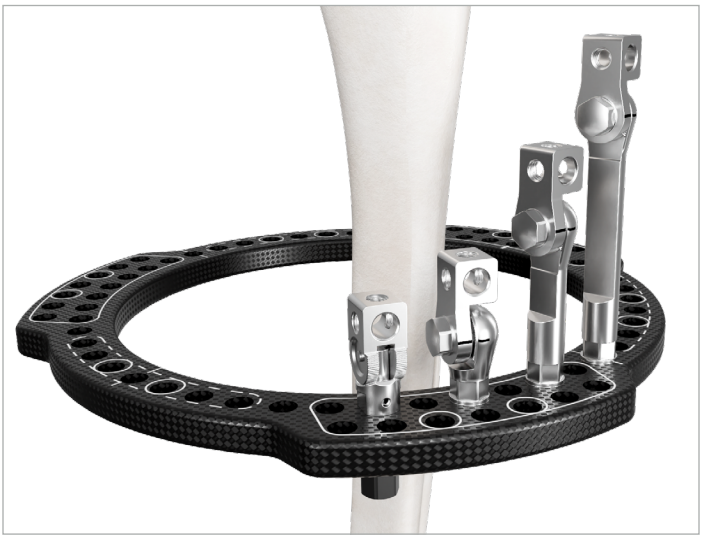


Figure 69

System Overview - Universal components

Rods, struts and couplings

Static struts

The Hoffmann LRF system includes 8mm diameter static struts of various lengths **(Table 8)** that can be used to connect rings statically. They are designed to be compatible with the Hoffmann II and Hoffmann 3 couplings for additional fixation options. **(Figure 70)**

NOTICE

Static struts are connected to rings using a hardware connection bolt.

Table 8: Static strut lengths by size

Item #	Strut size	Length (mm)
4933-1-520	Extra short	20
4933-1-530	Short	30
4933-1-540	Medium	40
4933-1-560	Long	60



Figure 70

Threaded rods

The threaded rods within the Hoffmann LRF system are 6mm in diameter and available in a range of lengths 30mm-400mm. Threaded rods are attached to the rings using M6 connecting nuts.

Hinge couplings (4933-0-800) (Figure 71)

Hinge couplings can be connected to threaded rods to create a range of hinged assemblies. The constrained hinge allows motion in a single plane. A pre-assembled hinge coupling may be locked in static frame applications.

⚠CAUTION

It is recommended that hinge couplings are reinforced with M6 connecting nuts when attached to threaded rods.

NOTICE

Hinge couplings are attached to rings using a hardware connection bolt.

NOTICE

When building a static connection between two rings, confirm that the self-locking nuts on the hinge couplings are fully tightened.

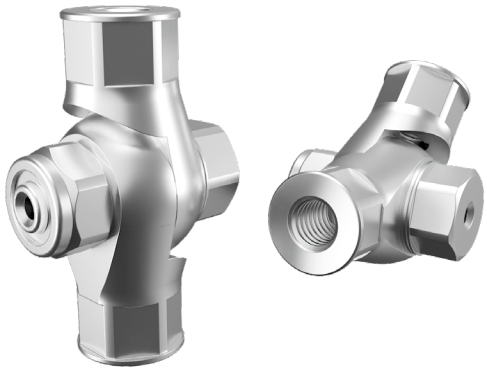


Figure 71

System Overview - Universal components

Male hinge post (4938-0-063)

A male hinge post may be used along with a threaded rod and dice nut or M6 nut to create a mechanism on a foot frame that allows for flexion or extension in equinus correction applications. **(Figure 72)**

The base of the post is designed to accommodate a 10mm wrench for counter-torque when tightening.

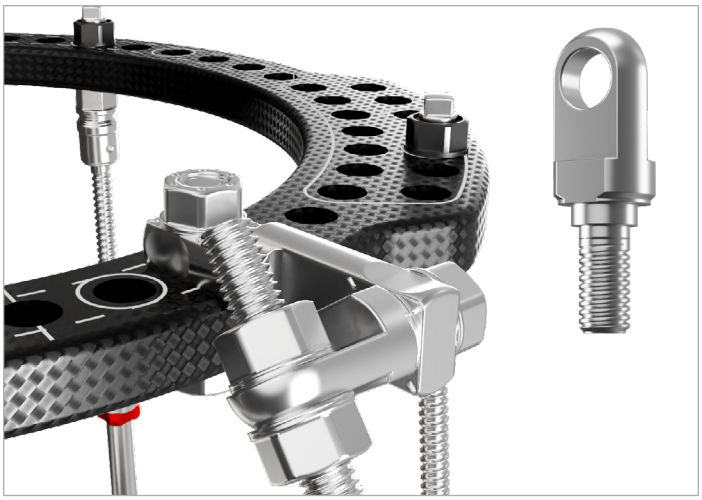


Figure 72

Clickers

Clickers are a low-profile strut option designed to be utilized in linear gradual correction or bone transport applications. **(Figure 73)**

- The clicker body is designed to accept a 10mm wrench for counter-torque during tightening.
- Available in four lengths with varying compression or distraction (C/D) limits **(Table 9, Figure 74A)**
- Compatible with threaded rods (M6)
- A built-in spring-loaded latch on the clicker knob provides a "click" every 90-degrees, which is equivalent to a ¼mm adjustment of a threaded rod.

Clockwise rotation (+) of the clicker knob results in distraction and counterclockwise rotation (-) results in compression.

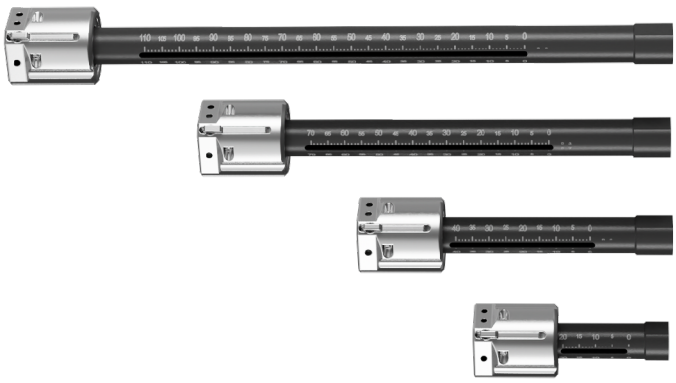


Figure 73

NOTICE

Additional length beyond the zero mark varies by clicker size. **(Table 10, Figure 74B)**

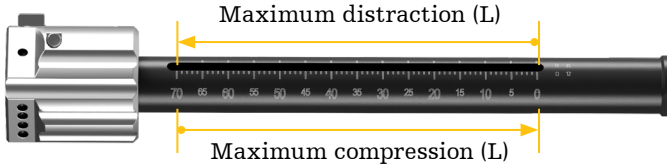


Figure 74A

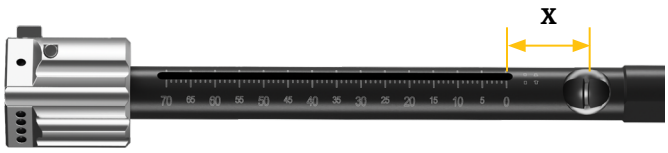


Figure 74B

Table 9: Clicker compression and distraction limits

Item #	Clicker actuation size L (mm)
4938-0-060	20
4938-0-100	40
4938-0-150	70
4938-0-200	110

Table 10: Clicker additional length beyond zero

Item #	Extra length beyond zero X (mm)
4938-0-060	0
4938-0-100	3
4938-0-150	14
4938-0-200	22

System Overview - Universal components

Telescopic struts

The telescopic struts within the Hoffmann LRF system offer dynamic capabilities for various frame constructs. The struts compress and distract in the axial plane and are designed for both acute adjustments and fine-tuning. Available in four size lengths, shown in **Table 11 and Figure 75**.

Table 11: Telescopic strut sizes and colors

Item #	Size	Safety wheel color
4933-0-100	Extra short	**Black**
4933-0-120	Short	**Yellow**
4933-0-140	Medium	**Blue**
4933-0-180	Long	**Red**

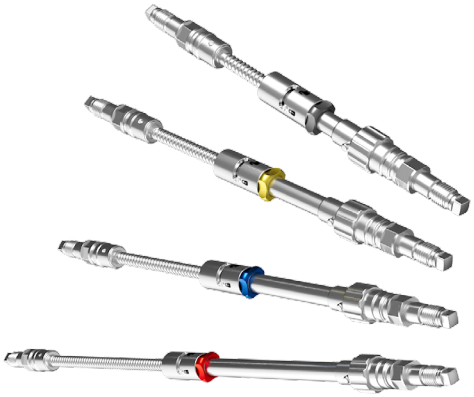


Figure 75

- Designed with ball joints that can achieve up to 6° of angulation in each direction
- The strut's quick release mechanism is designed for rapid length adjustment
- Designed with flat surfaces on each end for placement of counter-torque instrumentation
- A built-in dynamization feature allows up to 5mm of controlled dynamization. **(Figure 76)**

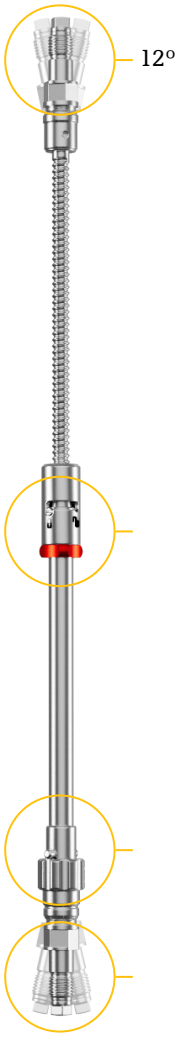


Figure 76

Prior to frame assembly, the ball joints can be straightened using the 5mm gold wrench (4940-9-030), a thumbwheel (4933-9-208), and the ratchet wrench (4933-9-202) for counter-torque. **(Figure 77)**

NOTICE

Telescopic struts are attached to rings using short M8 connecting nuts only (4933-1-010).

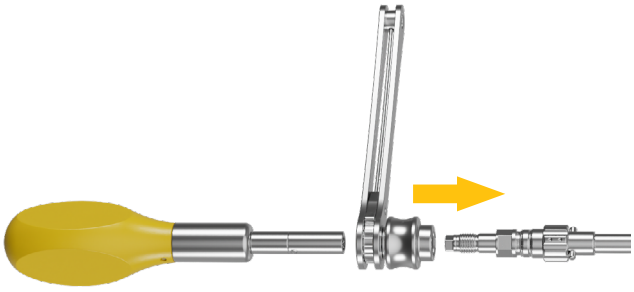


Figure 77

Disassembly for cleaning

1. Completely unscrew the colored safety wheel **(Figure 78)**
2. Follow the instructions for Cleaning and Sterilization (OT-RG-1).
3. After cleaning, carefully push up the spring and screw the colored safety wheel with the spring back up to the groove.

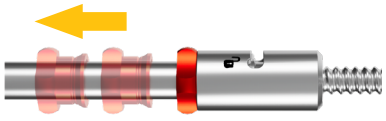


Figure 78

Specialized struts

The Hoffmann LRF system also offers Gradual Correction Struts, Transport Struts, and smartHEX Struts. Information about these components can be found in dedicated sections of the operative technique.

Hoffmann® LRF

Operative Technique

General information

Circular fixation with telescopic struts

Gradual correction

Bone transport

Hoffmann LRF - General information

General information

Ring selection

Select a ring size that allows for adequate clearance between the skin and the ring. Any anticipated swelling of the limb must be taken into consideration while picking the ring size. Ring templates for commonly used sizes are offered to measure appropriate ring diameters preoperatively.

Half pin and wire insertion

General awareness of "safe zones" in pertinent anatomy is important for safe insertion of wires and half pins.

The ring should be aligned perpendicular to the long axis of the deformity segment whether it is secured with wires, or they are used in conjunction with half pins.

Always use the Stryker predrilling assemblies for hydroxyapatite (HA) coated half pin insertion to avoid damage to the HA coating.

⚠CAUTION

If the HA coating is damaged due to incorrect instrument usage, fixation properties may be compromised.

⚠CAUTION

When inserting the standard blunt half pins with power, use a low speed to minimize heat generation. **(Figure 79)** High temperatures may cause bone damage (necrosis). Avoid applying excessive axial force.

⚠CAUTION

When inserting the HA-coated half pins, always utilize the Stryker AO Connect T-handles that come with the system. **(Figure 80)** Using power to insert a half pin may damage the HA-coating.

⚠CAUTION

Do not wash or attempt to re-sterilize an unpacked HA-coated half pin. **(Figure 81)** The coating may be damaged, and the effect of the HA coating may be compromised.

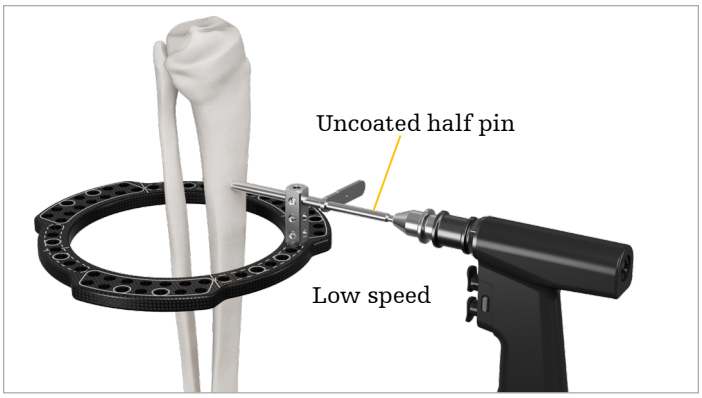


Figure 79

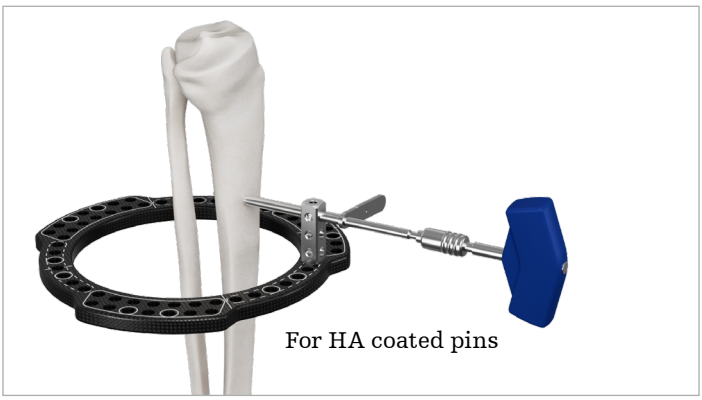


Figure 80



Figure 81

Hoffmann LRF - General information

Tissue sleeve selection

- When the tip of the drill bit reaches the desired depth, the handle of the tissue sleeve will align with the half pin thread measurement that can be read off the drill bit's scale. **(Figure 82)** Short drill bits are designed to be used with the short tissue sleeve only.
- 175mm half pins are designed to be used with the short tissue sleeve only. These length pins have one etching that, when aligned with the short tissue sleeve handle, indicates that the threaded region of the pin has fully cleared the sleeve's opening. **(Figure 83)**
- 225mm and 250mm half pins are designed to be used with short or long tissue sleeves. These length pins have two etchings: the first located closest to the sharp end aligns with the short sleeve. **(Figure 84)**; the second aligns with the long sleeve **(Figure 84)** These etchings align with the handle of the relative tissue sleeve when the threaded region of the pin has fully cleared the sleeve's opening.

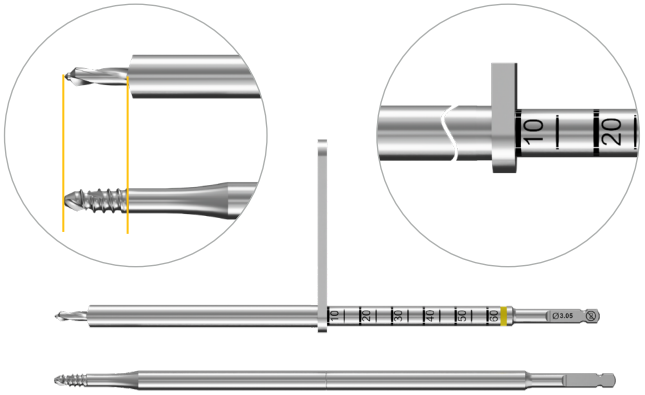


Figure 82

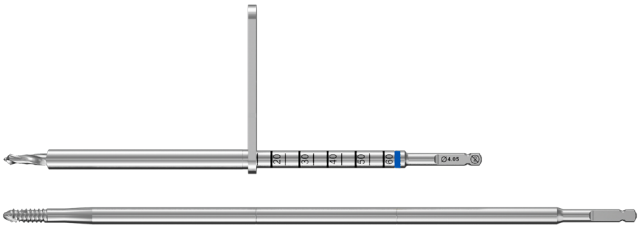


Figure 83

NOTICE

Surgeons should use their best clinical judgment when selecting half pin sizes in order to achieve the desired depth and purchase.

- After determining the required half-pin threaded length using the drill bit markings, advance the half-pin until the corresponding etch mark aligns with the short or long sleeve, as appropriate.

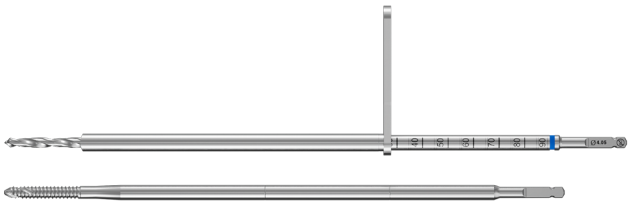


Figure 84

⚠CAUTION

Advance the half pin slowly as the desired depth is approached. A noticeable increase in insertion torque may indicate the thread runout region has been reached. Do not continue advancing the half pin beyond this point, as excessive force may damage the implant or compromise fixation.

Hoffmann LRF - General information

Pin insertion technique: pin cube (Figure 85)

The following steps outline the recommended method of half pin insertion using pin cubes:

1. When templating half pin placement above or below the ring, identify a ring hole and select an appropriate pin cube length based on the offset distance from the ring.
2. Secure the pin cube to the ring using a hardware connection bolt.

⚠CAUTION

For a 1-hole pin cube (4938-1-001) use only the short hardware connection bolt. In addition, when a 1-hole pin cube is used with an aluminum ring, a 4mm washer (4933-1-712) must be utilized. **(Figure 86)**

3. To prepare for drilling, select the appropriate length tissue sleeve, and insert it into the desired hole of the pin cube.
4. Place the tissue sleeve so that it contacts the bone, insert the drill into the tissue sleeve, and drill under power to the desired depth.
5. Measure the drill depth utilizing the markings on the drill and remove the drill. **(Figure 87)**
6. Insert the half pin into the tissue sleeve. Using a T-handle, manually advance the pin to the desired depth based on the measured drill depth marking. **(Figure 88)**

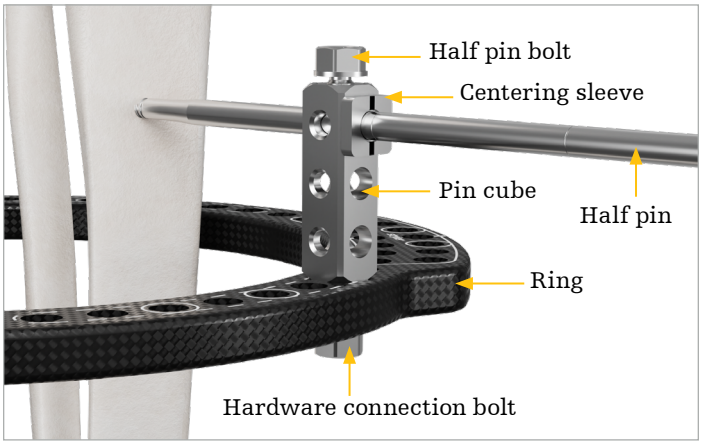


Figure 85

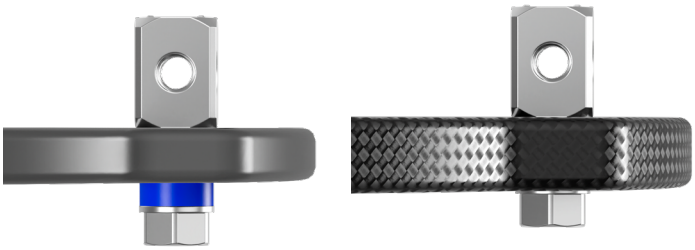


Figure 86

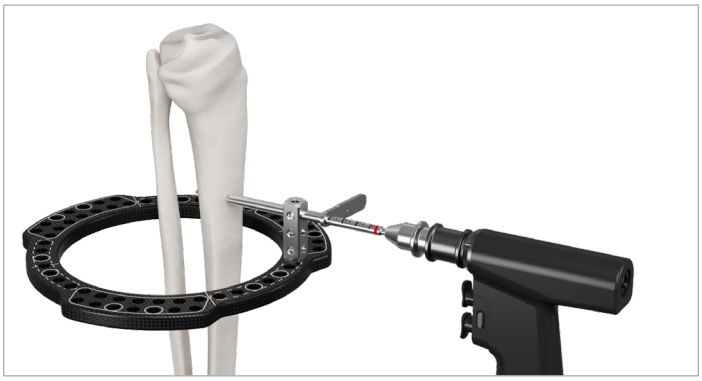


Figure 87

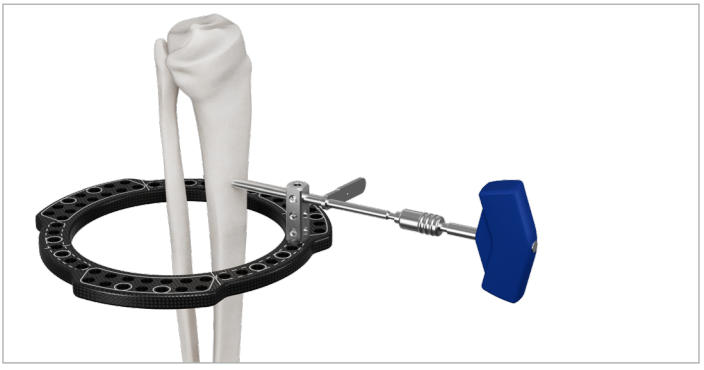


Figure 88

Hoffmann LRF - General information

7. Once the half pin is placed, remove the tissue sleeve, and replace it with the centering sleeve. **(Figure 89)**
8. After the centering sleeve is inserted, align the laser marking on the centering sleeve based on the planned half pin bolt insertion location, either top or side, and secure the half pin by inserting a half pin bolt from either of the side holes or top hole. **(Figure 89)**

NOTICE

The half pin bolt can be secured from either the side or the top of the pin cube. When orienting the centering sleeve, ensure that the laser marking aligns with the planned half pin bolt location to avoid unwanted contact while tightening.

NOTICE

If the centering sleeve does not easily fit into the pin cube, it may be deformed. In this case, replace it with a new, unused centering sleeve.

9. Tighten the construct using a spanner wrench, L-wrench or hex key. **(Figure 90)** The bolt also has a hex recess feature that is compatible with a 5mm hex key. Counter-torque should be used during final tightening to prevent incidental rotation of the component.

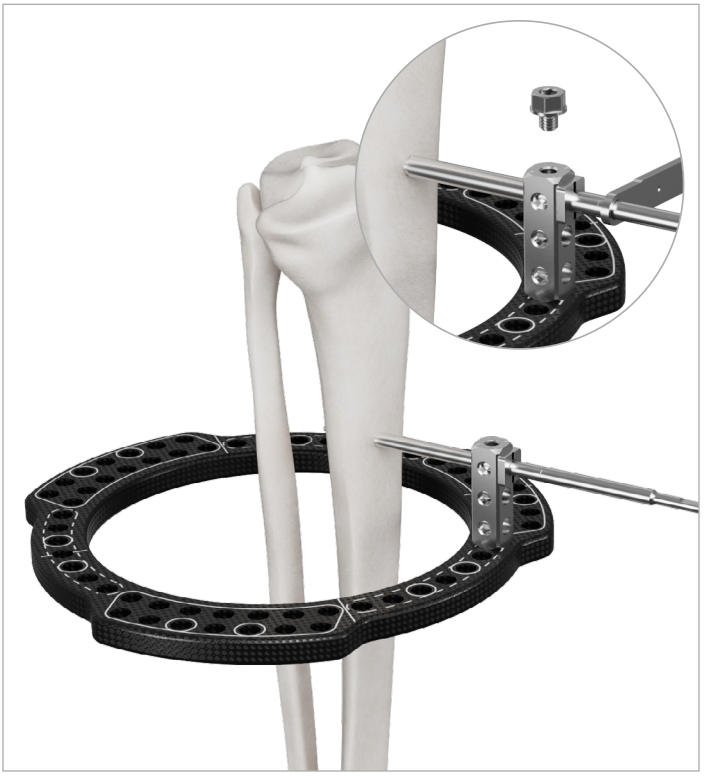


Figure 89

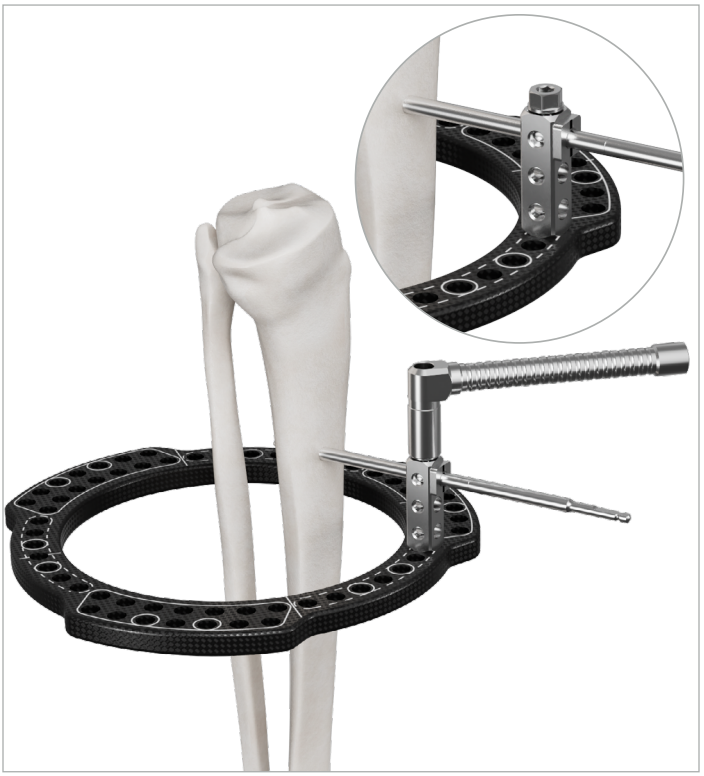


Figure 90

Hoffmann LRF - General information

Pin insertion technique: angled pin adaptor

The following steps outline the recommended method of half pin insertion using the angled pin adaptor:

1. When templating half pin placement above or below the ring, identify a ring hole and select an appropriate angled pin adaptor size based on the offset distance and required angulation from the ring.
2. Secure the angled pin adaptor to the ring using an appropriate size hardware connection bolt. Use a small hardware connection bolt with the small, angled pin adaptor.
3. Adjust the angulation of the pin adaptor by tightening the angulation screw on the side of the device.
4. To prepare for pre-drilling, select the appropriate length tissue sleeve and insert it into the hole of the angled pin adaptor, ensuring that the tissue sleeve is fully seated to the bone. **(Figure 91)**
5. Insert the drill into the tissue sleeve and drill under power to the desired depth. **(Figure 92)**
6. Measure the drill depth utilizing the markings on the drill, then remove the drill.
7. Insert the half pin into the tissue sleeve; using a T-handle, manually advance the pin to the desired position based on the measured drill depth marking. **(Figure 93)**
8. Once the half pin is placed, remove the tissue protection sleeve and replace it with a centering sleeve.
9. After the centering sleeve is inserted, align the laser marking on the centering sleeve based on the planned half pin bolt insertion location, either side or top. **(Figure 94)**

NOTICE

The half pin bolt can be secured from either side of the cube or the top. When orienting the centering sleeve, ensure that the laser marking aligns with the planned half pin bolt location to avoid contact while tightening.

10. Secure the half pin by inserting a half pin bolt from either of the side holes or top hole. Tighten the construct using a spanner wrench, L-wrench or hex key. **(Figure 95)**
11. Utilize counter-torque instrumentation to minimize rotation of the component during final tightening.

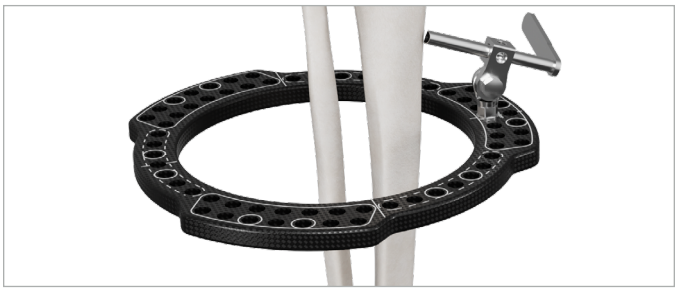


Figure 91



Figure 92



Figure 93

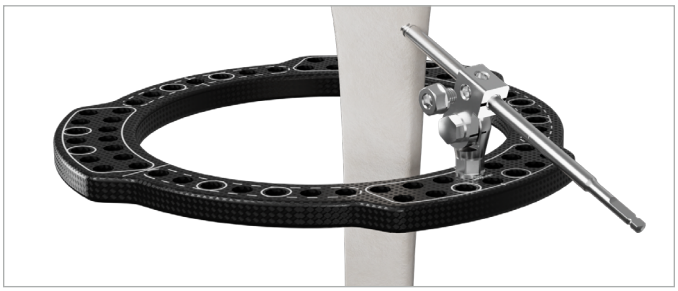


Figure 94

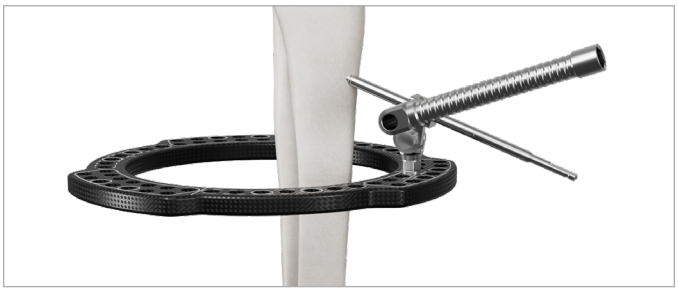


Figure 95

Hoffmann LRF - General information

Pin insertion technique: low profile angled pin adaptor

The following steps outline the recommended method of half pin insertion using the low-profile angled pin adaptor:

1. When templating half pin placement above or below the ring, identify a ring hole based on the required angulation from the ring.
2. Adjust the angulation of the low-profile angled pin adaptor as required.
3. Secure the low-profile angled pin adaptor to the ring using an M8 connecting nut; this will also lock the angulation.
4. To prepare for pre-drilling, select the appropriate length tissue protection sleeve and insert it into the hole of the low profile angled pin adaptor, ensuring that the tissue sleeve is fully seated to the bone.
5. Insert the drill into the tissue protection sleeve and drill under power to the desired depth. **(Figure 96)**
6. Measure the drill depth utilizing the marking on the drill in conjunction with the tissue sleeve and then remove the drill.
7. Insert the half pin into the tissue protection sleeve; using the T-handle, manually advance the pin to the desired depth based on the measured drill depth marking. **(Figure 97)**
8. Once the half pin is placed, remove the tissue protection sleeve and replace it with the centering sleeve.
9. After the centering sleeve is inserted, align the laser marking on the centering sleeve based on the planned half pin bolt insertion location (side or top).

NOTICE

The half pin bolt can be secured from either side of the cube or the top. When orienting the centering sleeve, ensure that the laser marking aligns with the planned half pin bolt location to avoid contact while tightening.

10. Secure the half pin by inserting a half pin bolt from either of the side holes or top hole. **(Figure 98)**
11. Tighten the construct using a spanner wrench, L-wrench or hex key. Utilize counter-torque instrumentation to minimize rotation of the component during final tightening **(Figure 99)**

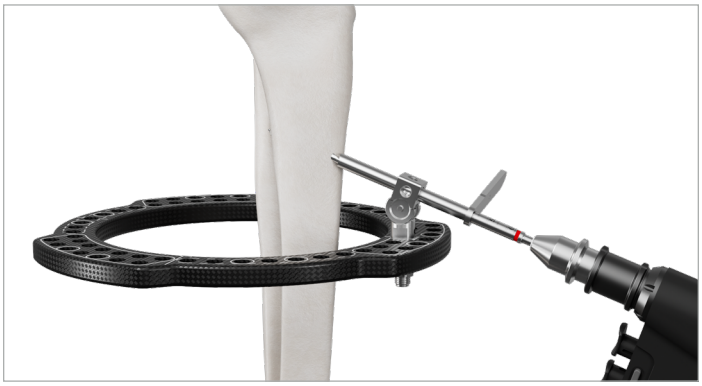


Figure 96



Figure 97

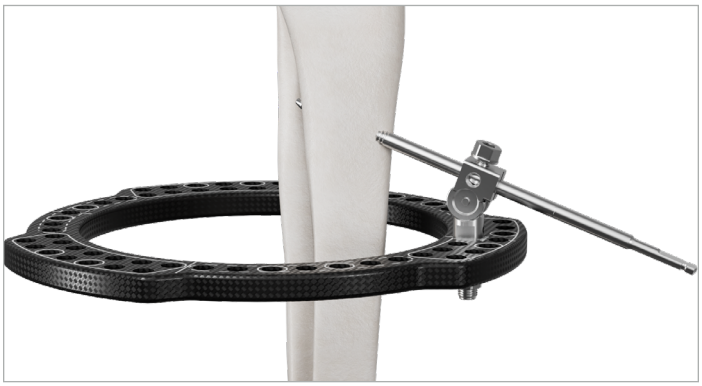


Figure 98

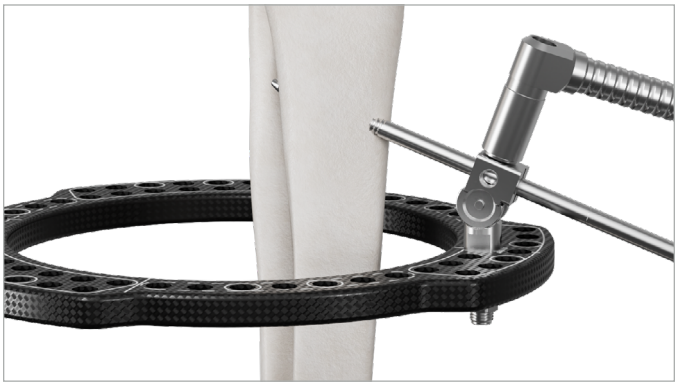


Figure 99

Hoffmann LRF - General information

Wire insertion technique: wire guide

NOTICE

Use the wire guide that matches the ring type (aluminum or carbon). Each wire guide is clearly marked for identification. **(Figures 100A-100B)**

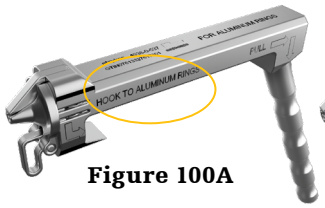


Figure 100A

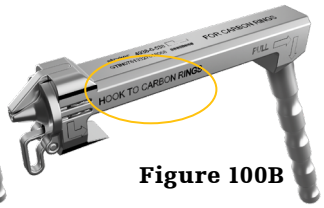


Figure 100B

The following steps outline the recommended method of wire insertion using a wire guide:

1. Place the wire guide directly onto the ring, ensuring that the flat surface of the guide has sufficient contact with the flat surface of the ring.
2. Hook the wire guide to the inner diameter of the ring in the desired position and pull toward the user to lock the trajectory. **(Figures 101-102)**
3. Place the K-wire (smooth or olive) through the wire guide utilizing a wire driver, taking care not to bend the wire during insertion.
4. Under power, advance the K-wire through both cortices. **(Figure 103)** If using an olive wire, the tip of the wire guide will hinge open, allowing the wire to advance to its final position. **(Figure 104)**
5. The wire guide can be used for wire placement above or below the ring.

NOTICE

If a wire guide is used for crossing wires on the same ring, insert only one wire above the ring and the other below the ring using the wire guide to prevent collisions between crossing wires.

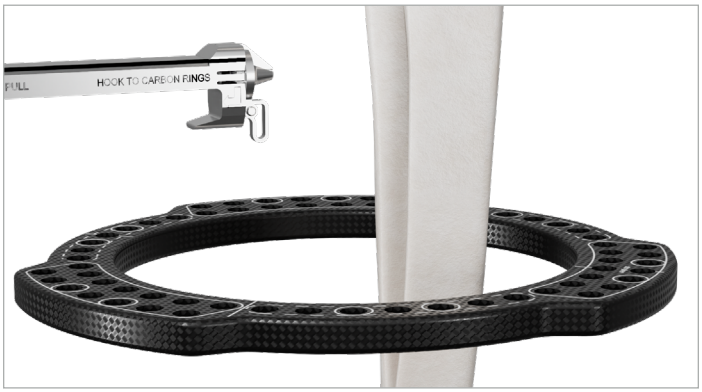


Figure 101



Figure 102

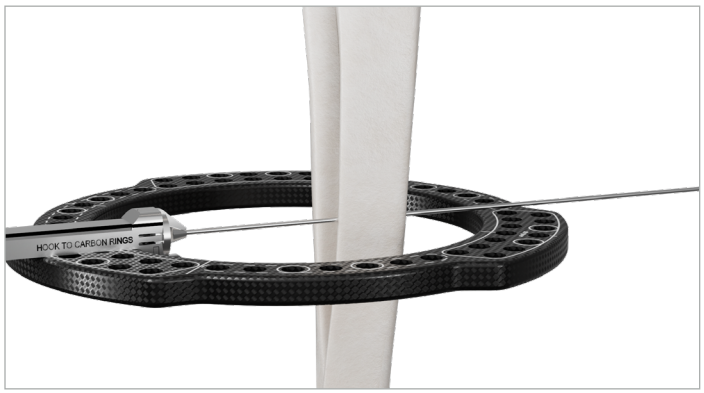


Figure 103



Figure 104

Hoffmann LRF - General information

Wire insertion technique: wire bolt

The following steps outline the recommended method of wire insertion using wire bolts:

1. Using a wire driver, insert the wire perpendicular to the long axis of the bone.
2. Advance the wire until it fully transects the limb.
3. The type of wire bolt used depends on the position of the wire in relation to the ring hole. If the wire is offset from the center of the ring hole, a slotted wire bolt may be used. If the wire is positioned at the center of the ring hole, a cannulated wire bolt may be used. **(Figure 105)**
4. Optional: use a wire bolt adapter to catch wires that are positioned obliquely or that are offset above or below the ring. **(Figure 106)**
5. When fine-tuning the position of fixation, ensure that there is adequate soft tissue clearance around the rings.

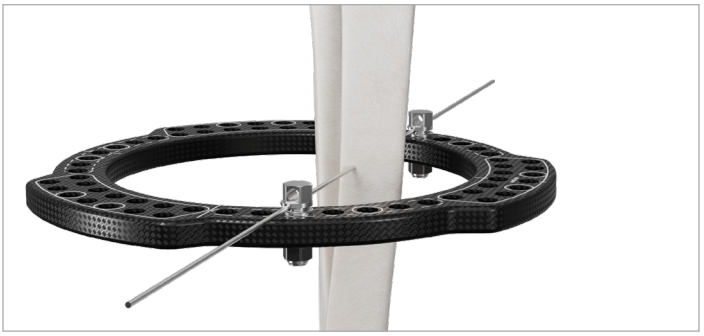


Figure 105

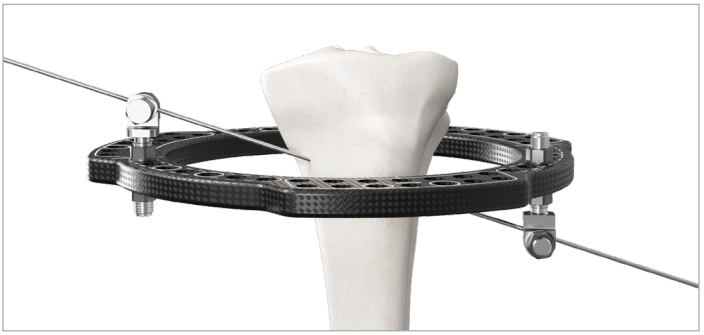


Figure 106

⚠CAUTION

Avoid bending the wires to reach fixation points on the ring, as this can increase the risk of wire breakage. Instead, use the additional system components like washers, adaptors, or wire posts to build up to the wire from the ring.

6. Catch the wire between the washer and the slot of the slotted wire bolt or in the center hole of the cannulated wire bolt, place it in the ring hole, and fasten it from the other side of the ring using an M8 connecting nut.
7. Tighten the M8 connecting nut using counter-torque instrumentation to restrict unwanted rotation of the wire bolt.
8. Catch the opposite end of the wire by placing another wire fixation component and hand-tighten it with an M8 connecting nut to the ring.
9. Tension the wire to the appropriate level using the wire tensioner.
10. Once the desired tension level is achieved, the M8 nut is fully tightened with an appropriate wrench. As a safety measure, break off or bend the excess wire.

NOTICE

Do not trim excess wire until tensioning is complete. If the tensioner does not grip the wire during tensioning, repeat the procedure: Check that the M8 nut on the opposite side of the wire is fully tightened. Turn black tensioner handle counterclockwise until the gold indicator is in the open padlock position. Slide the tensioner nose onto the K-wire. Proceed with clockwise turns until tensioned to the desired level.

NOTICE

Wire bolts and wire bolt adaptors are attached to rings using the M8 connecting nuts. The tall wire bolt adaptor is mounted onto the frame using two opposing M8 nuts.

NOTICE

Utilize counter-torque instrumentation to minimize wire bending during final tightening.

Hoffmann LRF - General information

Circular fixation with clickers

Clicker assemblies can be utilized to outfit a circular frame construct with dynamic struts. A stable frame construct utilizes four clickers. **(Figure 107)**

- To apply clickers, insert an appropriate length threaded rod into the threaded opening of the clicker cap. Spin the rod to advance it into the graduated tube. The open slot on the side of the tube provides visibility to the position of the threaded rod.

NOTICE

The clicker is designed with a positive "hard" stop so that the threaded rod cannot be advanced all the way through the tube.

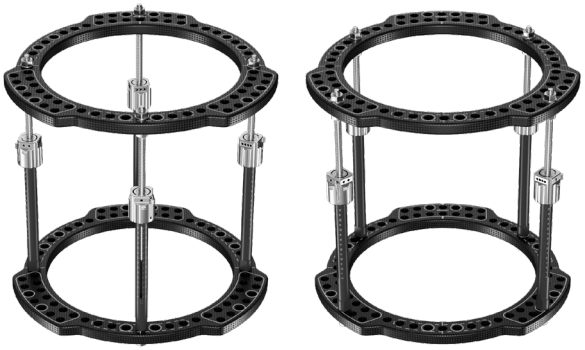


Figure 107

- If maximum distraction is required, the tip of the threaded rod should start at the 0mm mark at the end of the open slot. For maximum compression, the tip of the threaded rod should start at the maximum graduation measure at the other end of the open slot. **(Figure 109)**
- The threaded rod end is attached to the rings using an M6 connecting nut (4933-1-701). Orient the clickers so that the directional markings on the clicker cap are visible to the patient and the graduation scale faces externally. The clicker's tube end is attached to the rings using a hardware connection bolt. **(Figure 108)**

NOTICE

For the smallest clicker size (4938-0-060), use only the short hardware connection bolt (4938-1-300).

- Directional markings are located on the clicker cap **(Figure 108A)** and the base of the graduation scale.
  - To shorten the clicker, press the adjustment latch on the clicker cap to unlock and rotate it in the direction of the minus sign (-). If the clicker is oriented with the directional markings facing the patient, this should be counterclockwise.
  - To lengthen the clicker, press the latch to unlock and rotate it in the direction of the plus sign (+).
  - Once rotation begins, release the latch. As the rotation continues, the cap will turn ¼ of a rotation and click into place, adjusting the length by ¼mm (4 clicks = 1mm of adjustment).

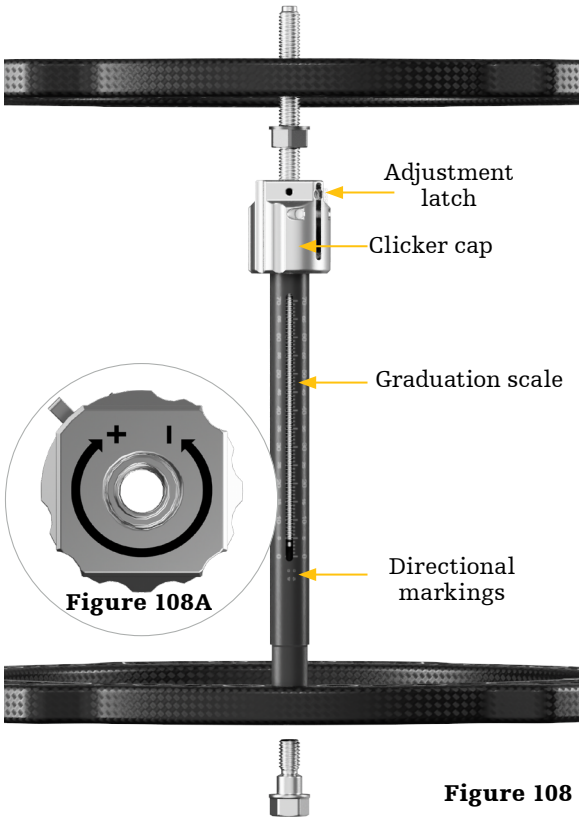


Figure 108A

Figure 108

NOTICE

It is recommended to adjust all clickers equally in sequence, turning each clicker one or two clicks at a time. Failure to do so may result in sticking or jamming of the graduation tube.

NOTICE

The threaded-rod end should remain within the safe zone, which is defined as the length of the graduated tube's open slot. **(Figure 109)**

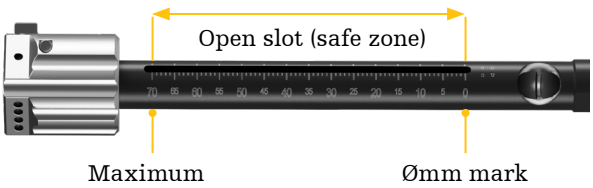
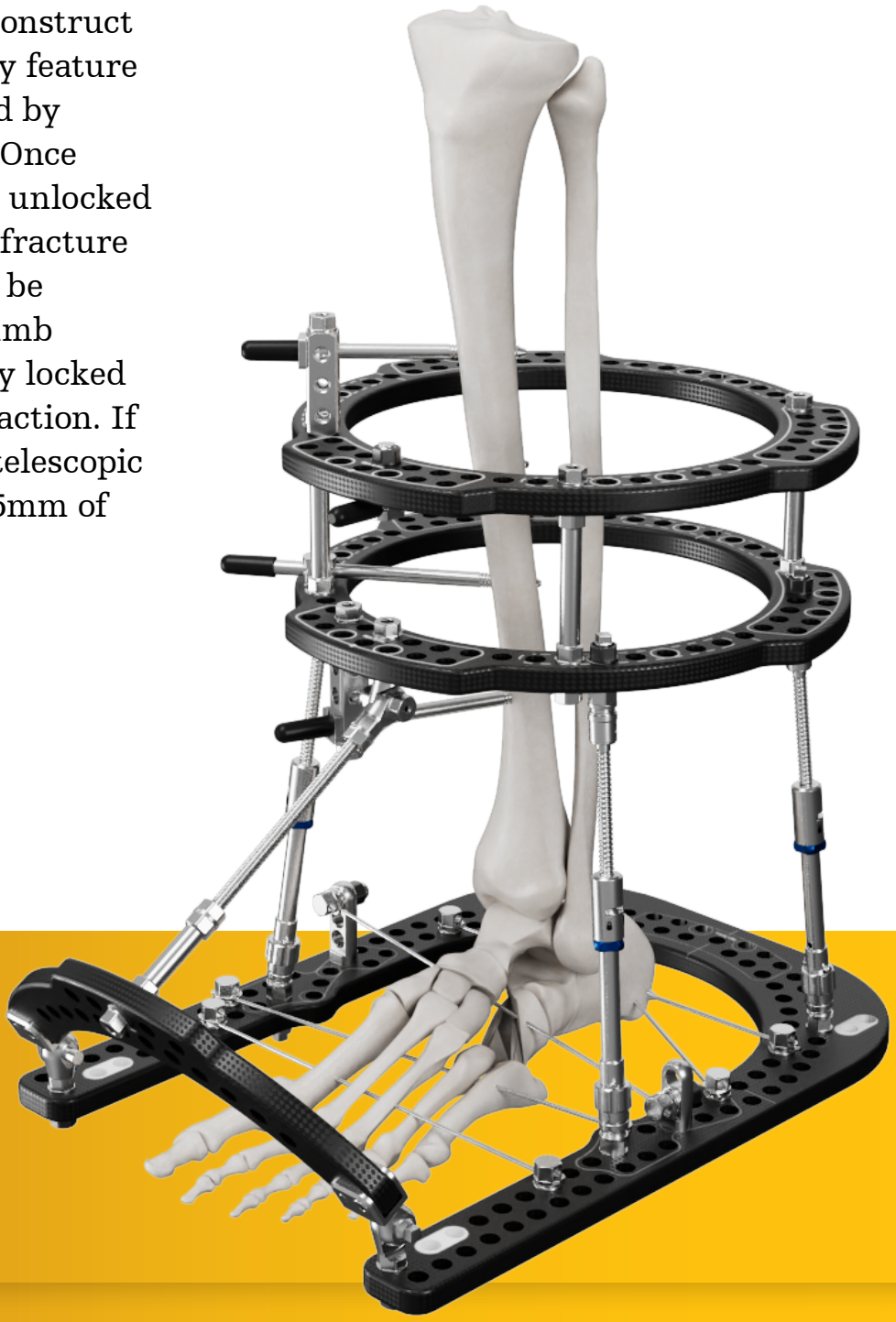


Figure 109

Hoffmann® LRF

Circular fixation with telescopic struts

A Hoffmann LRF frame construct with telescopic struts may feature two or more rings bridged by a minimum three struts. Once applied, the struts can be unlocked for gross adjustment and fracture reduction. The frame can be finely adjusted to aid in limb alignment and definitively locked to hold reduction or distraction. If deemed appropriate, the telescopic struts can provide up to 5mm of controlled dynamization.



Hoffmann LRF - Circular fixation with telescopic struts

Frame assembly methods

The user may either pre-build a construct or use the "rings first" approach when assembling a frame.

Rings first approach

Two rings are mounted to the bone independently utilizing wire or pin fixation. After mounting, the two rings are connected with appropriate length telescopic struts.

This approach may allow more options for wire and pin fixation because ring holes are not already occupied by the struts.

⚠CAUTION

If using a "rings first" application approach, spacing rings at a minimum ring-to-ring distance of 120mm is recommended.

NOTICE

The choice of fixation and placement is dictated by surgeon preference and the specific indications being treated. Patient positioning is dictated by indications and surgeon preference.

Steps

1. Insert the reference wire or pin: Using a reference wire or pin, the initial location and orientation of the reference ring is established. Be sure to insert the reference wire and attach rings as orthogonally as possible. **(Figure 110)**
2. Attach the proximal ring: The ring is attached with the master tab aligned with the anterior surface of the bone. **(Figure 113)** It is recommended that ring size should allow for approximately two finger breadths of space from the skin. Using an open ring may accommodate soft tissue and knee flexion.

NOTICE

Remember to mount the proximal ring first especially when using the closed rings.

NOTICE

When the frame is assembled around severe rotational deformities, ensure that struts do not impinge on soft tissues. Larger ring diameters can be considered to increase the clearance between the struts and the soft tissue.



Figure 110

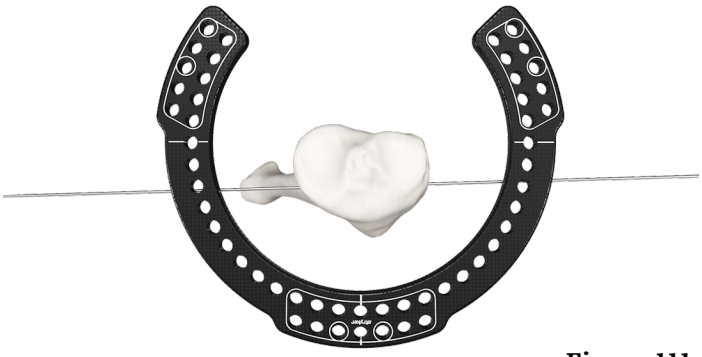


Figure 111



Figure 112

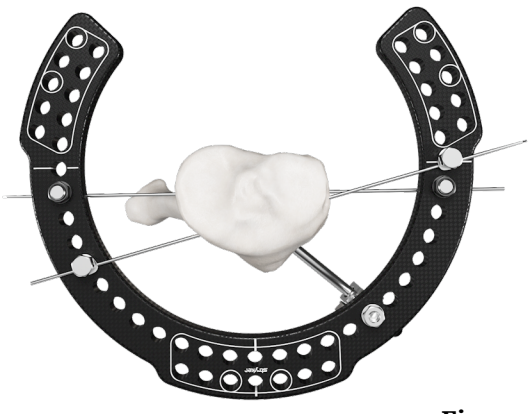


Figure 113

Hoffmann LRF - Circular fixation with telescopic struts

3. Using fixation components, fix the reference wire or pin to the ring. When applying fixation, take note of nominal strut attachment sites and avoid placing fixation there if possible.
4. When more than one point of fixation is secured to a ring, the ring orientation is provisionally fixed.
5. Mount the distal ring: Before inserting fixation for the distal ring, check that ring spacing can accommodate the minimum strut length in the location where the two rings are closest together. **(Figure 114)**
6. Attach the struts: To minimize fixation component interference when attaching struts, it may be preferred to attach the struts to the ring before applying all points of fixation.
7. Additional fixation: When the struts are in place, additional points of fixation can be strategically applied to avoid interference with strut attachment. If needed, hole offsetting can be used to accommodate points of fixation adjacent to strut attachment sites.



Figure 114

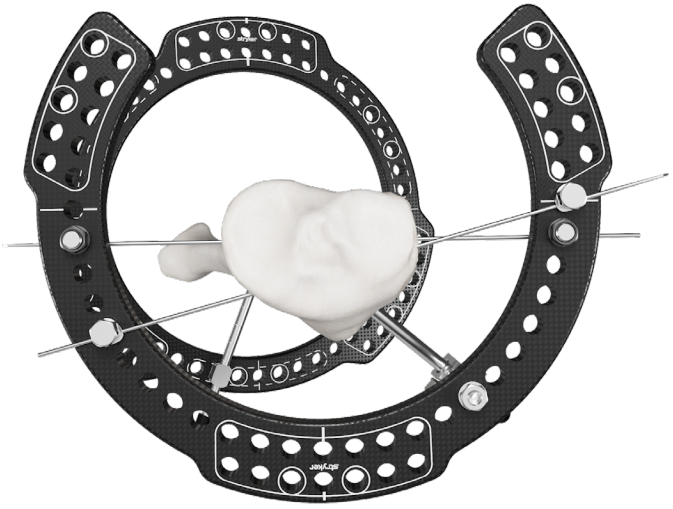


Figure 115

Hoffmann LRF - Circular fixation with telescopic struts

Pre-built frame approach

In this alternative approach, the rings and telescopic struts may be pre-assembled and applied to the patient as a construct.

NOTICE

When using the pre-built frame approach, it may be necessary to relocate the struts to accommodate for half pin or wire fixation during surgery.

If a pin or wire fixation lands over a hole that is occupied by a telescopic strut, the strut may be relocated to an open adjacent hole.

- Unlock the ball joints and quick-release mechanism.
- Detach the end of the strut due for relocation by removing the M8 connecting nut.
- Compress the strut until it safely clears the current hole and reinsert the free end into an available adjacent hole, as strut angulation allows.

Construct stability

Regardless of which frame assembly method is used, assess the construct's stability and add additional ring levels and points of fixation if necessary.

⚠WARNING

In certain instances, supplemental fixation points should be considered (i.e. obese patients or patients that are ambulatory in the early post operative phase).

NOTICE

Guidance for sterilization of a pre-built frame construct can be found in **Appendix A: Pre-built frame sterilization guidelines**.

Hoffmann LRF - Circular fixation with telescopic struts

Fracture reduction with telescopic struts

Once mounted, a Hoffmann LRF frame construct can be unlocked and used as a fracture-reduction tool. When proper gross alignment is achieved, it may be followed by fine-tuning and final locking. In addition to the quick-release mechanisms, all ball joints must be unlocked to achieve a full range of motion.



Before



After



Figure 116

Hoffmann LRF - Circular fixation with telescopic struts

Gross length adjustment

The length of the telescopic strut can be adjusted to fit between 2 rings. Gross length adjustment may also be useful during fracture reduction.

Steps

1. Unlock the ball joints at both ends of strut by utilizing a 5mm wrench (4933-9-205) or driver (4940-9-030).
2. Unlock the safety wheel by turning it counterclockwise **(Figure 117A),** taking care not to fully disengage the wheel—doing so will cause the internal spring to release. If this happens, it can be repositioned.
3. Unlock the quick-release mechanism by pushing down and rotating the pin into the unlocked position (indicated by an open padlock icon). **(Figure 117B)**
4. When unlocked, the strut can be compressed or distracted along the internal threaded rod.
5. Once the desired length is achieved, lock the quick-release mechanism by pushing down and rotating the pin into the locked position, indicated by a closed padlock icon. **(Figure 117C)** The safety wheel may then be retightened by turning it clockwise.
6. The ball joints at both ends of strut are then locked using the 5mm square wrench or driver. **(Figure 118)**

NOTICE

In addition to unlocking the quick-release mechanisms, unlocking the ball joints may ease gross length adjustment.

⚠CAUTION

The flat surfaces on the quick-release mechanism are for finger-grip adjustments only. Using a wrench directly on the quick-release mechanism may damage the strut.



Figure 117



Figure 117A



Figure 117B



Figure 117C



Figure 118

Hoffmann LRF - Circular fixation with telescopic struts

Fine-tuning length adjustment

The length of the telescopic struts also can be fine-tuned once the frame is assembled. This feature allows the clinician to compress or distract the construct at any time during the course of treatment.

Steps

1. Lock the quick-release mechanism by pushing down and rotating the pin into the locked position (indicated by a closed padlock icon).
2. Tighten the ball joint on the threaded end of strut.
3. Loosen the ball joint at tube end of strut.
4. The telescopic strut wrench (4933-9-207) can be used to rotate the strut. The hooks of the narrow end of the wrench fit onto the pins directly above the dynamization wheel. **(Figure 119)** Each full turn of the strut distracts or compresses by 2mm.
5. When desired adjustment is achieved, re-tighten the ball joint at the tube end of the strut.

CAUTION

Loosen the square drive just until you feel the resistance decrease. Don't loosen it too much, as this could damage or take apart the strut.

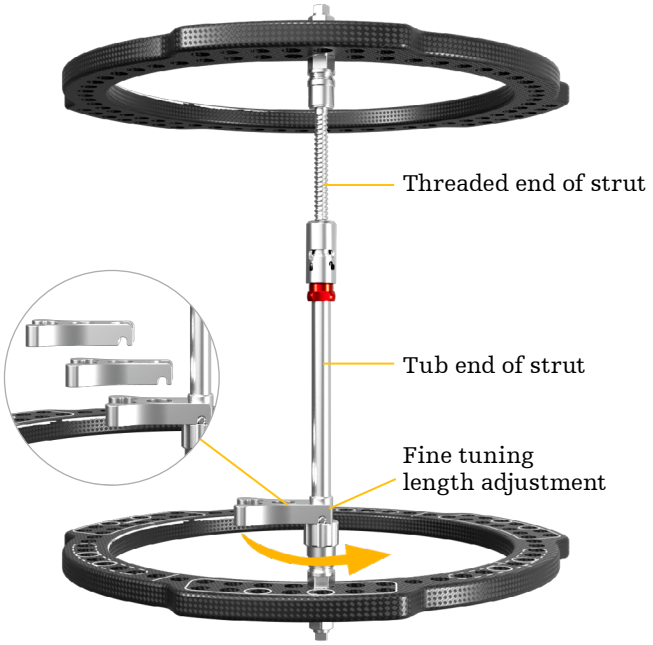


Figure 119

Hoffmann LRF - Circular fixation with telescopic struts

Telescopic strut dynamization

Dynamization may be initiated post-operatively during early stages of bone healing and after early callus formation as assessed radiographically. Struts can be gradually dynamized as determined by the clinician.

The dynamization wheel can be opened, adjusted and locked utilizing the wide end of the telescopic strut wrench (4933-9-207). **(Figure 120)** Each groove on the strut corresponds to 1mm of dynamization, up to 5mm total.

While using dynamization, patients should exercise extra caution when engaging in strenuous physical activity.

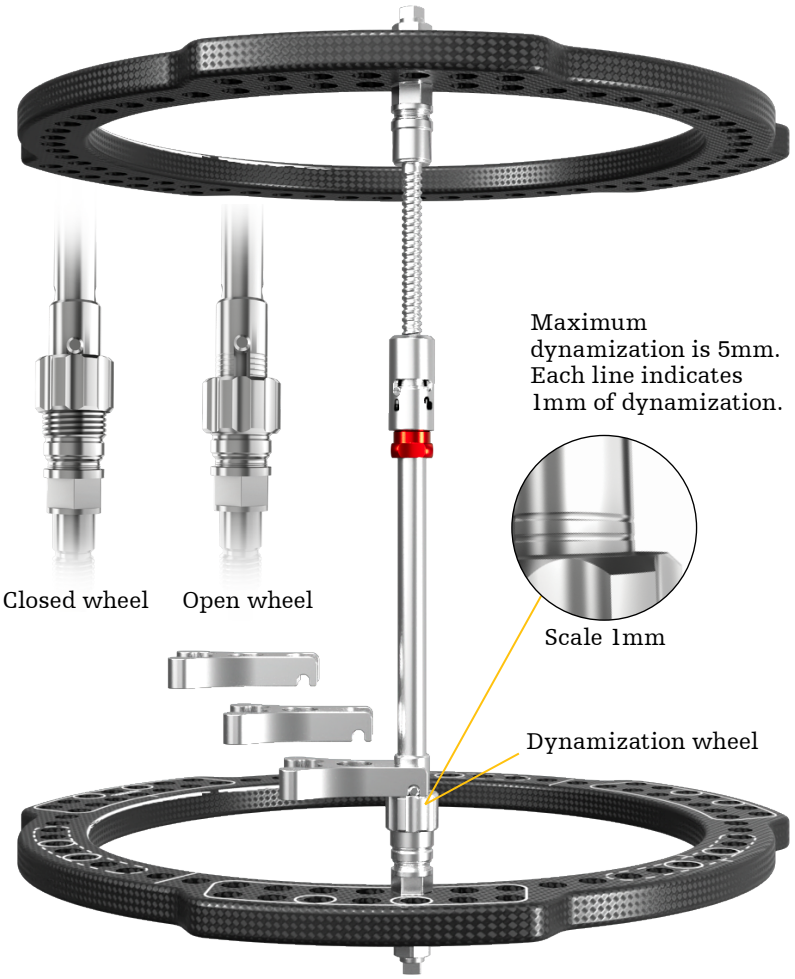
Telescopic strut removal

During the course of treatment, it may be necessary to remove or exchange a telescopic strut. To remove a strut without compromising the frame construct, there must be adequate length remaining to safely compress the strut so that the male end can clear the ring hole.

A black laser line on the threaded rod portion of the telescopic strut **(Figure 121)** indicates the compression limit for the strut so that it may be safely removed from a fixed frame construct.

NOTICE

A strut should be exchanged before the compression limit (indicated by the laser marking) is crossed.



Use open end on telescopic strut wrench (4933-9-207) on wheel (not on pin) to adjust dynamization

Figure 120

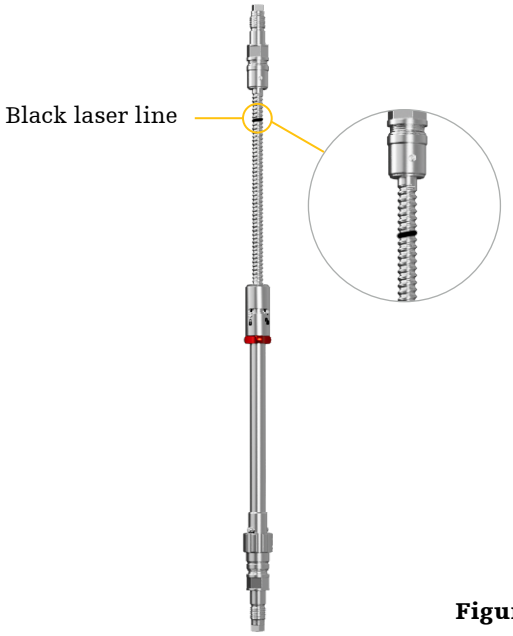


Figure 121

Hoffmann LRF - Circular fixation with telescopic struts

Telescopic strut frame construct example

Static foot and ankle frame (Figure 122)

It is recommended to insert a minimum of three points of pin or wire fixation per circular ring and a minimum of four points of wire fixation per foot ring. If only wires are used on a circular ring block, then four wires are recommended. A minimum of four struts is recommended for a foot and ankle frame application.

⚠ WARNING

To ensure sufficient construct stability, it is recommended that the tibial ring and foot arch are reinforced with supplemental fixation. For example: a distal tibial ring and foot arch bridged with hinged couplings and threaded rod. **(Figure 122)**

⚠ WARNING

In certain circumstances, supplemental fixation should be considered (i.e. obese patients or patients that are ambulatory in the early postoperative phase). Construct design and weight bearing protocols are always at the surgeon's discretion.

⚠ CAUTION

Confirm all nuts and connections are tightened upon completion of frame.

Confirm all quick-release mechanisms and ball joints on struts are in the locked position.

⚠ CAUTION

The wires should be curled or trimmed short to prevent soft tissue injury.



Figure 122

Hoffmann® LRF

Gradual correction

The Hoffmann LRF Gradual Correction Tray introduces telescopic hinge struts and telescopic motor struts that are designed for procedures requiring gradual corrective adjustments.







Hoffmann LRF - Gradual correction

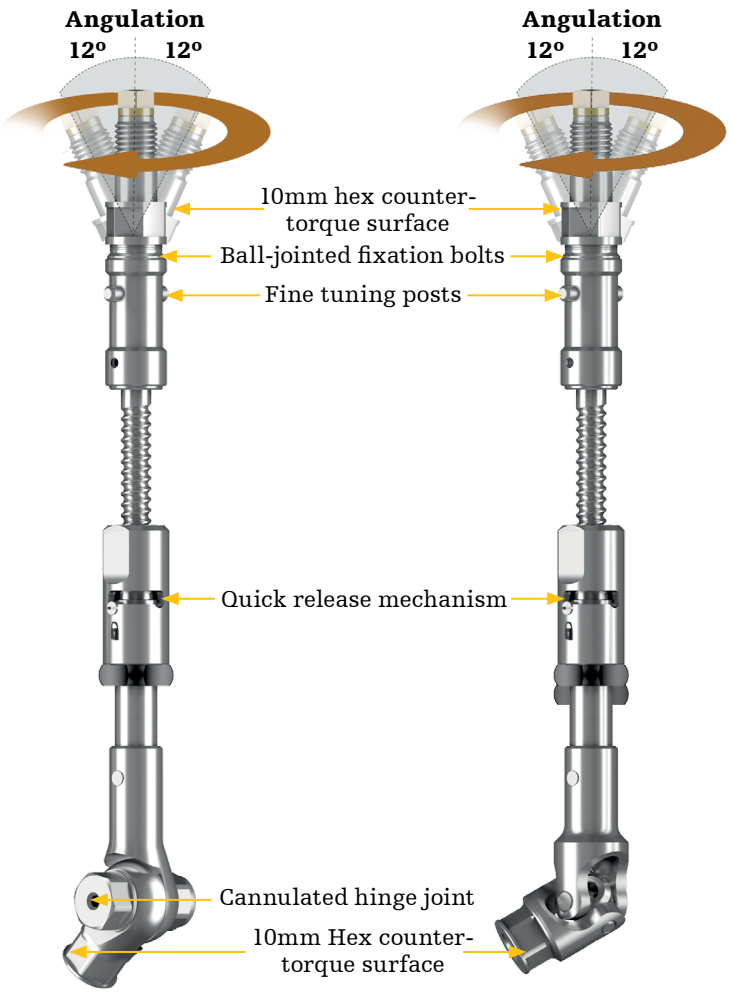
Hinged telescopic struts

The hinged telescopic struts are designed to align and pivot around a specified axis of rotation. This is accomplished via universal hinged couplings integrated into the telescopic strut's design. **(Figure 123)**

- A quick-release mechanism allows for rapid gross length adjustment
- Ball-jointed fixation bolts allow the struts to be mounted to rings that are not parallel or of different diameters
- The length of the strut can be fine-tuned by rotating the quick-release mechanism (in a locked position) relative to the threaded portion of the strut (one full revolution represents 2mm of travel). Alternatively fine tuning can also be achieved by turning the fine tuning posts with a wrench with respect to the quick release mechanism.
- Adjustable from 125-150mm in length ring-to-ring

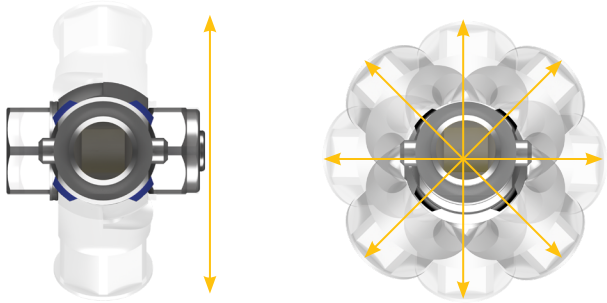
NOTICE

To avoid inadvertent disassembly of the quick-release mechanism, do not loosen the colored safety nut beyond the etched line. If the colored safety nut is accidentally loosened beyond the etched line and the mechanism disassembles, simply push the colored safety nut and spring back into the quick-release body and re-tighten the nut with clockwise turns until the assembly reengages. **(Figure 125)**



Hinged telescopic strut constrained **Hinged telescopic strut unconstrained**

Figure 123



Lockable, uniplanar range of motion **Polyaxial range of motion**

Figure 124



Figure 125

Hoffmann LRF - Gradual correction

Fine-tuning length adjustment with hinged telescopic struts

When struts are attached to only one ring: The length of the hinged telescopic struts can be fine-tuned during frame assembly. This sequence is important when aligning the hinged end of the strut with the specified axis of rotation. **(Figure 126)**

NOTICE

When making angular adjustments to the ball joint, only loosen the square drive enough to reduce resistance. Over-loosening the square drive may disassemble and / or damage the strut.

Before making any ball joint adjustments, ensure that the ball joint end of the strut is securely attached to the ring with connecting nut.

1. Lock the quick-release mechanism by aligning the pin in the locked padlock position.
2. Tighten the ball joint at the threaded end of the strut.
3. Rotate the hinged end of the strut around the threaded portion of the strut to adjust length.
4. Close the colored safety wheel once the desired distance between rings is achieved.

One full revolution of the strut is equivalent to 2mm of compression or distraction.

⚠CAUTION

The flat areas on the quick-release mechanism are for finger-adjustment only. **(Figure 127)** Attempting to rotate the mechanism with a wrench or pliers may damage the strut.

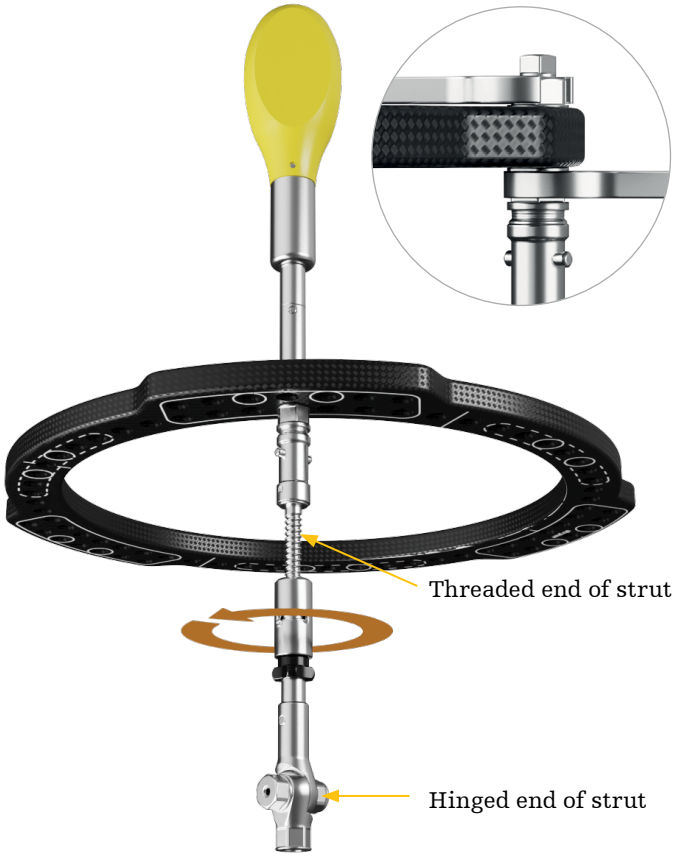


Figure 126



Figure 127

Hoffmann LRF - Gradual correction

When struts are attached between two rings:

If the hinged end of the strut is already attached to a ring, the length of the strut can be finely adjusted by rotating the ball-jointed end of the strut.

Before making any length adjustments, ensure that both ends of the strut are securely attached to the rings.

NOTICE

Only loosen the square drive enough to reduce resistance. Over-loosening the square drive may disassemble and/or damage the strut.

1. After securing the hinged end of the strut to the ring, lock the quick-release by loosening the safety wheel and aligning the pin in the locked padlock position.
2. After securing the threaded end of the strut to the ring, unlock the ball joint.
3. The "clawed" end of the telescopic strut wrench (4933-9-207) can be used to rotate the threaded end of the strut within the barrel end of the strut.
4. Once proper strut length (frame height) is achieved, the ball joint on the threaded end of the strut is securely locked.
5. Close the colored safety wheel once desired frame height is achieved.

⚠ CAUTION

The flat surfaces on all quick-release mechanisms are for finger-adjustment only. Attempting to rotate the mechanism with a wrench or pliers may damage the strut. Take caution not to unintentionally over distract or compress the frame and anatomy if both rings are fixed to the bone.

One full revolution of the strut represents 2mm of compression or distraction.



Figure 128

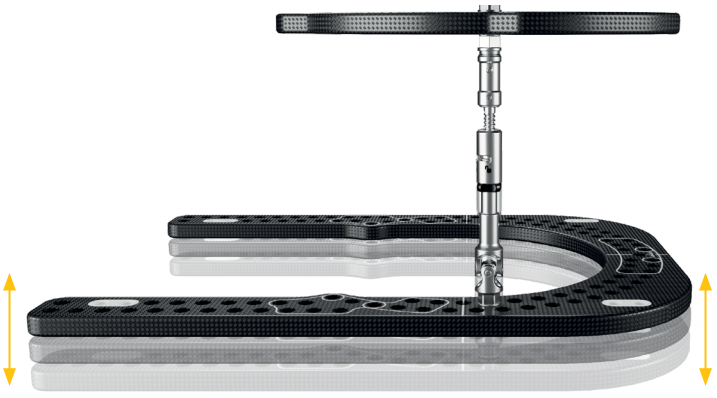


Figure 129

Hoffmann LRF - Gradual correction

Telescopic motor struts

Telescopic motor struts are used to drive angular motion around the frame's axis of rotation in a controlled, gradual fashion. The motors are designed with a threaded attachment post to outfit either a constrained or universal hinge coupling. Telescopic motors can be mounted in an anterior or posterior frame location as per the indication and surgeon preference.

Table 12: Strut sizes (including hinge coupling)

Size	Length (mm)	Travel (mm)
Extra short	142-167	25
Short	161-195	34
Medium	187-247	60
Long	239-351	112

- The quick-release mechanism is designed to allow for rapid telescopic length adjustment.
- The clicking mechanism offers visual, audible, and tactile confirmation of an adjustment. Each "click" represents 1/4mm of travel.
- Dimple markers on the clicking mechanism are designed to allow the patient to keep track of daily adjustments
- Easy to read adjustment scale
- The constrained hinge coupling is lockable and designed to limit frame angulation to a single plane when range of motion control is desired.
- The universal hinge coupling is designed to permit angulation in multiple planes when additional construct range of motion is desired.

⚠ CAUTION

The flat surfaces on all quick-release mechanisms are for finger-adjustment only. Attempting to rotate the mechanism with a wrench or pliers may damage the strut. To maintain intended performance, hinged telescopic struts and motors should not be re-sterilized beyond 100 autoclave cycles.

⚠ CAUTION

To avoid inadvertent disassembly of the quick-release mechanism, do not loosen the colored safety nut beyond the etched line. If the colored safety nut is accidentally loosened beyond the etched line and the mechanism disassembles, simply push the colored safety nut and spring back into the quick-release body and re-tighten the nut with clockwise turns until the assembly reengages.

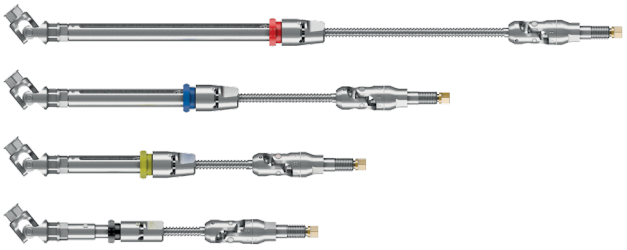


Figure 130

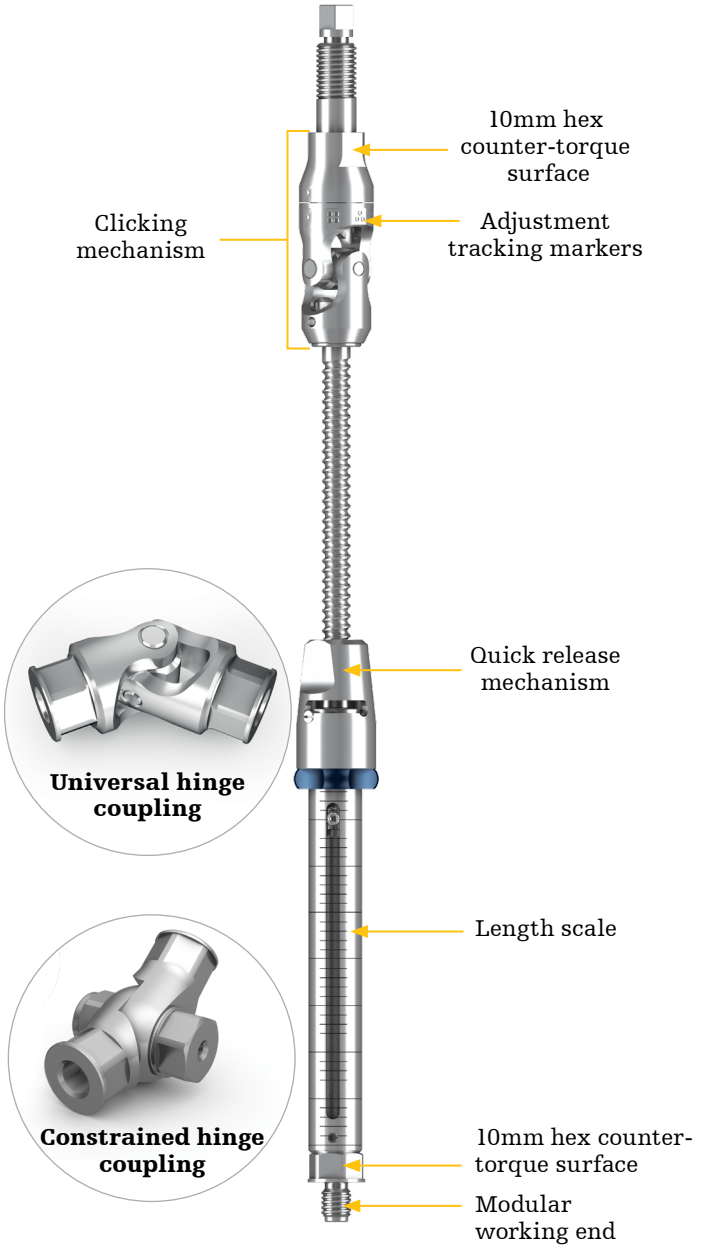


Figure 131

Hoffmann LRF - Gradual correction

Technique for equinus foot correction using gradual correction struts

Several techniques exist for equinus foot correction. All techniques require distraction of the ankle to protect the articular surface between the tibia and talus during correction. Gradual correction techniques require a stable ankle. It is important to note that pin and wire placement will vary by indication and surgeon preference. The steps below detail the recommended procedures for using the gradual correction components within the Hoffmann LRF system.

Two (2) approaches for hinge placement are discussed: the tibial ring-block-first approach (Method A) and the guide-wire-first approach (Method B). Hinges are aligned along the joint line of the ankle (Inman's axis). Constructs with an anterior motor are referred to as "pull" constructs; **(Figure 132)** constructs with a posterior motor are referred to as "push" constructs. **(Figure 133)**

CAUTION

Due to the length limitations of the telescopic hinges, the guide-wire-first approach may be advantageous in certain cases because placement of the hinges is not dictated by the distance of the ring block in relation to the ankle joint. Rather, the approximate location of the ring block is dictated by the length of the hinges. In either approach, it is important to leave at least 10mm of travel in the hinged telescopic struts to accomplish the final distraction. Do not mount the ring block at a distance that fully extends the length of the strut.

"Pull" construct



Figure 132

"Push" construct



Figure 133

Hoffmann LRF - Gradual correction

Method A:

Tibial ring-block-first approach

1. Prebuild a two-ring tibial block with four threaded rods or 60mm static struts. The lower tibial ring is placed 110-120mm above the level of the ankle joint. **(Figure 134)**
2. The first olive wire is an axial wire placed lateral to medial on the distal ring, 110-120mm above the level of the ankle joint. This wire will be placed on the bottom of the ring. **(Figure 135)** There must be at least 2-3cm of space between the ring and skin and the tibia is centered from medial to lateral.
3. A C-Arm is used to ensure that the olive is flush with the bone, and the wire is tensioned.

   The two-ring construct can now be rotated around this wire to align the rings to the tibia (lateral view). The line of reference is the posterior cortex of the tibia.

   The second olive wire is an axial wire placed medial to lateral at the level of the proximal ring. The wire is placed on the top surface of the proximal ring. **(Figure 136)**

   A C-Arm visualizes the olive flush with the bone, and the wire is tensioned. These first two wires lock the two-ring tibial construct.
   The construct should now be assessed for position. The construct should be at right angles to the tibia (AP and lateral view).

Following Step 3, if the remaining connections are to be half pins, the tension on the two wires is loosened and the wires are simultaneously re-tensioned. **(Figure 137)** Alternately, two half pins can be placed above and below each ring.

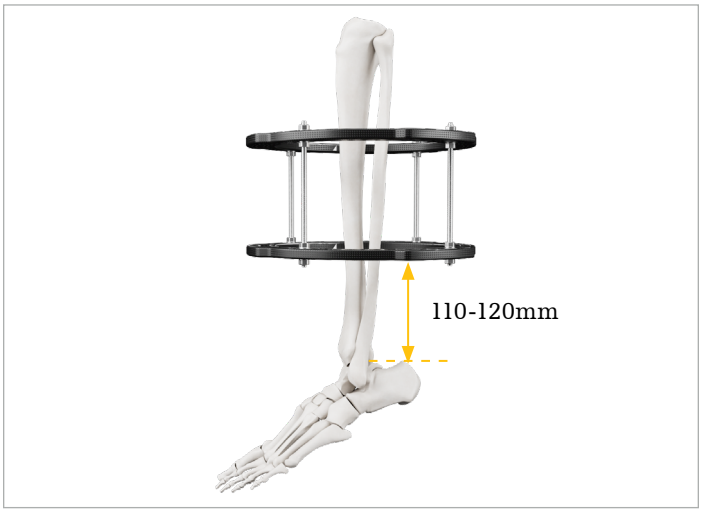


Figure 134



Figure 135



Figure 136

Hoffmann LRF - Gradual correction

NOTICE

The following steps provide instructions on how to apply the frame using K-wires as the primary mode of fixation.

4. The third olive wire is a medial-face wire placed on the bottom side of the proximal ring. This wire starts just lateral to the crest of the tibia and exits the tibia just in front of the posterior border on the medial side of the tibia. **(Figure 138)** The first wire is de-tensioned, and both wires are re-tensioned simultaneously.
5. The fourth wire (smooth) is a fibular wire placed on the top of the distal ring from lateral to medial. This wire should exit through the fibula or just in front of the fibula. **(Figure139)** The first distal tibial ring wire is de-tensioned, and both wires are re-tensioned simultaneously.
6. The stability of the tibial construct is assessed, and additional connections are added as necessary. As currently constructed, the tibial block is stable in medial-lateral bending but may be unstable in anterior-posterior bending. Since equinus is a sagittal plane deformity, the construct must be stable in that plane to prevent deformation of the rings. A-P stiffness is accomplished by placing an A-P Apex-pin on either side of the distal ring, proximal ring or both. The use of A-P half pins will provide maximum rigidity in the sagittal plane. **(Figure 140)**

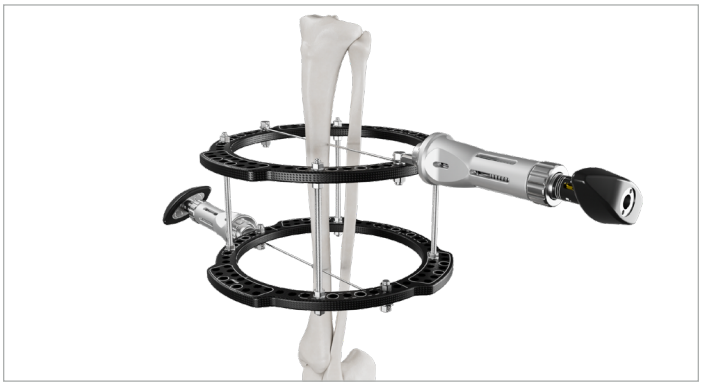


Figure 137



Figure 138



Figure 139



Figure 140

Hoffmann LRF - Gradual correction

7. Starting on the lateral side of the ankle, attach the ball-jointed end of the strut to the distal tibial ring.

   If necessary, the ball joints can be unlocked to accommodate for non-orthogonal orientation of the tibial ring block. Once satisfactory strut trajectory is achieved, lock the ball joint to maintain intended positioning.

   Unlock the quick-release mechanisms to grossly adjust the strut length so that the hinge aligns exactly with the tip of the lateral malleolus. A similar hinge assembly is attached to the medial side, with the medial hinge's pivot point aligned approximately 1cm distal to the tip of the medial malleolus. Once proper alignment is achieved, all hinges, ball joints, and quick-release mechanisms are verified locked to maintain desired positioning.

⚠CAUTION

At full extension, hinged telescopic struts can span rings that are a maximum 150mm apart (including 10mm needed for final distraction). If the distance between the foot ring and distal tibial ring exceeds 140mm, threaded rods with hinge couplings can be used as an alternative.

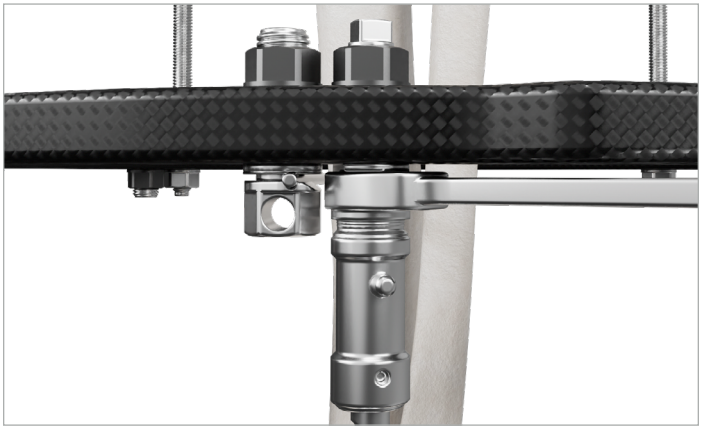


Figure 141

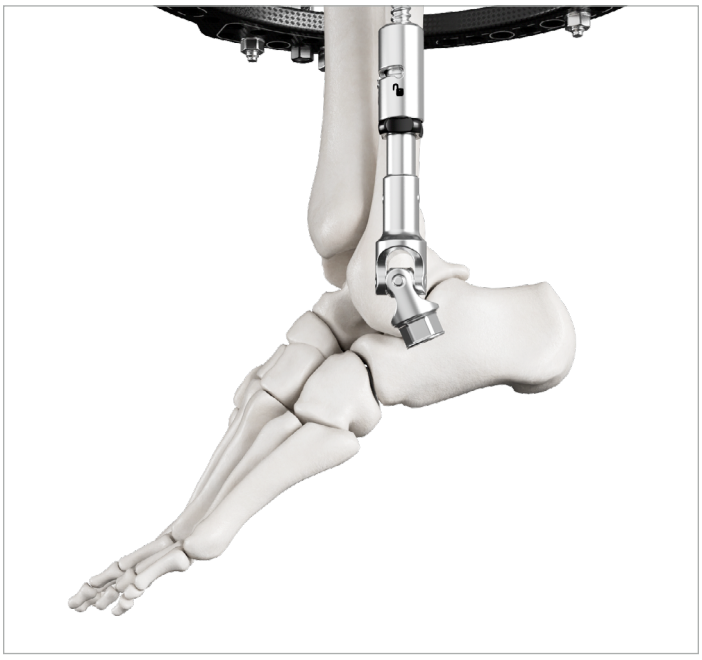


Figure 142

Hoffmann LRF - Gradual correction

Method B:

Guide-wire-first approach

NOTICE

Due to the length limitations of the hinged telescopic struts, the guide wire first approach may be advantageous because placement of the hinges is not dictated by the distance of the ring block in relation to the ankle joint.

Rather, the approximate location of the ring block is dictated by the length of the hinges. In either approach, it is important to leave at least 5-10mm of travel in the hinged telescopic struts to accomplish the final distraction.

1. Do not mount the ring block at a distance that fully extends the length of the strut. A guide wire is used to define the axis of rotation of the ankle joint. If using a closed ring or ring block, slide the rings onto the leg first. With fluoroscopic assistance, insert a smooth wire through the talus from approximately 1cm distal to the tip of the medial malleolus aiming toward the tip of the lateral malleolus. The starting position is anterior-medial. Aim your wire in a slightly posterior-lateral direction.
2. Slide the tibial ring or ring block onto the leg. Using the guide wire as a reference point for the hinges, attach the ball-jointed end of the struts to the distal tibial ring. To avoid interference with the hinges, the targeting wire can be cut short on either side so that the tip of the wire aligns with the hinge's pivot point. Once struts are attached, make side-specific adjustments to the length of each strut to accommodate non-orthogonal placement of the tibial ring/ring block if necessary. The total travel possible of the Strut is 25mm. Before fixating the tibial ring/ring block, ensure that each strut is compressed with at least 10mm of length left to accomplish the final distraction.
3. Insert the first olive wire as described in Method A, Step 2 and attach the ring or ring block with fixation of choice following Method A, Steps 3-6.

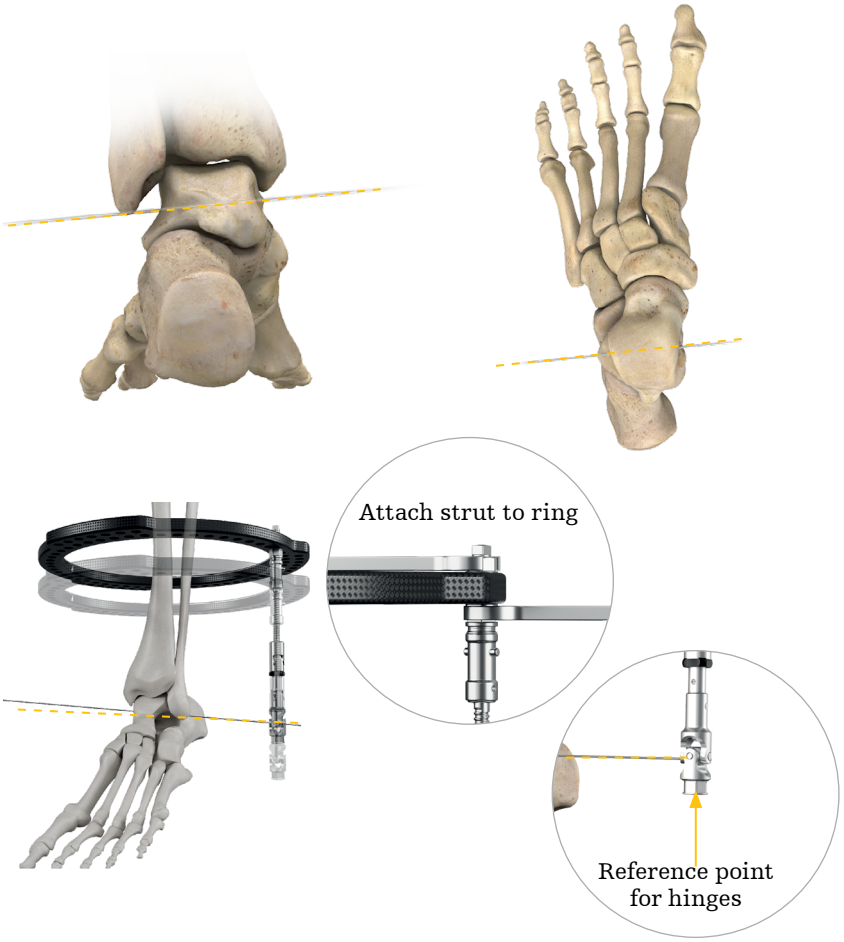


Figure 143

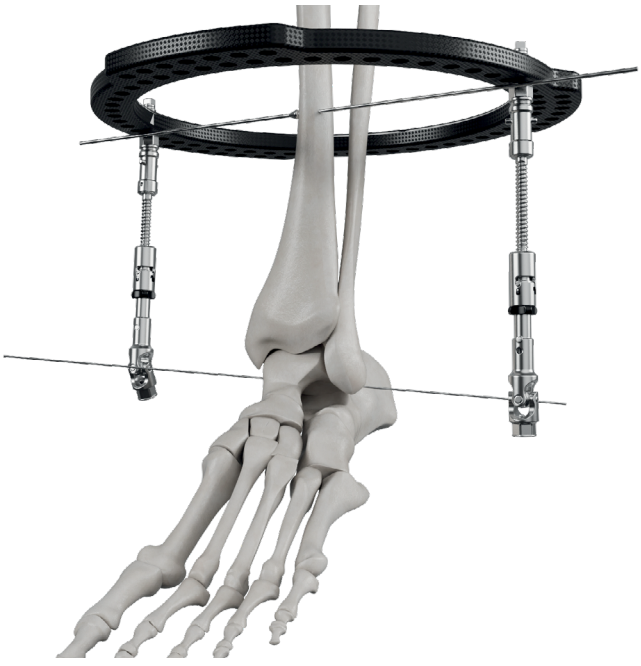


Figure 144

Hoffmann LRF - Gradual correction

Attaching the foot ring

1. The foot ring is attached to the hinged end of the strut using ring connection bolts or short hardware connection bolts. Hardware connection bolts come in two lengths and can be used with washers to accommodate the height offset of the hinge in relation to the foot ring. **(Figure 145)**

NOTICE

Utilize the hinge's counter-torque surfaces to prevent unwanted rotation of the hinge during final tightening of the connection bolts.

NOTICE

Make sure to check the hinges' range of motion by plantar and dorsiflexing the foot ring. Checking for smooth motion of the foot ring will verify that the hinges have not rotated during final tightening.

The long hardware connection bolt (4938-1-310) with washers can span a 16mm gap between the foot ring and the hinge attachment sites. If the distance between these connections exceeds this length, short threaded rods and M6 connecting nuts can be used to connect the hinges to the foot ring.

A similar hinge assembly is attached to the medial side. Once proper alignment is achieved, all hinges, ball joints, and quick-release mechanisms are verified as locked to maintain desired positioning.

⚠CAUTION

Placing the hinges too far posteriorly may result in the impingement of articular cartilage, even after distraction.

NOTICE

To allow for easy application, the foot arch should be securely mounted to the foot ring before any wires are tensioned. Attaching the foot arch a few holes back from the open end of the foot ring may help maintain a more vertical orientation of an anteriorly placed motor. **(Figure 148)**



Figure 145

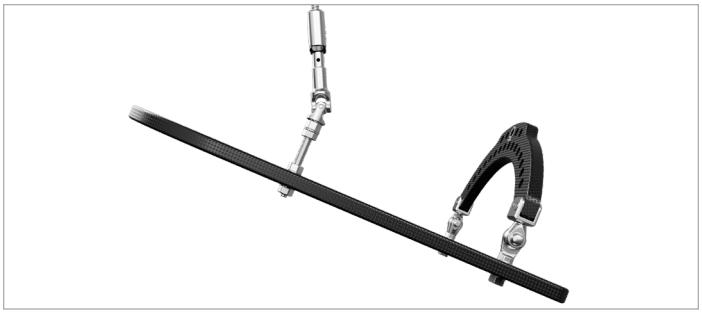


Figure 146

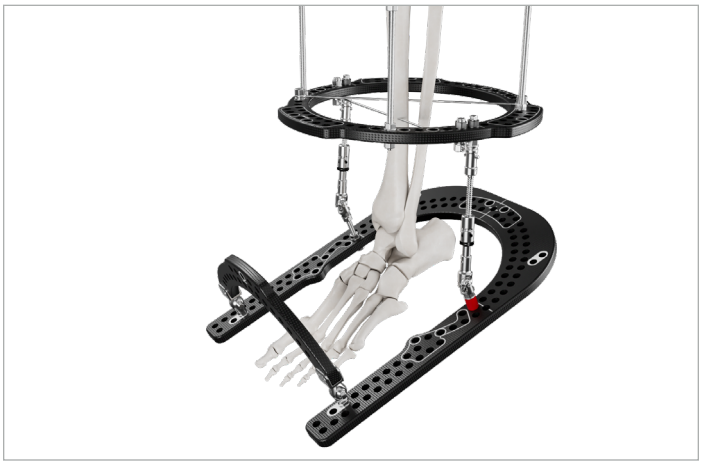


Figure 147



Figure 148

Hoffmann LRF - Gradual correction

Foot ring wire fixation

1. The first foot wire is an olive wire placed lateral to medial through the calcaneal tuberosity. This wire is placed on the top of the foot ring and is tensioned. Care must be taken to avoid the neurovascular structures on the medial side of the calcaneus. In some cases, a more direct lateral to medial wire trajectory may help keep the wire in the “safe zone”.
2. The second foot wire is an olive wire placed medial to lateral at the level of the metatarsal bases. This wire may be placed more distally to increase the lever arm for equinus correction. The wire is tensioned, and the foot should now be centered in the foot ring.
3. Minding the calcaneal safe zones, the third foot wire is a smooth wire placed above the foot ring and enters just in front of the Achilles tendon. Wire is aimed from posterior-medial to anterior-lateral. The first calcaneal wire is de-tensioned, and both wires are re-tensioned simultaneously.



Figure 149



Figure 150



Figure 151

Hoffmann LRF - Gradual correction

4. The fourth foot wire is a lateral-to-medial olive wire at the level of the metatarsal bases. Placement above or below the foot ring is dictated by local anatomy. The first forefoot wire is de-tensioned, and both wires are re-tensioned simultaneously.
5. With the hinges aligned and wire fixation in place, the construct may be assessed to verify unobstructed dorsiflexion and plantarflexion.

NOTICE

An additional wire may be placed in the talus to help prevent distraction though the subtalar joint.

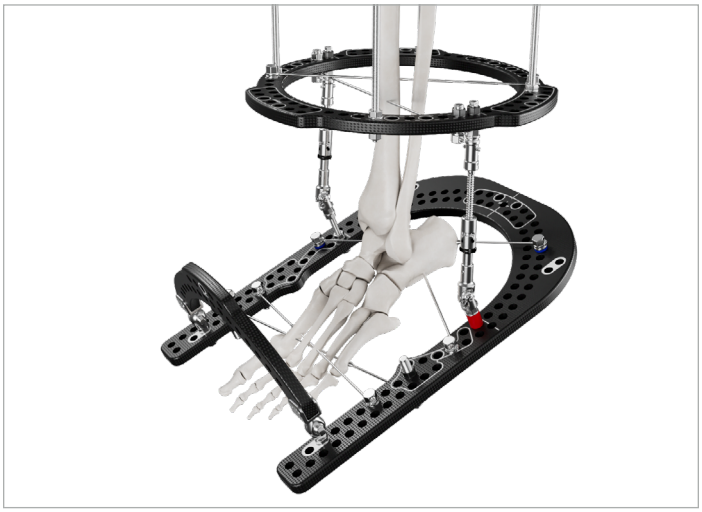


Figure 152



Figure 153



Figure 154

Hoffmann LRF - Gradual correction

Using a threaded rod assembly as an alternative construct

A hinge attached to the end of a threaded rod can be used as an alternative to the hinged telescopic strut. Distraction can be accomplished by incrementally loosening and tightening the nuts below and above the tibial ring until the desired amount of distraction is achieved. **(Figure 157)** Hinge placement methods and notes should be followed as outlined in previous sections of this guide.

NOTICE

Reinforce the universal hinge coupling with M6 connecting nuts to help prevent connections from loosening throughout the course of treatment.

⚠CAUTION

Make sure to select a long enough threaded rod to allow for 10mm of distraction.

NOTICE

One full revolution of the M6 connecting nut equates to one millimeter of distraction.



Figure 155

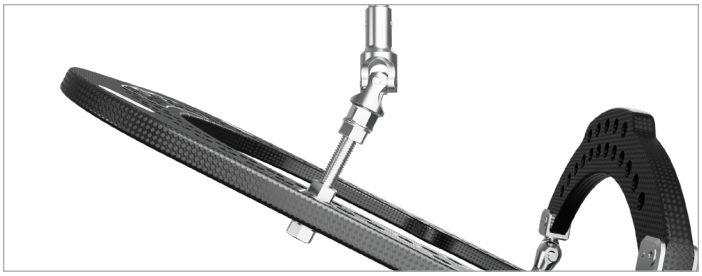


Figure 156

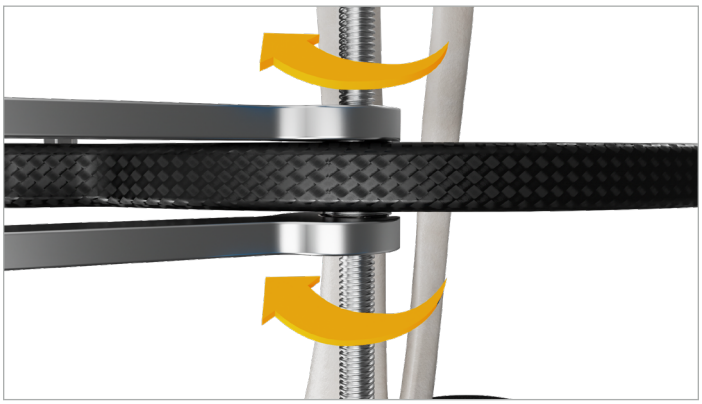


Figure 157



Figure 158

Hoffmann LRF - Gradual correction

Telescopic motor strut attachment

The telescopic motor struts can be applied posteriorly (push construct) or anteriorly (pull construct) based on the degree of angulation and surgeon preference. Once the mounting approach is confirmed, the distance between strut attachment sites is measured and the appropriate length strut is selected. Based on the indication, the universal or constrained hinge coupling is securely tightened to the end of the strut. At the surgeon's discretion, the equinus deformity may be overcorrected by 10° if indicated. This overcorrection should be considered when selecting the length of the telescopic motor strut.

⚠CAUTION

The shortest length motor (extra short) is 142mm fully compressed (ring-to-ring distance). Equinus deformities with greater than 40o of plantarflexion may be difficult to treat with a posterior motor since the posterior portions of the foot ring and distal tibial ring may be too close to mount the motor in between. Consider an anterior motor approach for this degree of deformity. **(Figure 159)**

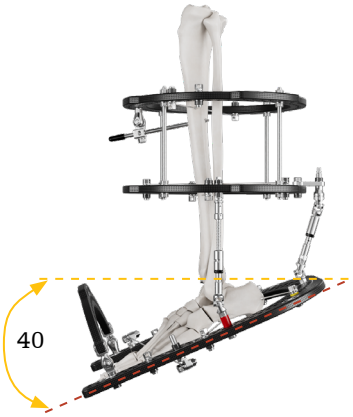


Figure 159

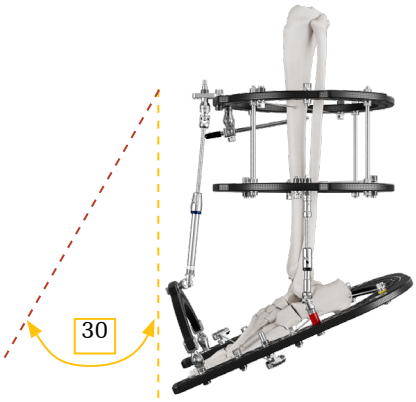
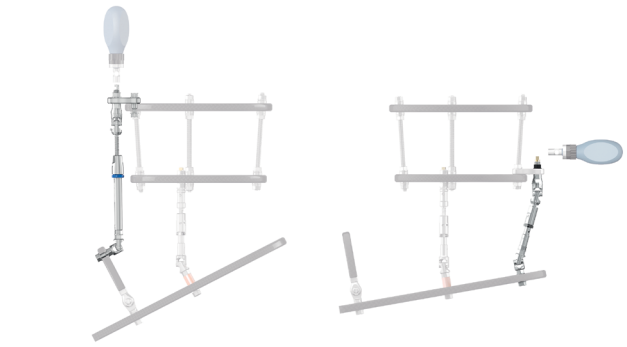


Figure 160

⚠CAUTION

When mounting an anterior motor, the angle of the motor should be 30o or less. **(Figure 160)**

When taking the anterior motor mounting approach, the angle of the foot arch can be adjusted in preparation for the attachment of the telescopic motor strut. While the strut lengths overlap, selecting the longest size possible will minimize the need for strut changeouts. **(Figure 161)**



Anteriorly mounted motor Posteriorly mounted motor

Figure 161

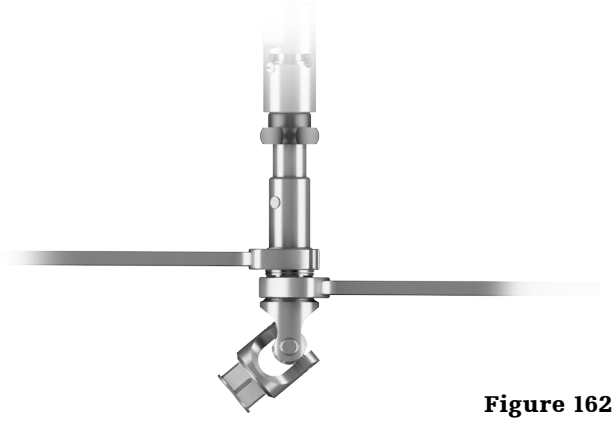


Figure 162

Hoffmann LRF - Gradual correction

NOTICE

Attachment of the telescopic motor strut can be done before or after final distraction of the ankle.

Once the strut and hinge are assembled, the clicker end of the strut is attached to the ring using an M8 connecting nut.

To offset the attachment of the strut on the tibial block, a slotted plate can be applied to the ring using a medium M6 connection bolt and nut. **(Figure 163)**

On the hinged end, the hinge connection bolt is used to attach the strut to the ring or foot arch. Utilize the strut's counter-torque surfaces to definitively secure each end.

Before surgery is complete, confirm that access to the strut's adjustment point is not obstructed by other frame components. **(Figure 164)**

The dimple markers on the clicking mechanism's counting wheel should be aligned in the starting position. **(Figure 165)** The single reference dimple on top portion of the counting wheel should align with the single dimple mark on the lower portion of the counting wheel. This is designed to allow the patient to keep track of quarter millimeter adjustments by starting them in the initial start position.

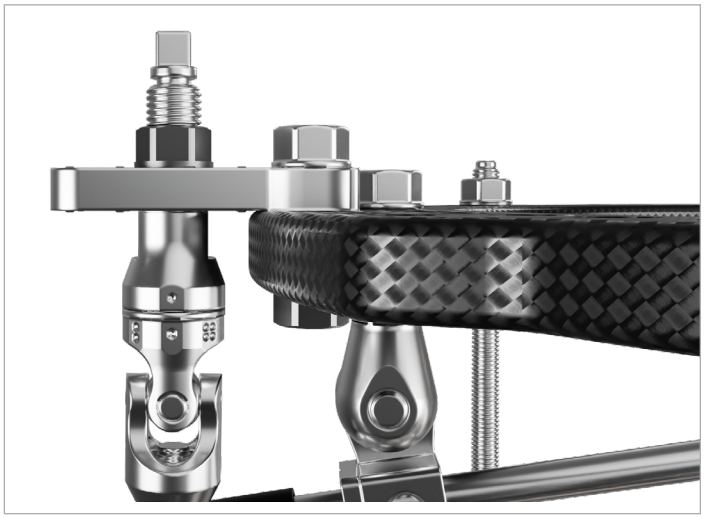


Figure 163

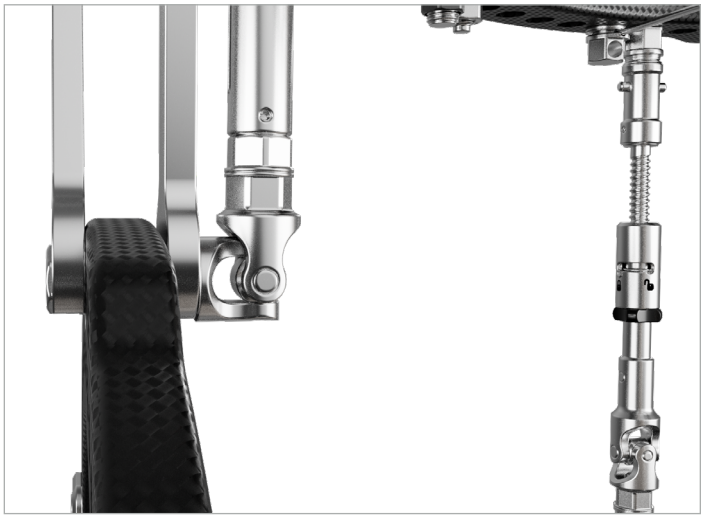


Figure 164



Figure 165

Hoffmann LRF - Gradual correction

Final distraction

Distraction is necessary to protect the articular cartilage during equinus correction. The amount of distraction needed is based on the specific indications of the patient and surgeon discretion. The distraction is done intraoperatively.

1. Distraction of the struts needs to be done progressively. For example, the quick-release on the medial strut should remain locked while the quick-release on the lateral strut is unlocked and manually distracted 2-3mm by pulling on the foot ring assembly. The lateral strut is locked to hold the initial distraction while the medial strut is adjusted 2-3mm. Repeat adjustments until the joint space is uniformly distracted to the appropriate distance.
2. Once the desired amount of distraction is achieved and confirmed, the quick-release mechanisms are relocked to maintain the distraction
3. If needed, fine length adjustment features of the hinged telescopic strut can be used until the desired amount of distraction is achieved. When taking this approach, first confirm the quick-release mechanisms are locked. Adjust each strut one at a time, keeping one strut fully locked while the other is being adjusted.

NOTICE

One full revolution of the strut in the counterclockwise direction equals 2mm of distraction.

⚠CAUTION

After distraction, confirm that the hinges are aligned on the ankle joint's center axis of rotation, and ensure that all component interfaces are definitively locked tight.

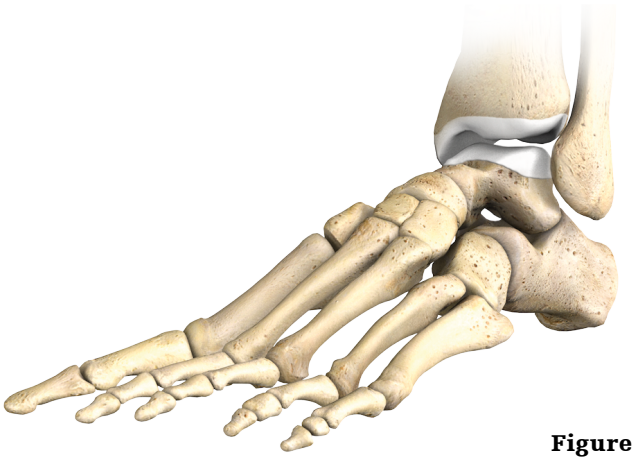


Figure 166

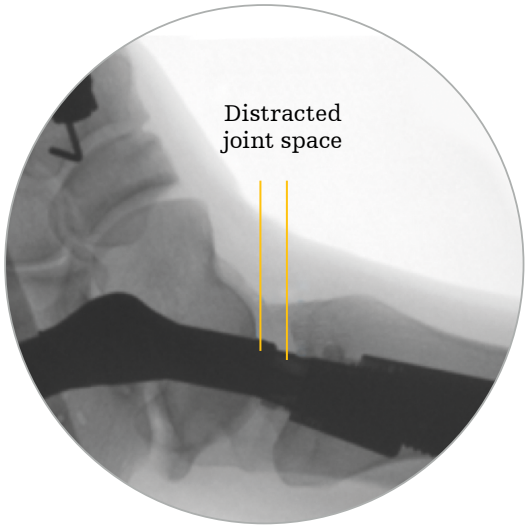


Figure 167

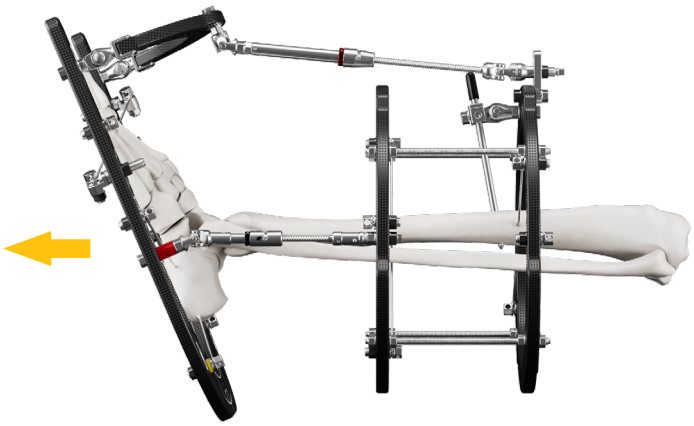


Figure 168

Hoffmann LRF - Gradual correction

Post operative adjustments

During the post-op gradual adjustment phase, the patient can utilize the adjustment instrument (4934-9-100, ordered separately) **(Figure 169)** to actuate the motor and slowly dorsiflex the foot. The counter wheel on the adjustment instrument can be used to keep track of daily corrections.

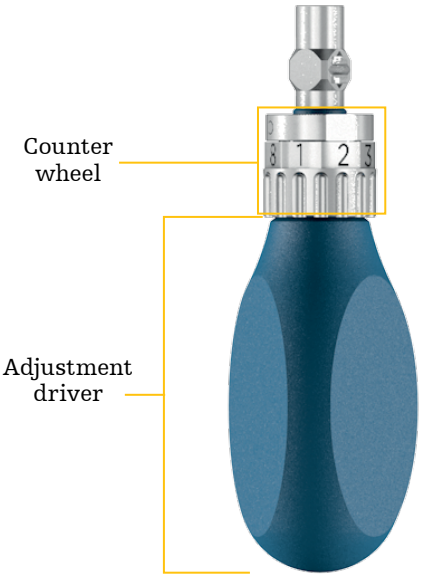


Figure 169

⚠ CAUTION

Fast adjustment rates may lead to complications including soft tissue or neurovascular damage. Rates of correction are indication-specific and may vary patient-to-patient. Rates of correction may also differ when taking an anterior motor approach vs. a posterior motor approach.

Once the custom adjustment schedule is devised by the surgeon, the patient or caregiver can execute gradual corrective adjustments as prescribed. Each click represents ¼mm of travel; therefore, one full revolution (eight ¼mm clicks) represents 2mm of compression or distraction.

To compress the length of the motor (as performed with an anterior "pull" construct), the clicking mechanism is turned clockwise. To distract the motor (as performed with a posterior "push" construct), the clicking mechanism is turned counterclockwise. Take caution not to rotate the clicking mechanism while applying the adjustment driver. Typically, the 1mm of motor travel is broken up into four ¼mm adjustments (four clicks).

⚠ CAUTION

When making adjustments, use caution not to erroneously adjust the wrong frame components. Only make adjustments to the intended strut. After a full day of adjustment (four clicks represent 1mm of travel), the correction should be verified by the following steps below.

1. The reference dimple on the top of the clicker should be aligned with the single dimple marker on the lower half of the adjustment instrument's counting wheel. This represents a half-revolution of the clicker (corresponding to 1mm of travel).
2. The reference markers found on the counting wheel should match the dimple reference markers on the strut's clicker. After a full day (four clicks), the number four on the counting wheel should align to the single dimple marker.
3. Using the correction schedule as a reference, confirm that the strut's lengthening scale indicates the appropriate metric. For example, if the strut is compressed from 305mm at the start of the day, after four clicks, the scale should indicate 304mm. This will also validate that the adjustment is moving in the intended direction.

Hoffmann LRF - Gradual correction

Reinforcing frames for weight bearing

Partial weight bearing with crutches or a walker can begin during the last 10 degrees of correction. Full weight bearing may ensue when the deformity is fully corrected. At this point, the frame should be reinforced with additional support assemblies to accommodate an increased amount of loading. **(Figure 170)**

⚠CAUTION

Once correction is achieved and patients are allowed to weight-bear, an additional static telescopic strut or threaded rod assembly is strongly recommended for increased construct stability.

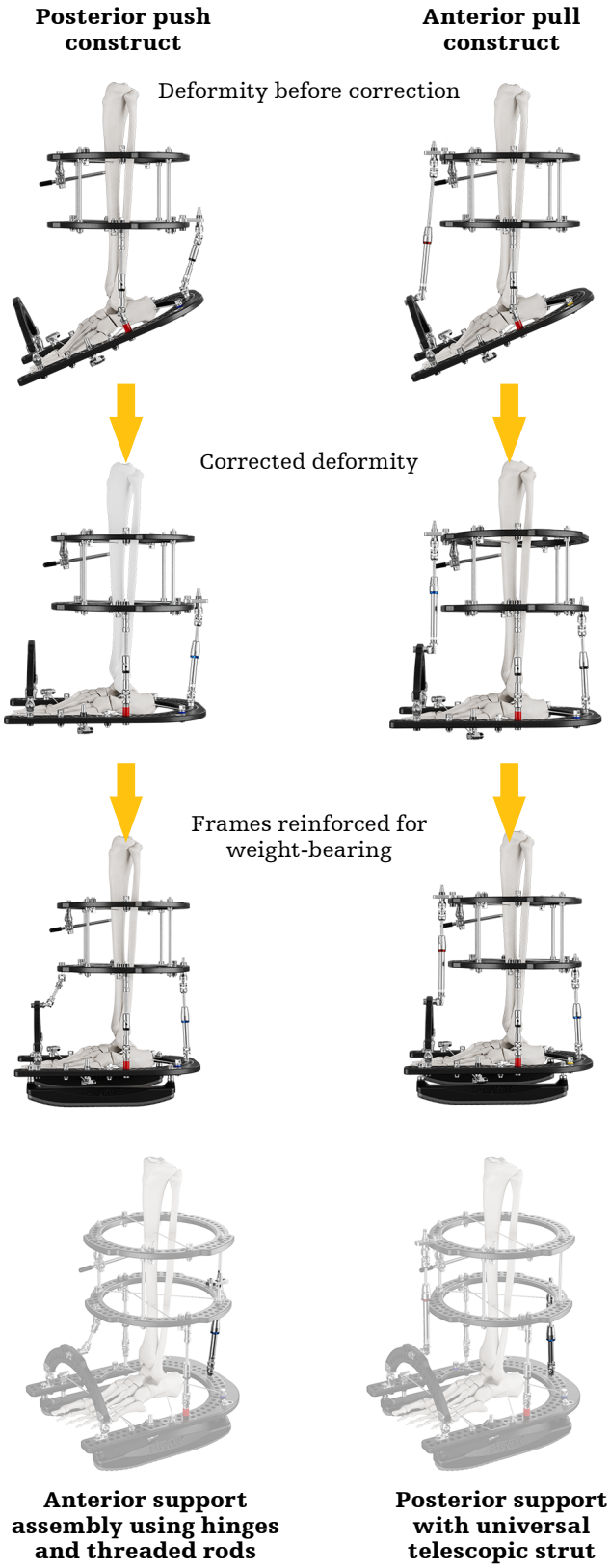


Figure 170

Hoffmann LRF - Gradual correction

Exchanging a telescopic motor strut

When performing a gradual correction procedure on a large angular deformity, it may be necessary to replace the motor strut once its full travel is used. As the correction progresses, the motor's travel will be consumed, and once fully expended, it can be replaced with the next size motor.

When exchanging struts, the surgeon must ensure that the correction achieved so far is not lost. Before removing a fully expended motor strut, the frame must be stabilized and reinforced to maintain the correction. Several methods using supplemental components are available for this procedure.

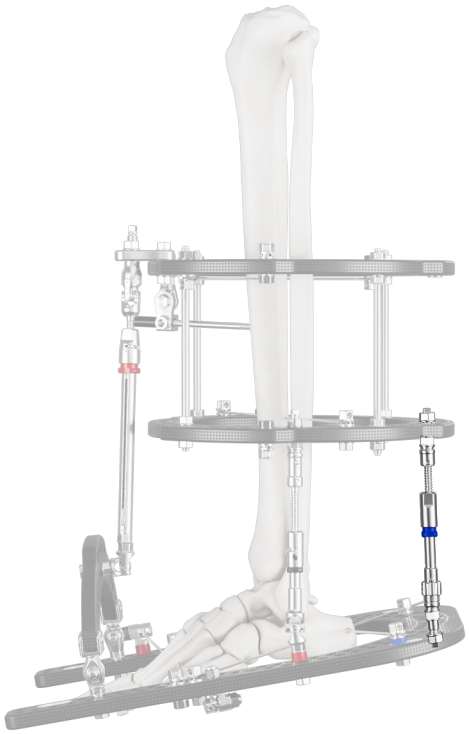
NOTICE

Additional stabilization of the frame is especially important if lockable hinges are utilized.

Telescopic strut brace

On the posterior portion of the frame, a telescopic strut can be used to span the rings proximally and distally to the joint space or osteotomy. **(Figure 171)**

Be sure that the telescopic strut is securely tightened to the rings with the appropriate connecting nuts and that all ball joints and quick-release mechanisms are securely locked.



Posterior fixation with universal telescopic strut

Figure 171

Hoffmann LRF - Gradual correction

Simple hinge brace

Alternatively, a simple hinge and threaded rod assembly can be used to stabilize the frame. **(Figure 172B)**

When using this approach, confirm that the hinge coupling is securely tightened to the ring and threaded rods using M6 connecting nuts and bolts. Also confirm that the hinge coupling is locked.

Strut change-out kit brace

Another available option is to utilize the dedicated strut change-out components (8mm posts and rods) to span and stabilize the frame during a strut change-out. **(Figure 173A)** Again, before exchanging the strut, ensure that all supplemental fixation components are securely locked.

Once the hinges are locked and the frame is reinforced, the original long telescopic motor strut can be removed.

The medium telescopic motor strut is now attached in the fully extended position in place of the original long motor strut. **(Figure 173B)**

Once the new strut is installed and tightened, the supplement fixation may be removed **(Figure 173C)**, and the correction process can resume.



172A

Posterior fixation with threaded rod



172B

Posterior fixation with Hoffmann 3 components



172C

Anterior strut prior to correction

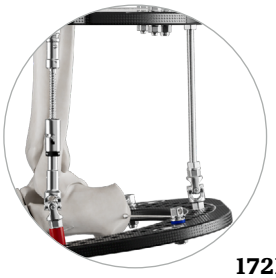


172D

Anterior strut fully expended



172E



172F



173A



173B



173C

Hoffmann® LRF

Bone transport

The Hoffmann LRF Bone Transport Tray introduces bone transport struts designed for bone transport and bone lengthening.



Hoffmann LRF - Bone transport

Bone transport overview

Description of bone transport frames:

External circular bone fixation system designed to provide bone transportation to aid in the correction of massive skeletal defects and severe open fractures or excision of tumors, through distracting until desired correction has taken place. This system is single use.

Description of bone lengthening frames:

External circular bone fixation system designed to provide fixation of the fracture fragments until bone consolidation occurs and for the correction of deformities. This system is single use.

⚠ WARNING

Transport struts are not intended for direct mount to a foot ring.

Safety clips are a single use item. Anytime a safety clip is removed from the strut it should be replaced with a new, unused, safety clip.

Safety clips are required to be used on any bone transport strut that is being placed on a patient.

The transport frame is applied to the extremity after limb stabilization and wound debridement has occurred. The frame is then secured to the extremity using pin and wire fixation. Subsequently, a corticotomy is performed to detach a segment from the remaining healthy bone.

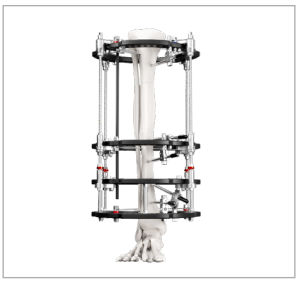
This separated piece of bone will become the transport segment.


Segmented defect


Segmented resection


Bone Transport


Distraction and regeneration formation


Bone docking


Healing

Figure 174

Hoffmann LRF - Bone transport

Transport strut overview

Hoffmann LRF Transport Struts (4933-0-400) are supplied in the collapsed, locked position. Mounting arms on each strut can be unlocked and repositioned to accommodate proper ring placement within the frame.

Derotation posts on the moving and distal ring mounting arms allow for ring attachment above or below the mounting arm depending upon the anatomy at the affected site.

Transport Struts are designed for bone transport procedures but can be modified for bone lengthening procedures.

⚠CAUTION

When using tabbed rings for transport or lengthening procedures, only use transport struts with the words "Tabbed Ring Compatible" laser-marked on the strut's bottom quick-release sleeve. **(Figure 175)**

NOTICE

For ease of assembly and transport, it is recommended to connect the struts to the rings while still in the collapsed, locked position.

NOTICE

Transport Struts are single use. Unused struts may be reprocessed if needed by following instructions found in the Cleaning and Sterilization Guide (OT-RG-1), and the Preparing for Cleaning Guide specific to this device (H-CSG-1).

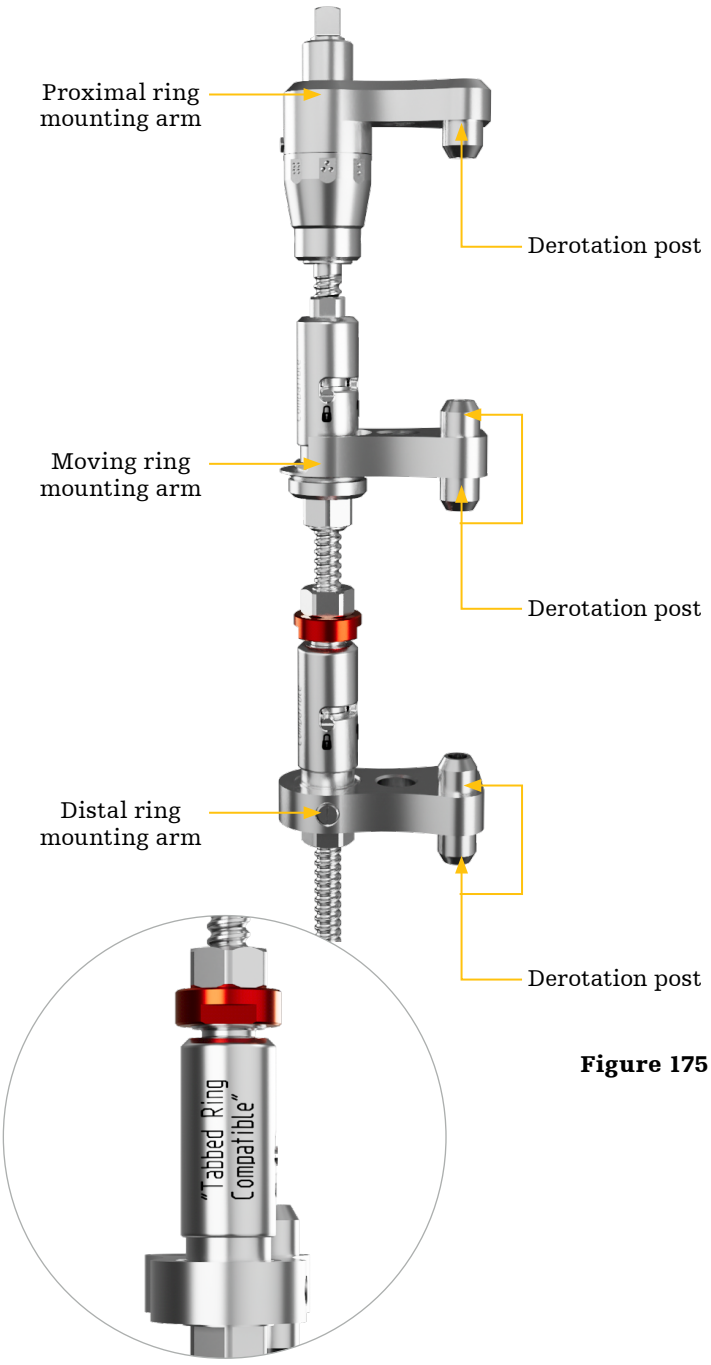


Figure 175

Hoffmann LRF - Bone transport

Frame configuration

The moving ring is driven by adjustments made to the square driver at the top of the strut.

Quick-release mechanisms on the moving and distal ring mounting arms allow for rapid adjustment.

Following proper ring placement, the quick-release mechanisms are definitively locked in place by attaching a safety clip below the quick-release mechanism. The patient should be instructed to periodically check to ensure safety clips are still attached.

WARNING

Safety clips are a single use item. Anytime a safety clip is removed from the strut it should be replaced with a new, unused, safety clip. Safety clips are required to be used on any bone transport strut that is being placed on a patient.

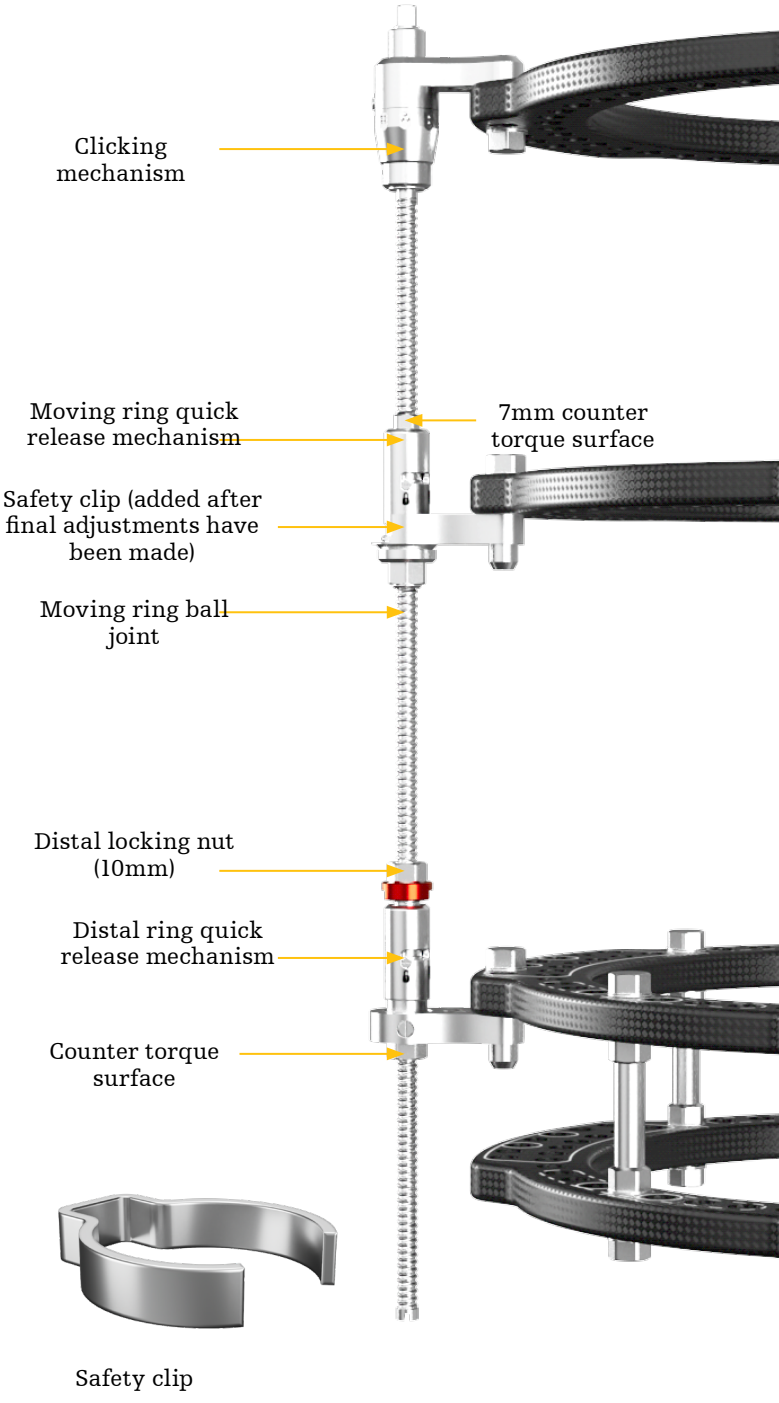


Figure 176

Hoffmann LRF - Bone transport

Distal ring mounting arm adjustment

To adjust the distal ring mounting arm, loosen the red distal locking wheel and unlock the quick-release mechanism.

The distal locking nut is loosened by applying counter- torque to the counter-torque surface under the mounting arm. The quick-release mechanism is unlocked by aligning the pin in the “unlock” position. Once unlocked, the distal ring mounting arm can slide to the desired location on the strut. **(Figure 177)**

NOTICE

The frame shall be pre-assembled before surgery with the proximal ring secured in place and the moving and distal rings provisionally locked in place to allow for adjustment during surgery.

To definitively fix the distal ring mounting arm in place, re-lock the quick-release mechanism and re-tighten the red distal locking nut.

The quick-release mechanism is locked by aligning the pin in the locked position. The distal locking nut is locked by applying counter-torque with the Spanner Wrench to the surface under the distal ring mounting arm.

⚠ WARNING

After final adjustment of the ring, ensure the distal locking nuts (red) are securely tightened to prevent unwanted distraction.

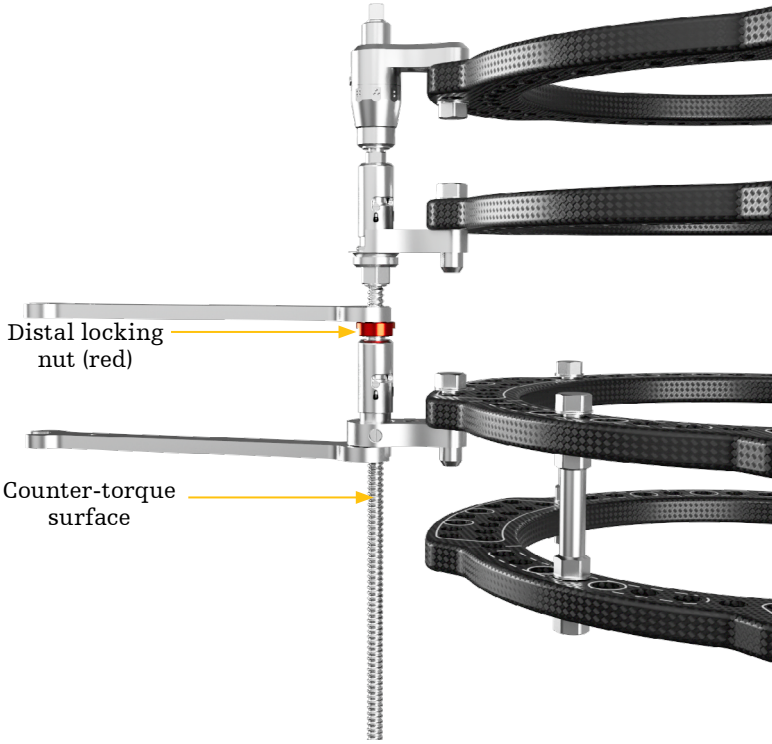


Figure 177

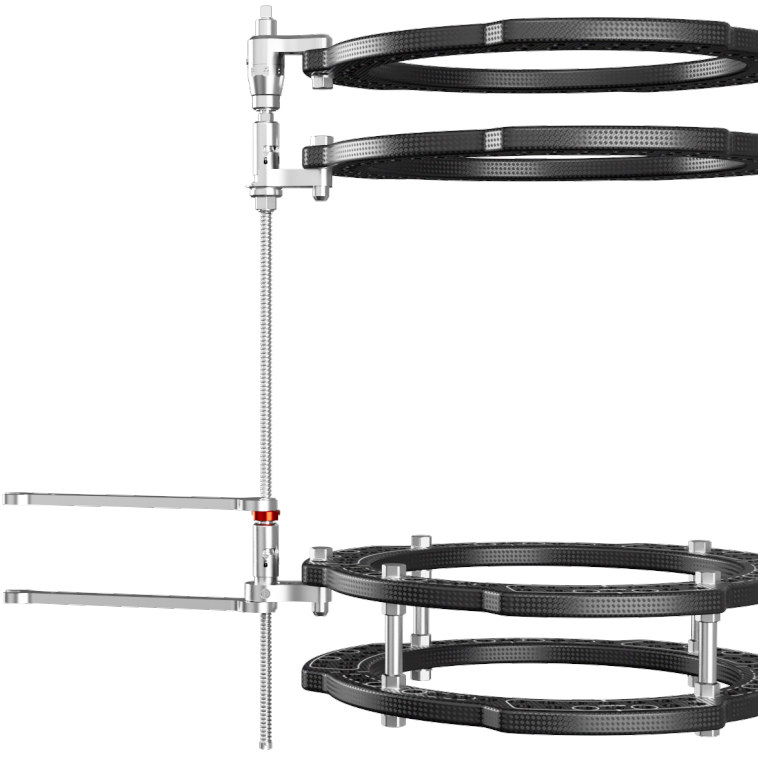


Figure 178

Hoffmann LRF - Bone transport

Moving ring mounting arm adjustment

To adjust the moving ring mounting arm, unlock the quick-release mechanism by aligning the pin in the "unlock" position. Once unlocked, the moving ring mounting arm can slide to the desired location on the strut.

Once proper placement is achieved, re-lock the quick-release mechanism by realigning the pin in the locked position.

If necessary, the moving ring ball joint can be unlocked to allow for +/- 6° of multiplanar angulation of the moving ring. The ball joint is unlocked via counterclockwise revolutions. To unlock the ball joint, use the counter-torque surface (7mm). Once proper placement is achieved, re-tighten the ball joint on the frame.

⚠ CAUTION

Over-tightening the 7mm counter-torque surface could strip the surface, preventing further unlocking of the ball joint and rapid adjustment of the moving ring. Wrench tightening of the ball joint should only occur when the struts are mounted to rings.

⚠ WARNING

Ensure the moving ring ball joint nut is securely tightened after proper placement is achieved or after desired angulation is obtained.



Figure 179

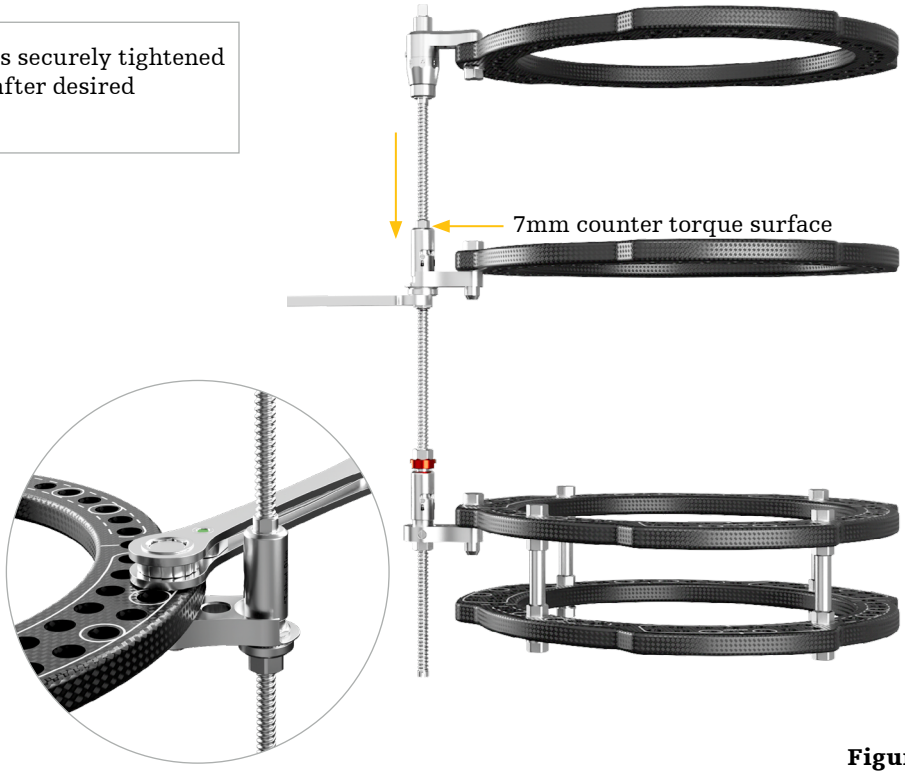


Figure 180

Hoffmann LRF - Bone transport

Ring and transport strut orientation

Transport Struts are connected to rings using ring connection bolts (4933-1-702).

To ensure proper strut spacing and alignment between rings for a stable four-strut construct, place struts equidistant in the orientation show in. **(Figure 181)**

- For a 4-strut construct, place the struts at the equator lines.
- The strut's derotation post should be aligned in the denoted holes

NOTICE

Ensure equal strut placement for 4-strut constructs. **(Figure 182)**

NOTICE

For additional confirmation that rings are stacked properly, the labeling on each ring should face the same direction.

The struts should be attached to the rings while still in the collapsed position. This should ensure that all struts are parallel along the length of the frame, resulting in ease of movement of the transport ring.

NOTICE

The maximum dynamic length for a frame construct with transport struts is 375mm ring-to-ring. The overall frame length can be increased by adding ring-level extensions proximally and/or distally.

The minimum distance between the proximal and moving ring is 40mm, allowing for 120mm of transport. Transport Struts are offered in one size and are custom cut to length as indicated.

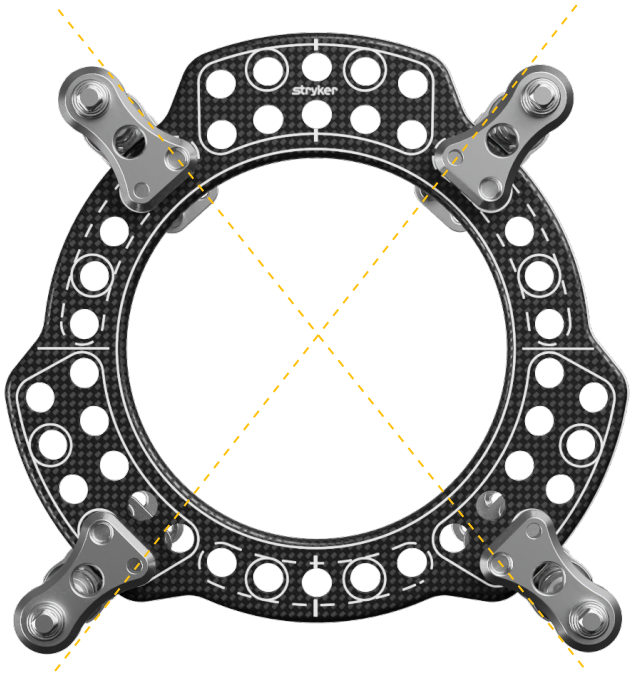


Figure 181

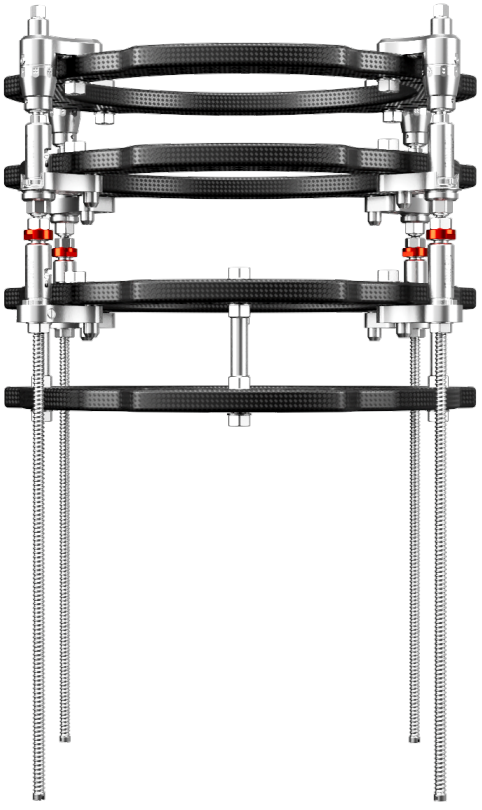


Figure 182

Hoffmann LRF - Bone transport

The transport strut moving arm and distal arm can be mounted above or below the rings in order to minimize ring-to-ring distance and maximize transport potential. **(Figure 183)**

Mounting considerations

When constructing the frame, the struts can be oriented in two ways: direct anterior-posterior or with a 45° rotary offset. **(Figure 184)**

Positioning the frame with a strut directly anterior will allow the surgeon to align the frame in the same plane as the bone. This typically requires radiographic visualization.

The strut can be visually aligned with the center of both ends of the defect. The struts, however, may interfere with anteroposterior and mediolateral radiographs.

Rotating the frame 45° will position the struts in an orientation that does not obstruct radiographic views. With this approach, however, the user cannot use a strut to assess the frame's alignment and transport trajectory with the bone.

NOTICE

Transport struts are not compatible with foot rings.

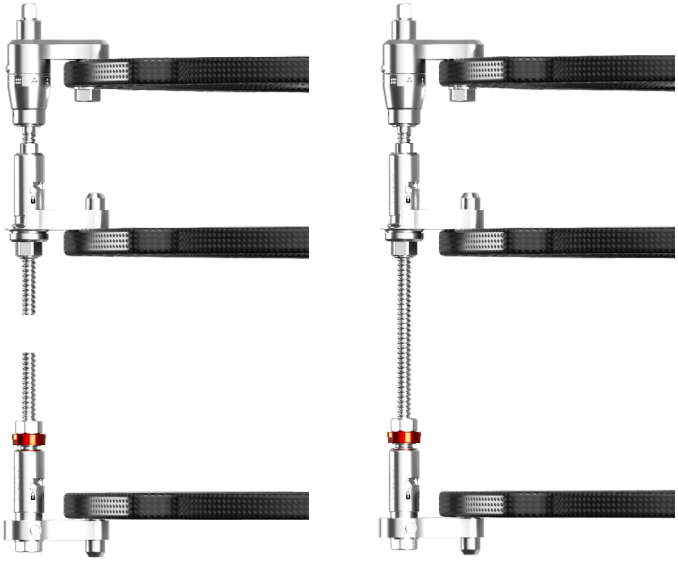


Figure 183



Anterior alignment

Offset alignment

Figure 184

Hoffmann LRF - Bone transport

Ring spacing: distal ring

After frame assembly, rings are spaced to the appropriate locations on the strut as dictated by the anatomy at the affected site.

Steps

1. Unlock the red distal locking nut on each of the four distal mounting arms. Apply a torque wrench to the 10mm counter-torque surface below the mounting arm and loosen the red distal locking nut with a second wrench. **(Figure 186)**

NOTICE

Do not over-loosen the distal locking nut. Loosen just enough to free the mounting arm. Avoid repetitive locking and unlocking of the distal locking nut.

2. Unlock each of the four quick-release mechanisms by aligning the quick-release pin in the unlocked position. **(Figure 187)** Once all distal locking nuts and quick-release mechanisms are unlocked, the distal ring can be moved freely to the appropriate location. **(Figure 188)**
3. Once proper spacing of the distal ring is achieved, the orientation is definitively locked in place by realigning the quick-release pin in the locked position and re-locking the red distal locking nuts. **(Figure 189)**

NOTICE

If the intended frame height is unknown, the distal locking nut shall remain unlocked, until the frame is adjusted to the proper length on the patient.

⚠ WARNING

Failure to lock the red distal locking nuts may result in unwanted distraction of the distal ring.

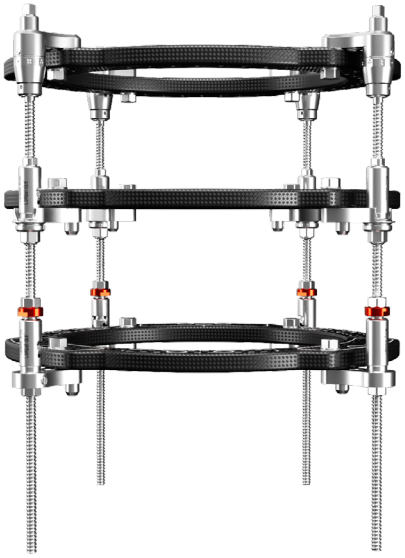


Figure 185

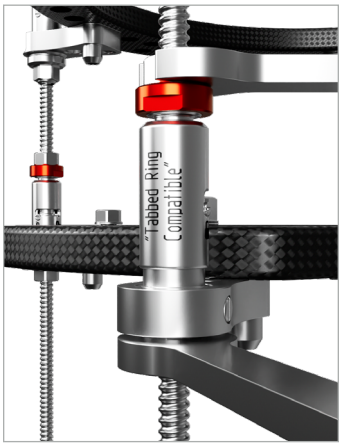


Figure 186



Figure 187

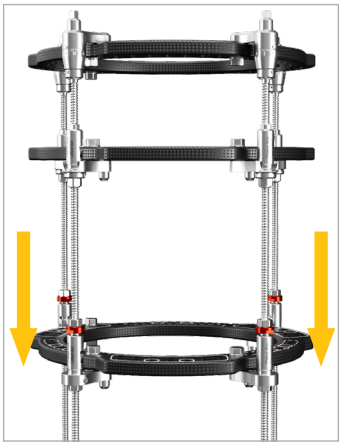


Figure 188



Figure 189

Hoffmann LRF - Bone transport

4. Once the distal ring is definitively locked into position, excess rod length can be cut off using a rod cutter. **(Figure 190)**

NOTICE

If patient limb length is unknown at the time of pre-build, this step can happen at the end of the procedure.

WARNING

Special attention should be paid during rod cutting so that debris or small components do not land in the surgical site.

5. Cut threaded rods can be outfitted with end caps (4933-0-402) to protect any sharp edges.
6. After positioning the distal ring, the moving ring can be positioned in the proper location for attachment to the planned transport bone segment.
7. Unlock each of the four quick-release mechanisms on the moving ring mounting arms by aligning the quick-release locking pin in the unlocked position. **(Figure 191)** Once unlocked, the moving ring can be grossly adjusted into position.

Optional step

8. If needed, the range of motion permitted by the moving ring mounting arms' ball joints allows the moving ring to be applied in a non-orthogonal fashion.**(Figure 192)** To unlock the ball joints, use the 10mm end of the spanner wrench to loosen the ball joint release nut. Repeat on all four struts.

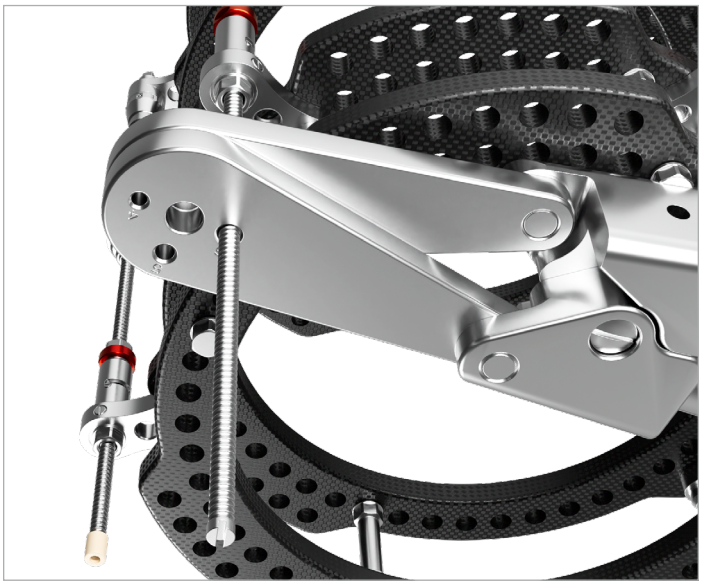


Figure 190

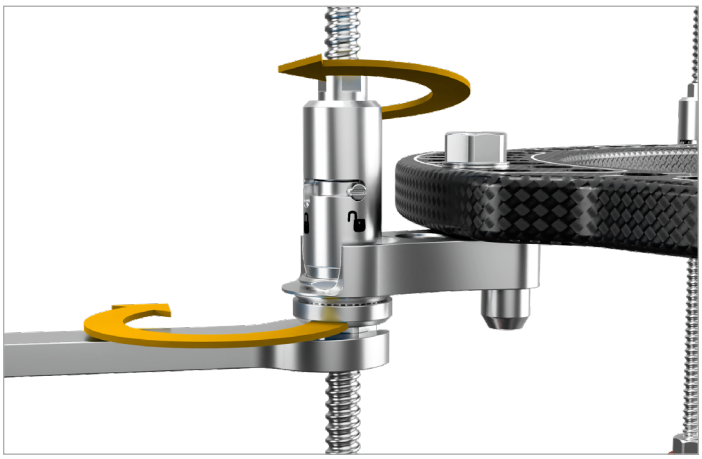


Figure 191

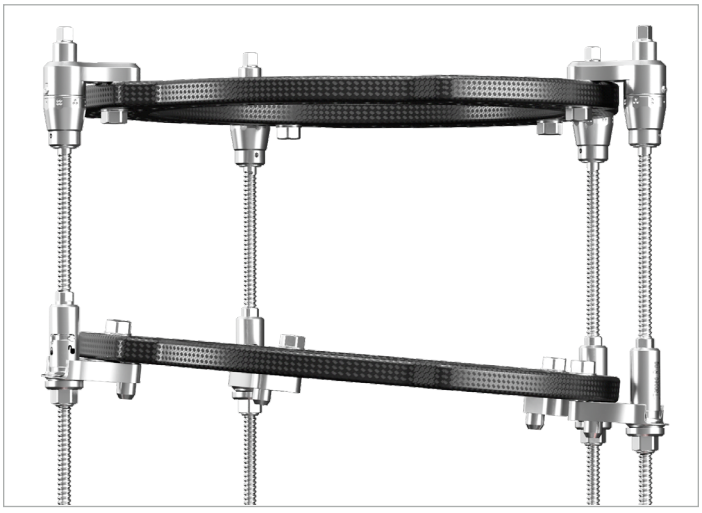


Figure 192

Hoffmann LRF - Bone transport

9. Once proper positioning of the moving ring is achieved, be sure all four ball joints are completely tightened, and quick-release mechanisms are in the locked position to prevent unwanted deviation of the moving ring. **(Figure 193)**

⚠ WARNING

Moving ring ball joints should only be used to affect initial ring placement. Utilizing the ball joints to acutely reposition the moving fragment prior to docking may disrupt the growth of the regenerate bone.

10. Prior to applying the frame, verify that the rings are uniformly spaced and parallel with the lengthening ruler (4933-0-300). It is recommended that the frame span the entire limb. Attaching a second ring level will help accommodate fixation in the distal limb. Additionally, this approach may provide better rigidity as the transport struts and dynamic portion of the frame can be shorter in length.
11. All four clicking mechanisms on the proximal mounting arms should be in the neutral starting position. The single reference dimple on the upper half of each clicking mechanism should be aligned with the single dimple on the lower half of the clicking mechanism. **(Figure 194)** This will help ensure that struts are properly set for uniform, sequential adjustments when the patient begins actuating the frame.
    To prevent unwanted ring motion, unlock the quick-release on the moving ring mounting arm before setting the clicking mechanism to the neutral starting position.



Figure 193



Figure 194

Hoffmann LRF - Bone transport

Technique for tibial defect

Steps

1. The patient should be in a supine position with flexion in the hip and the knee of approximately 20°. The pre-assembled frame is slid over the affected limb. **(Figure 195)**
2. If needed, perform additional adjustments to finalize ring spacing.
3. Ensure all distal locking nuts, ball joint release nuts, and quick-release mechanisms are locked and securely tightened. **(Figure 196)**
4. At least four points of fixation to the proximal ring are necessary to properly secure the proximal tibia to the frame and to prevent frame shifting when inserting distal ring fixation. **(Figure 197)** Fixation points may be a combination of wires and pins. It is important to note that pin and wire placement will vary by indication and surgeon preference.

⚠WARNING

In certain instances, supplemental fixation should be considered (i.e. obese patients or patients that are ambulatory in the early postoperative phase).

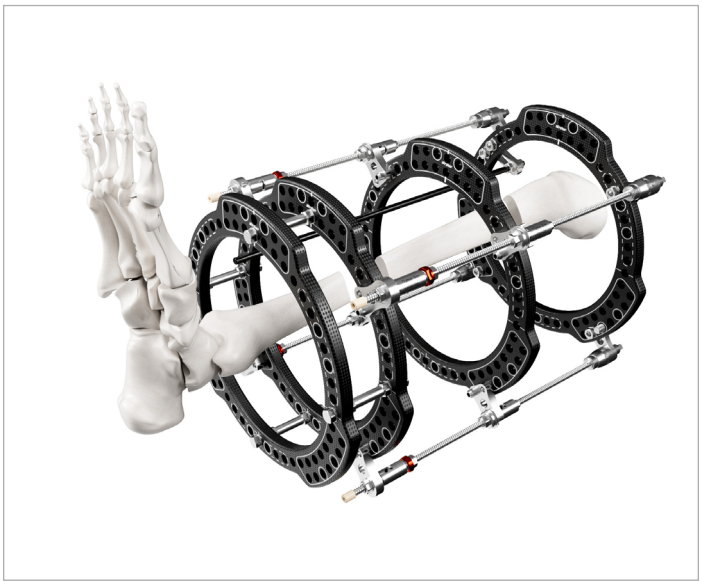


Figure 195

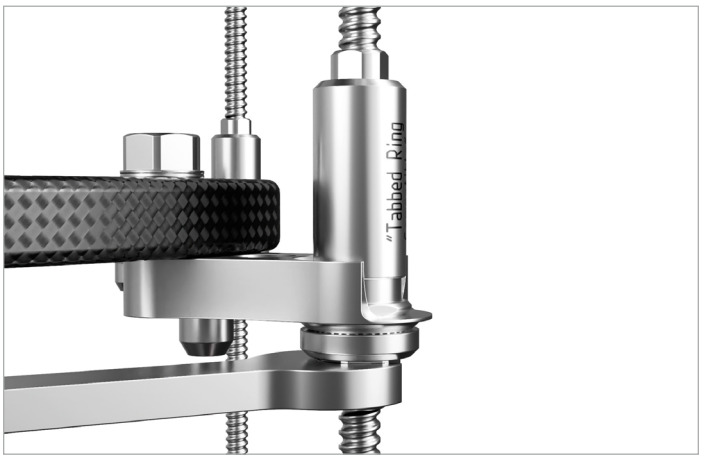


Figure 196



Figure 197

Hoffmann LRF - Bone transport

5. At least four points of fixation to the distal ring are necessary to properly secure the distal tibia to the frame. **(Figure 198)** Care must be taken when mounting the distal segment. Using imaging, confirm that the segments are aligned in both the mediolateral and anteroposterior views. This will help ensure proper docking as the transport segment moves along the path of travel.

⚠CAUTION

Ensure that the distal and proximal bone segments are axially aligned during frame application.

6. The moving ring shall be placed within the distal third of the proximal segment. At least three points of fixation are necessary to properly secure the segment to the frame. **(Figure 199)**

⚠CAUTION

All fixation components are to be secured to rings using M8 nuts.

Confirm that all fixation components are securely tightened to the frame. Be sure to use counter-torque. **(Figure 200)**

NOTICE

After pins or wires are securely fixed to the frame, the excess length may be cut down using a pin cutter or wire cutter. Wire ends may also be curled under the ring depending on surgeon preference.

⚠CAUTION

Wires should be curled or cut. Cut pins should be capped to prevent skin injury.

7. A corticotomy is performed to create an intermediate fragment (transport segment) from the remaining, healthy bone. **(Figure 201)** The injury created by the corticotomy will initiate a reparative process in which the regenerate bone will begin to form. Utilize fluoroscopy to ensure that the corticotomy is complete.



Figure 198



Figure 199

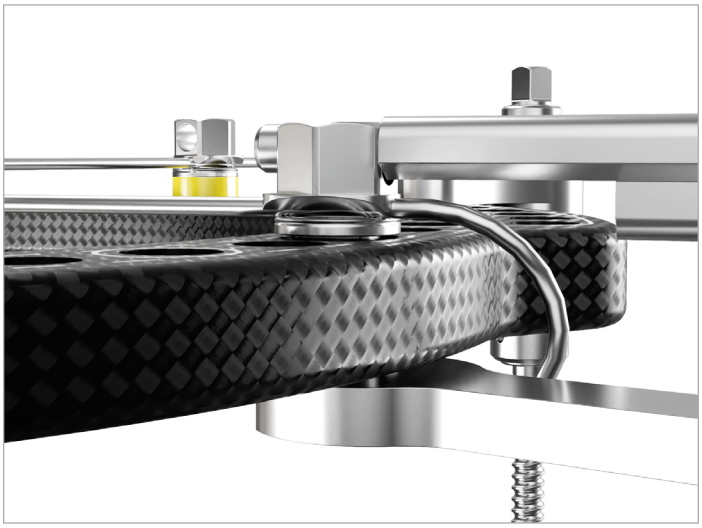


Figure 200



Figure 201

Hoffmann LRF - Bone transport

8. Perform a final check of all quick-release mechanisms to confirm that all are in the locked position. Confirm that all other components are securely tightened.

NOTICE

Ensure that all distal locking nuts are securely tightened before transport is initiated.

9. To prevent inadvertent unlocking, ensure that the safety clips (4933-0-401) have been applied to all struts, directly underneath the quick-release mechanisms. **(Figures 202-205)**

⚠ WARNING

Safety clips must be used. Handle with caution so that bending of the safety clips does not occur.

⚠ WARNING

Safety clips are a single-use item. Anytime a safety clip is removed from the strut it should be replaced with a new, unused, safety clip.

10. The lengthening ruler can be mounted to the frame to monitor the amount of moving ring travel throughout the course of treatment. Using a medium size hinge connection bolt and M6 connecting nut, attach a slotted plate to the ring. Using two more M6 connecting nuts, attach the lengthening ruler to the slotted plate. **(Figure 206)**

NOTICE

The lengthening ruler is made from aluminum and should be tightened to the frame using a thumbwheel only. Applying excessive torque while tightening may damage the ruler.



Figure 202



Figure 204

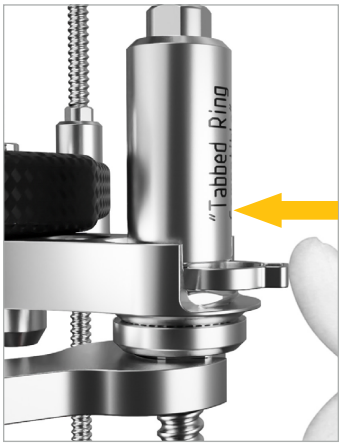


Figure 203



Figure 205

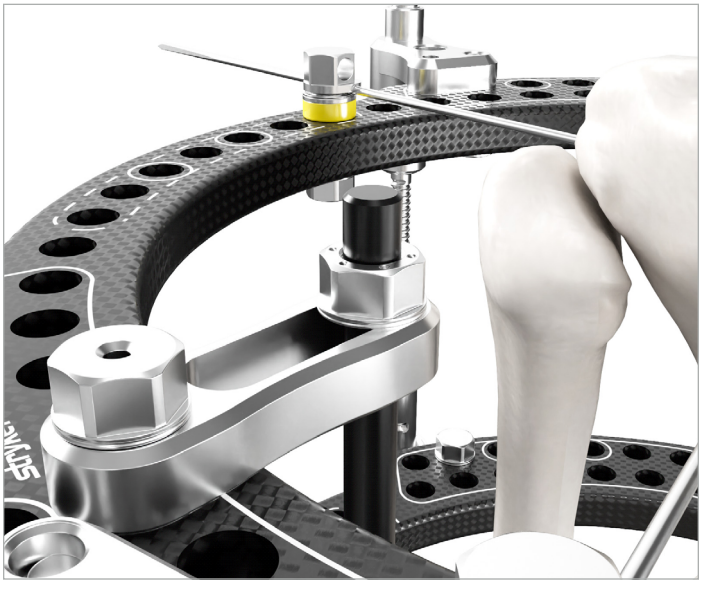


Figure 206

Hoffmann LRF - Bone transport

Safety clip removal

Steps

1. Removal of the safety clip (4933-0-401) is done using the narrow, pronged end of the telescopic strut wrench.
2. Seat the end of the wrench prongs into the square hook of the safety clip. **(Figures 207A-B)**
3. Use a slow controlled pull to remove the safety clip from the strut.**(Figures 207C-D)**

⚠WARNING

Safety clips must be used. Handle with caution so that bending of the safety clips does not occur.

⚠WARNING

Safety clips are a single use item. Anytime a safety clip is removed from the strut it should be replaced with a new, unused safety clip.

4. Always replace with a new, unused safety clip back onto the bone transport strut directly below the quick-release mechanism. **(Figures 207E-F)**

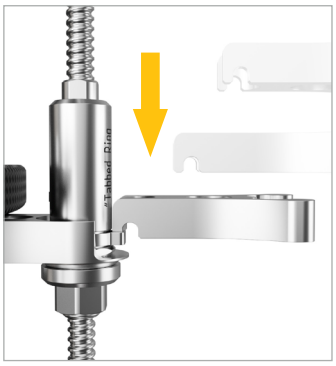


Figure 207A

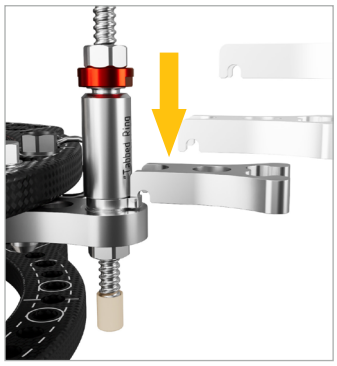


Figure 207B

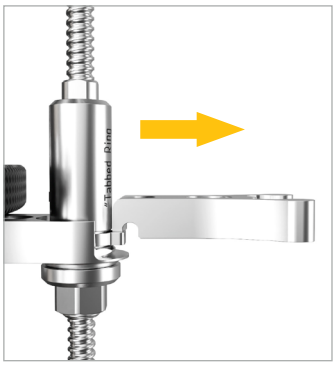


Figure 207C



Figure 207D



Figure 207E



Figure 207F

Hoffmann LRF - Bone transport

Post-transport lengthening

In certain indications, additional lengthening may be required after transport to fully restore normal limb length. This can be accomplished with a simple modification to the frame.

When converting from a bone transport to a bone lengthening frame, attach the moving ring to the distal ring using threaded rods or static struts. **(Figure 208)** This will allow both the moving ring and distal ring to move together in tandem.
To achieve tandem movement, unlock the distal mounting arms by removing the safety clips and unlocking each quick release.

NOTICE

Maximum total bone transport and bone lengthening distance should not exceed 120mm.

To ensure that compression is maintained at the docking site, keep all points of fixation in place.

NOTICE

Prior to lengthening adjustments, verify that there is sufficient travel (exposed rod) left on the strut to achieve the desired length.

Ensure the desired lengthening distance protrudes through the distal mounting arm.

NOTICE

Keep the distal locking nuts and distal quick-releases open for the duration of lengthening to allow the moving ring and distal ring to move in tandem. **(Figure 209)**



Figure 208

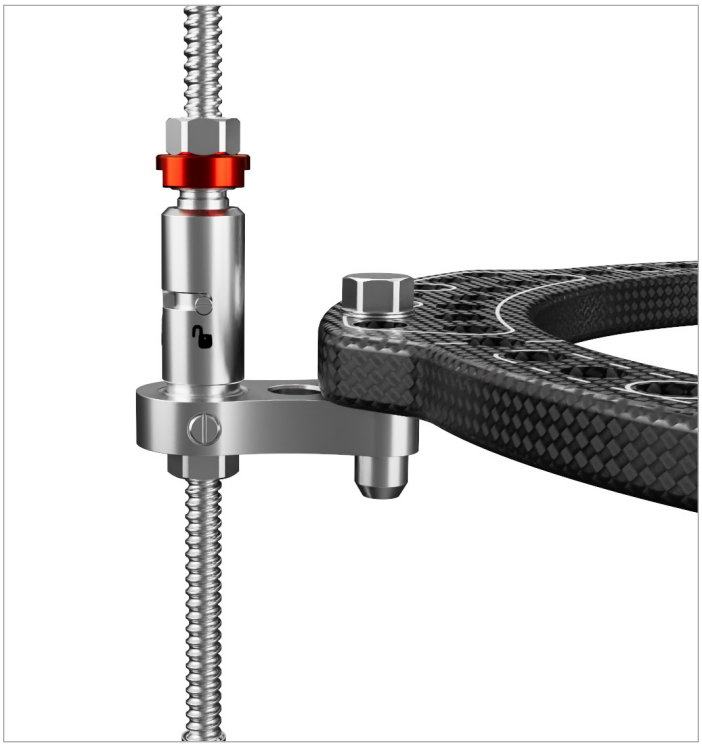


Figure 209

Hoffmann LRF - Bone transport

Distraction and transport

Patient adjustment

- During the distraction phase, the patient can utilize the adjustment instrument (4934-9-100) to actuate the moving segment. The counting wheel on the adjustment instrument can be used to keep track of sequential rounds of adjustment.
- Each "click" of the strut signifies ¼mm of compression or distraction. One complete revolution of the strut (eight clicks) is equal to 2mm of compression or distraction travel.

⚠CAUTION

It is recommended that the rate of lengthening does not exceed 1mm per day. Faster distraction rates may lead to complications including soft tissue/neurovascular damage and non-union. Slower rates of correction may also lead to complications, such as premature consolidation. Correction rates should be set at the surgeon's discretion.

- The patient or caregiver can adjust the frame by engaging the strut's clicking mechanism at the top of the strut. Every ¼mm is denoted by an audible and tactile "click."
- To drive the moving ring position from proximal to distal, the patient must administer counterclockwise adjustments. **(Figure 211)** To drive the moving ring position from distal to proximal, clockwise adjustments must be made. **(Figure 213)**

⚠CAUTION

Patients must be careful not to unintentionally rotate the clicking mechanism while seating the adjustment instrument.

NOTICE

The counting wheel on the adjustment instrument is intended to help track how many adjustments have taken place throughout the day. For example - after making a round of strut adjustments in the morning, the patient can advance the counting wheel on the driver to log their morning adjustment session. "Clicks" on the adjustment instrument are not representative of ¼mm clicks from the strut.

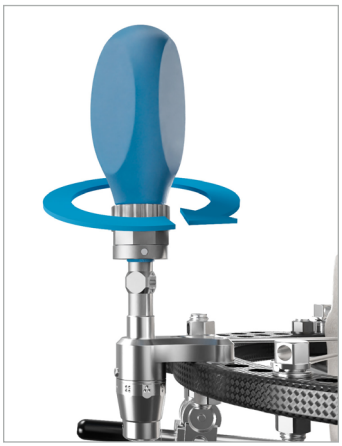


Figure 210

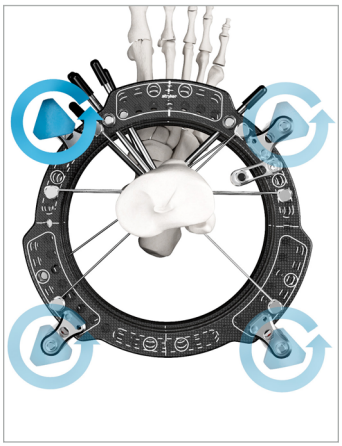


Figure 211

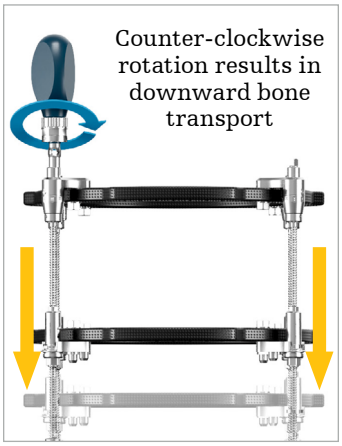


Figure 212

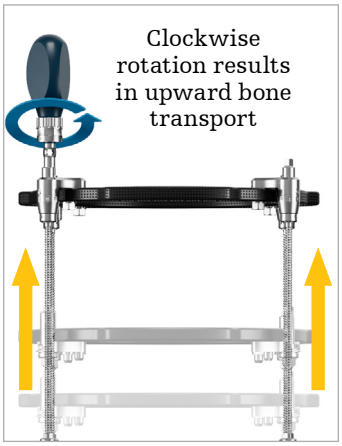


Figure 213

Hoffmann LRF - Bone transport

Clicking mechanism

- Dimples located around the strut's clicking mechanism can be used to help track the patient's adjustment progress.
- Ensure that all four clicking mechanisms start in the neutral position with the single reference marker (proximal) aligned with the single dimple. **(Figure 214)** This will allow patients to perform uniform adjustments. These dimples will also allow patients to keep a consistent record of their corrections.
- All four struts should have the same number of dimples matched with the single reference marker. This visual adjustment confirmation may also increase compliance. If one or more struts are inconsistent, the patient or caregiver may compensate with future adjustments.

NOTICE

All four clicking mechanisms must start in the neutral position with the single reference marker aligned with the single dimple.



Figure 214

Hoffmann LRF - Bone transport

Lengthening frame

Procedure for pre-building a frame

The Hoffmann LRF Transport Strut can be modified pre-operatively to perform lengthening procedures. The struts are capable of up to 120mm of lengthening.

Steps

1. Using a rod cutter, cut and remove the stopper on the threaded end of all four struts. **(Figure 215)**

⚠CAUTION

Be careful not to cut struts too short. Pre-operatively plan how long the strut should be and how much length is needed as per the indication. Ensure that each strut has enough rod length left to achieve the desired amount of lengthening.

⚠CAUTION

Rod cutting must be performed before the time of surgery to prevent debris or small components landing in the surgical site.

2. Unlock the distal locking nuts and quick-release mechanisms on each of the struts **(Figure 216)** and slide off the unneeded components.

NOTICE

When removing the distal ring mounting arm, ball bearings from the quick-release mechanism may become loose and fall out.

3. Affix an end cap (4933-0-402) to each rod.

NOTICE

Gentle force may be required to seat the end cap on the strut.

4. Once the distal mounting arms are removed, the moving ring can be unlocked and repositioned to the appropriate distance. The rings should remain parallel.
5. Attach a distal ring to the moving ring using static components, such as threaded rods. **(Figure 217)** By elongating the frame along the length of the limb, soft tissue stresses will be reduced. Fixation should only be attached to the proximal and most distal ring.

NOTICE

In pure lengthening cases, the moving ring should act as a “dummy” ring, in that it does not have any fixation on it. The “dummy” ring is in place to minimize the length of the dynamic portion of the frame (i.e. Transport Struts), making it more rigid. With respect to minimizing soft tissue stress, a longer overall frame and wide spread of the fixation is achieved with the addition of the distal ring level.

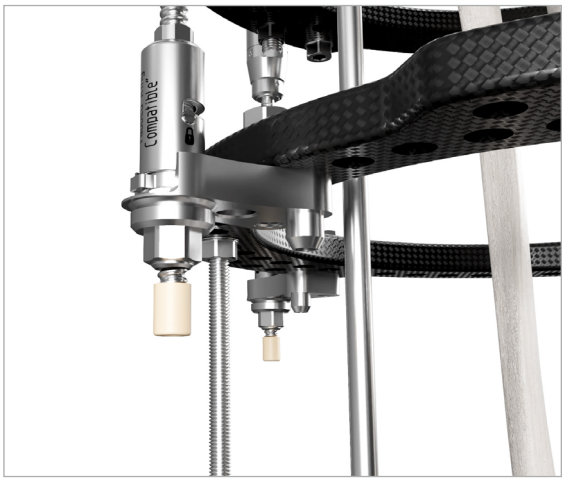


Figure 215

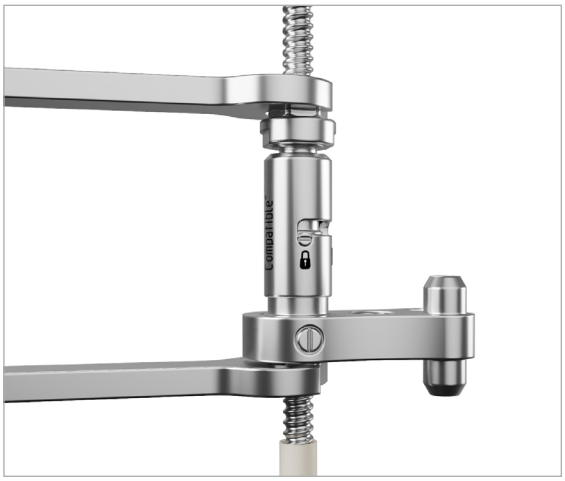


Figure 216



Figure 217

Hoffmann® LRF smartHEX™

Operative Technique

smartHEX Strut overview

Rings and mounting locations

Applying the smartHEX construct

Post-operative strut adjustments

Hoffmann LRF smartHEX - Strut overview

smartHEX Strut overview

When assembled into the hexapod configuration, the smartHEX struts are designed to provide a range of motion capable of correcting three-dimensional deformities. **(Figure 218)**

- The struts are designed to be double telescoping with independent gradual and acute adjustments.
- The gradual adjustment thumb knob features a spring-loaded self-locking feature that engages at each quarter turn (¼mm increments) with audible and tactile feedback. Its nickel Teflon (NiPTFE) coating appears as a darker "smoky" color.
- Quick-release acute adjustment allows the construct to be unlocked for rapid, acute manipulation. It is located where the inner tube slides out of the larger outer tube.
- The spring-loaded push button is the quick-release mechanism's primary locking feature, designed to reduce the risk of accidental unlocking during treatment.
- The strut is locked when the slot on the quick release thumb knob aligns with the closed-lock icon on the outer tube. The strut is unlocked when the same slot aligns with the open-lock icon on the outer tube. **(Figure 219)**
- Separate colored and numbered safety clips (4936-2-301) are provided as the secondary locking feature of the quick-release mechanism. For instructions on installation of safety clips see: Strut identification post frame build

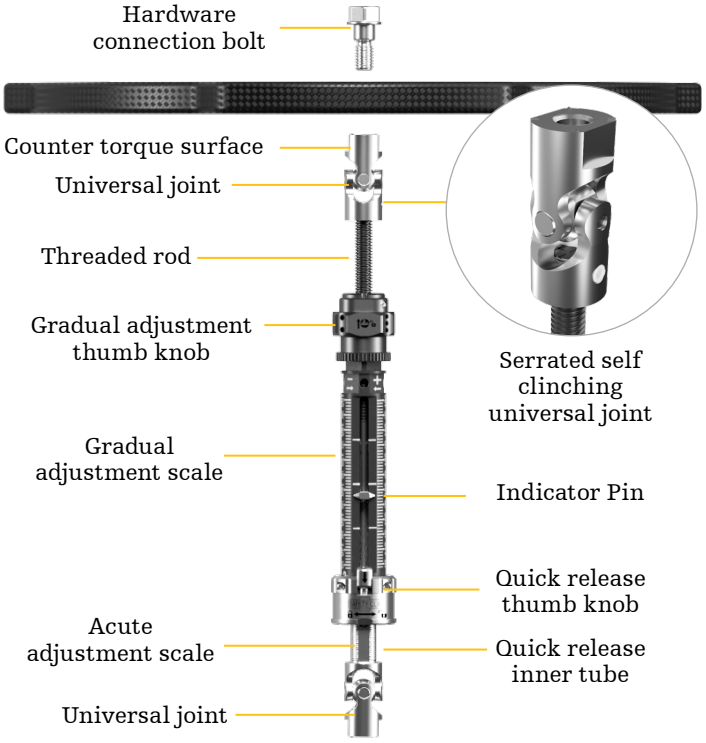


Figure 218

NOTICE

To adjust the length of the strut, turning it in the "+" direction will increase the length, while turning it in the "-" direction will decrease it. Please note that if the strut is flipped, the directions of adjustment will remain the same, meaning turning in the "+" direction will increase the length, and turning in the "-" direction will decrease it.

⚠CAUTION

To maintain intended performance, smartHEX struts should not be re-sterilized beyond 100 autoclave cycles.

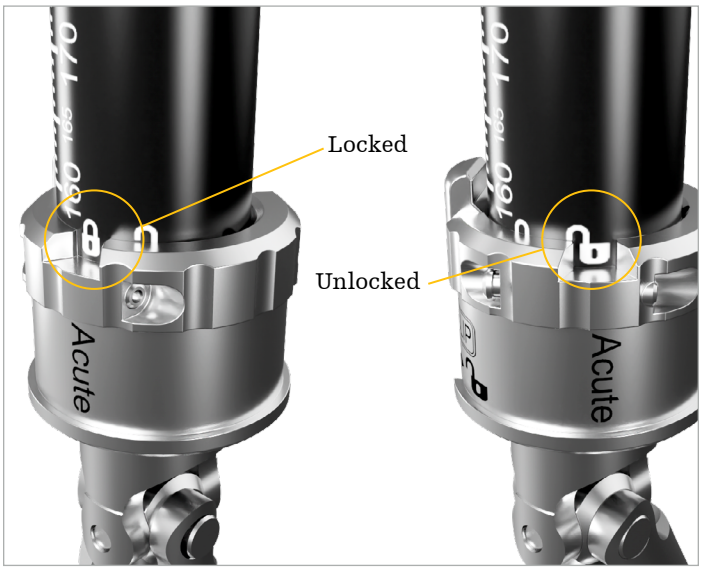


Figure 219

Hoffmann LRF smartHEX - Strut overview

Strut sizes and adjustments

The overall adjustment length of a strut is the gradual adjustment scale plus the acute adjustment scale. The gradual adjustment reading is on the indicator pin. The acute adjustment reading can be read off the side of the quick-release inner tube, with the reading taken at the edge of the quick-release thumb knob. When the inner tube is fully collapsed onto the quick-release thumb knob, the acute adjustment reading is zero.

NOTICE

Struts sizes extra short, short, medium and long feature a quick-release mechanism. The mini strut does not have this mechanism.

To lengthen

1. Pull the thumb knob **(Figure 220A)** up to unlock it.
2. While holding it up, turn the knob in the "+" direction (~45°).
3. Release the thumb knob.
4. Continue turning the knob in the "+" direction until you hear a "click", which means it is locked in place (this indicates one click).

To shorten

1. Pull the thumb knob **(Figure 220A)** up to unlock
2. While holding it up, turn the knob in the "-" direction (~45°).
3. Release the thumb knob
4. Continue turning the knob in the "." direction until you hear a "click", which means it is locked in place (this indicates one click)

To lock

Press down the push button **(Figure 220B)** and turn the quick release knob in the direction of the lock symbol.

To unlock

Press down the push button **(Figure 220B)** and turn the quick release knob in the direction of the unlock symbol.



Figure 220A

Figure 220

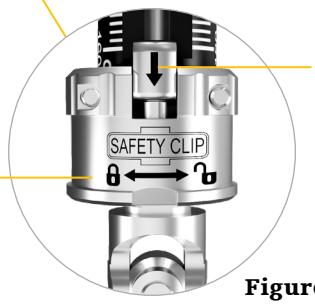


Figure 220B

Hoffmann LRF smartHEX - Strut overview

Strut directional markings

There are two locations on the strut that indicate the direction of strut actuation. The "+" (lengthen) and "-" (shorten) directional arrows indicate adjustments in accordance with the patient's correction plan. **(Figure 221)**

NOTICE

When the threaded rod portion of the strut is fully collapsed, the turn direction marking on top is not visible to the patient or the caregiver. In this circumstance, refer to the turn direction marking on the side of the outer tube.



Figure 221

Table 13: Strut adjustment limits

Strut Size	Overall Length* (mm)	Gradual Adjustment* (mm)		Acute Adjustment* (mm)	
		Min	Max	Min	Max
Mini	84-105	84	105	N/A	N/A
Extra short	102-150	102	126	0	-
		126	150	-	24
Short	116-192	116	154	0	-
		154	192	-	38
Medium	134-246	134	190	0	-
		190	246	-	56
Long	160-310	160	242	0	-
		242	310	-	68

Hoffmann LRF smartHEX - Strut overview

Strut cleaning and maintenance

The smartHEX strut should be fully extended prior to cleaning. After cleaning and sterilization of the strut is complete, apply lubricant along the joint between the quick release and the outer tube. **(Figure 222)** Cleaning instructions and lubricant information can be found in the Cleaning and Sterilization Guide (OT-RG-1).

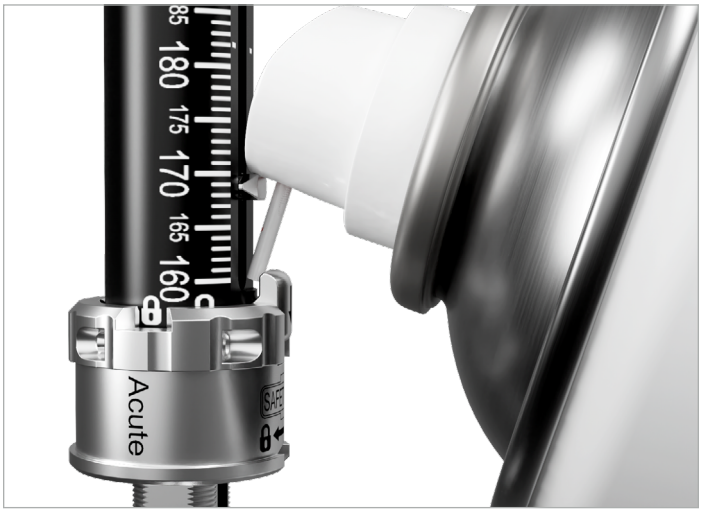


Figure 222

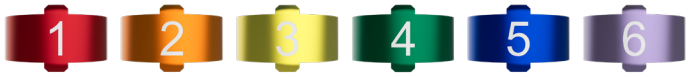
Hoffmann LRF smartHEX - Strut overview

Strut identification

Several features on the smartHEX device are designed so that patients or caregivers can clearly identify each strut for adjustment according to the correction plan.

Strut safety clip set (4936-2-301)

The safety clips' primary function is to prevent the quick-release mechanism from unintentionally unlocking. The strut safety clips come in a set of six numbered one through six. They are color-coded in red, orange, yellow, green, blue, and violet (purple). Safety clips snap around the quick-release thumb knob of the smartHEX strut. Because the colors and numbers of the safety clips match the ID caps, they may also be used to identify the struts. The strut safety clips are installed intraoperatively.



NOTICE

Because the mini strut size does not include a quick-release mechanism, the safety clip cannot be applied. Refer to the ID caps for identification of mini struts.

ID cap kit (4938-1-051) (Figure 224)

The ID Cap Kit includes six ID caps and six ID stickers. The ID caps or ID stickers are used to assign each strut a color and number. Each ID cap fits into the hex recess at the top of the hardware connection bolt. The ID stickers are offered as an alternative to the ID caps per surgeon preference. The ID caps or stickers are non-sterile and are applied post-operatively.

NOTICE

The ID caps and stickers must not be sterilized or reprocessed.

NOTICE

The ID stickers should be installed on a smooth surface of the strut, strut controller or ring for better adhesion during the treatment period.



Figure 223



Figure 224

Hoffmann LRF smartHEX - Rings and mounting locations

Rings and mounting locations

For more information about ring sizes, types and layout of ring holes, refer to the Universal Components section of the Operative Technique.

The holes on the circular region of all types of rings are symmetric, equidistant, and grow uniformly between different sizes; hence, there are no limitations in terms of how they need to be oriented.

Ring markings

The Hoffmann LRF Rings feature various sets of markings that aid in the building of a hexapod frame. The master marker is identified by the Stryker logo. **(Figure 225C)**

All rings, except the foot arch, have a solid border within the tabbed region that defines all holes where struts may be mounted in a hexapod configuration. The full and half rings have a dashed border within the non-tabbed region that defines all the holes where struts may be mounted in a double-stack hexapod frame configuration. Default mounting locations for the struts are indicated by a solid circle. **(Figure 225A)**

When two half rings are assembled, the solid and dashed borders match the markings on the full ring. **(Figure 225B)**

NOTICE

Strut mounting sites vary depending on the ring type and size selected.

NOTICE

Frames constructed using two 2/3 rings only (proximal and distal) have not been mechanically evaluated and are not recommended.

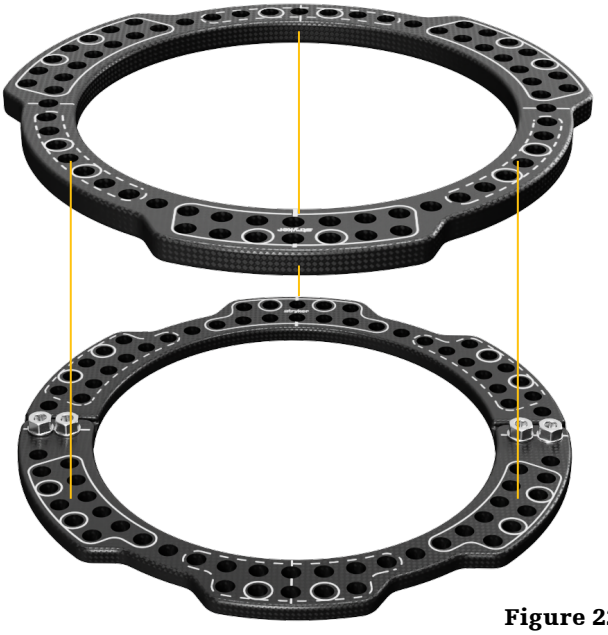


Figure 225

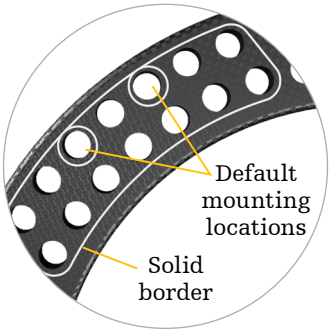


Figure 225A

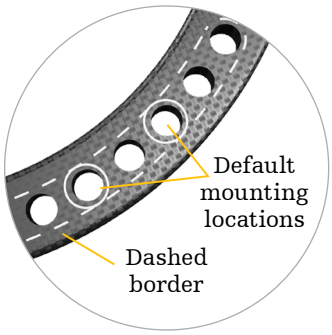


Figure 225B

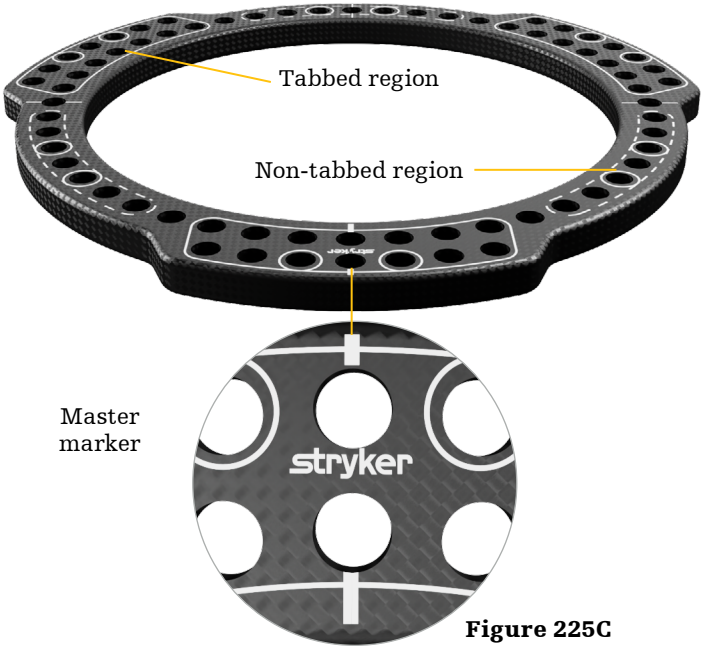


Figure 225C

Hoffmann LRF smartHEX - Rings and mounting locations

Ring default mounting locations

When the default mounting locations in a hexapod configuration are used, the struts are mounted to the holes indicated with a solid circle within the solid border of a tabbed region.

Struts 1 and 2 are mounted on the tabbed region identified by the master marker. Moving counterclockwise, Struts 3, 4, 5 and 6 are mounted on the other tabbed regions. **(Figure 226)**



Figure 226

NOTICE

The smartHEX Web Application defaults to specific mounting sites for open rings.

When the foot ring is identified as the distal ring and a circular ring as the proximal ring, refer to the default mounting locations of the struts on the distal foot ring. **(Figure 227)**

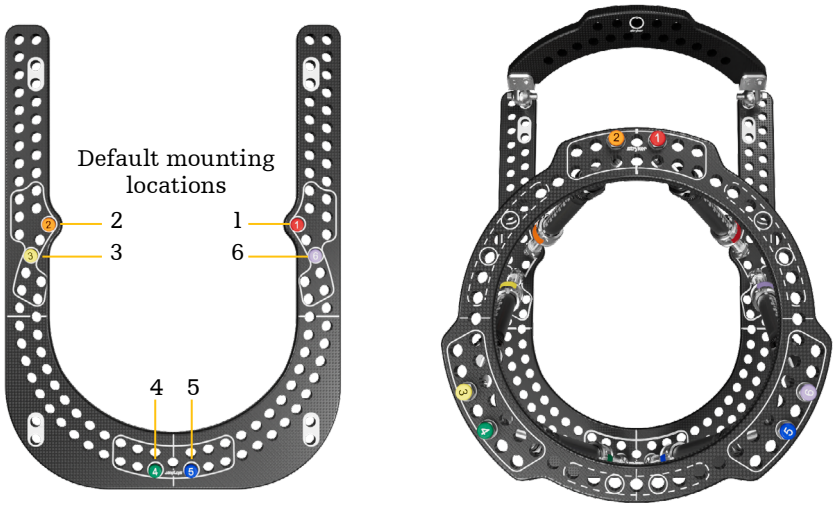


Figure 227

Hoffmann LRF smartHEX - Rings and mounting locations

Ring non-default mounting locations

If the default mounting locations are unusable because of external fixation components occupying those holes or other reasons, struts may be offset into any of the holes within the solid border of the tabbed region. **(Figure 228)** As well as the dashed border of the non-tabbed region. Struts may be adjacent to each other but should not cross or be radially adjacent to each other. **(Figure 229)**

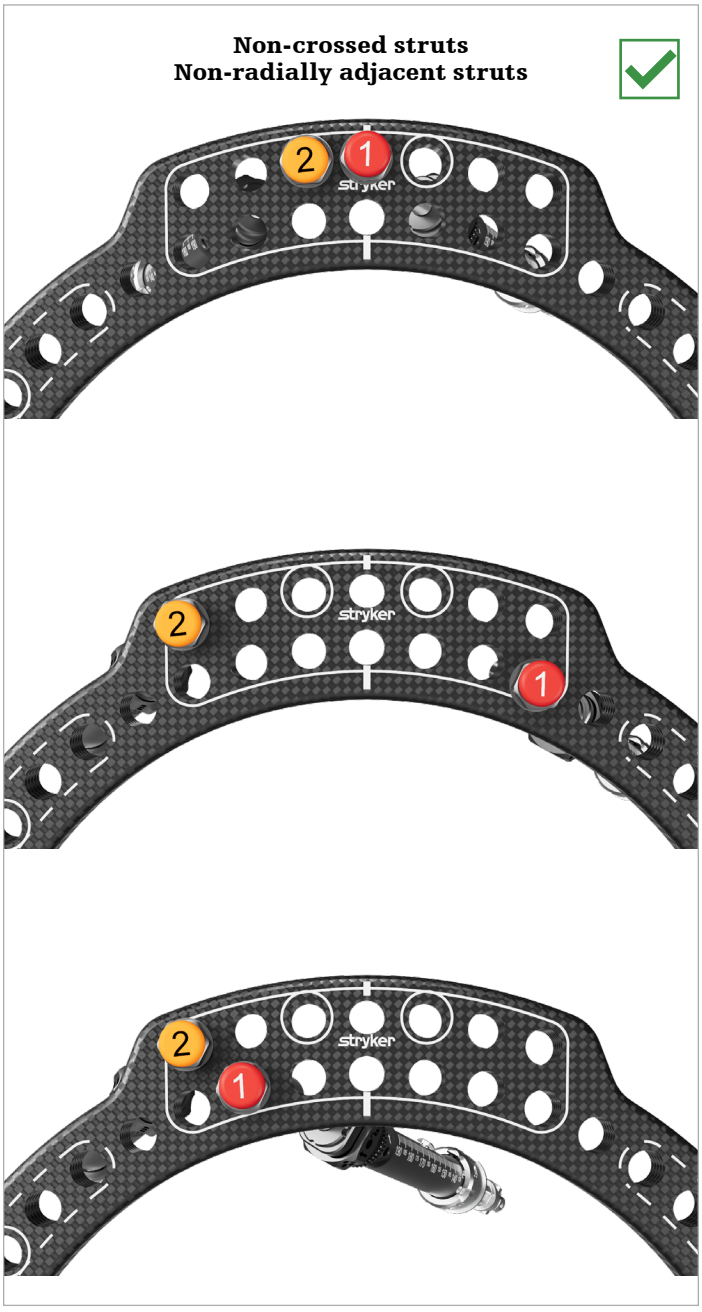


Figure 228

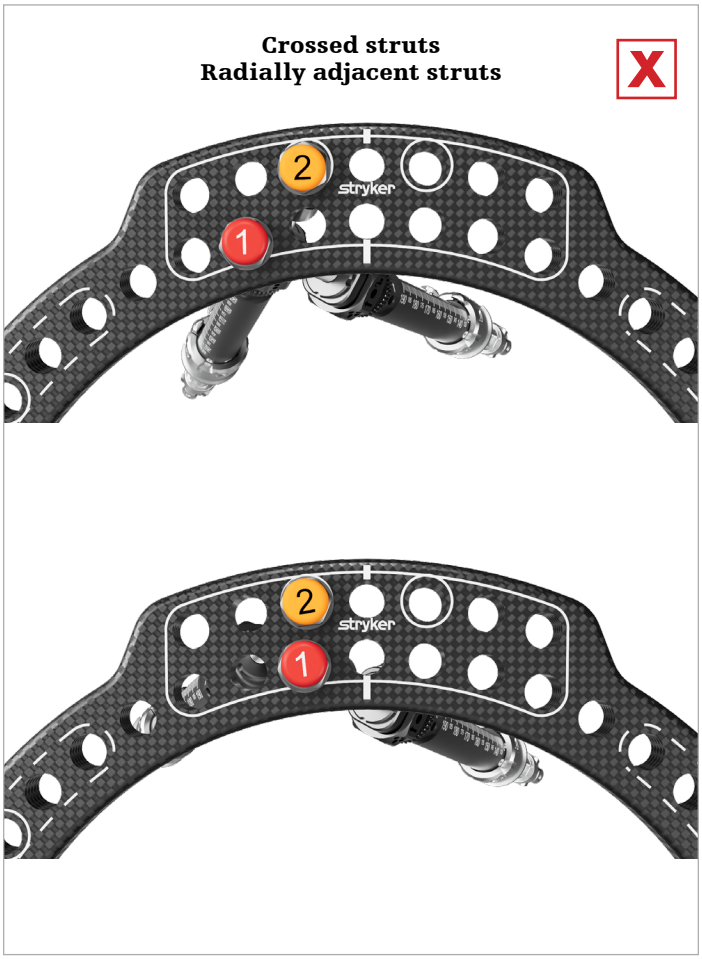


Figure 229

Hoffmann LRF smartHEX - Rings and mounting locations

Ring default mounting locations for double-stacked frames

There are multiple ways that the distal rings can be oriented in a double-stacked hexapod configuration.

Option 1

The configuration has the proximal and shared (middle) ring master markers both facing forward. In this setup, the hexapod struts are attached to all six regions of the shared ring, including the three tabbed regions and the three non-tabbed regions. **(Figure 230)**

Option 2

This configuration involves rotationally offsetting the shared (middle) ring master marker, which can help maximize tabbed space or accommodate the use of a 2/3rd ring as the shared ring (miter frame). Within the Web App the middle ring needs to route 60°. **(Figure 231)**

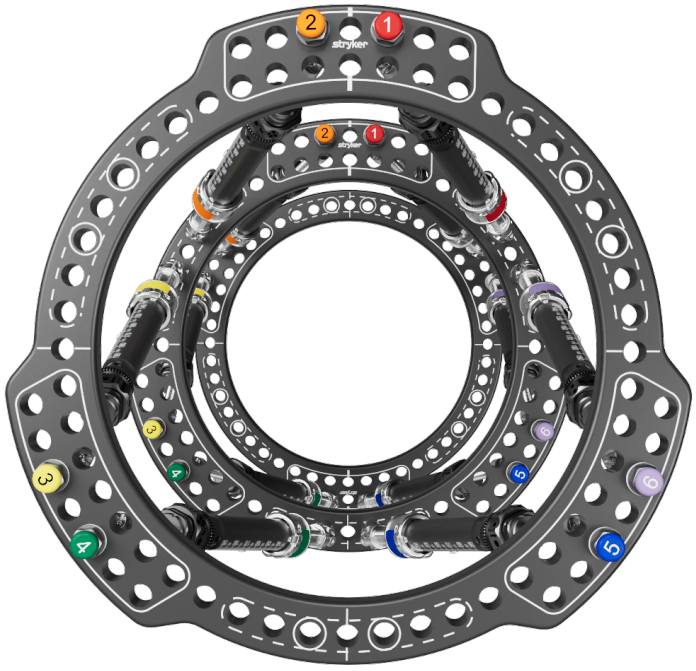


Figure 230

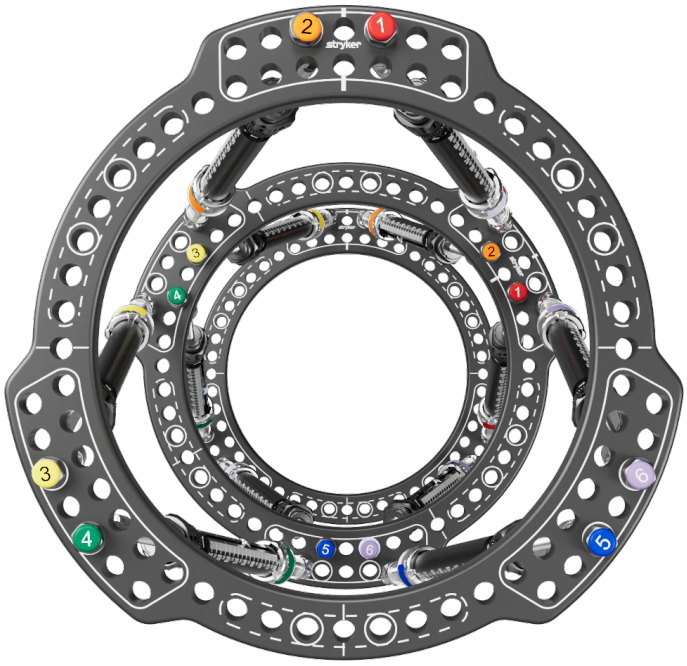


Figure 231

Hoffmann LRF smartHEX - Rings and mounting locations

Strut offsetting

The smartHEX struts can be positioned up to three holes away from their default attachment sites by offsetting clockwise or counterclockwise on either the inner or outer rows of ring holes. Once final strut placement is determined, the strut's specific offset location can be entered into the smartHEX Web Application to adjust the correction algorithm.

The offset feature offers flexibility in strut placement, making it easier to work around fixation components and in tight ring-to-ring distance scenarios. Offsetting struts can improve access to the surgical site, increase radiographic visibility, and may reduce the need for strut changes. If the strut's working length is limited, offsetting one or both ends can help recoup length.

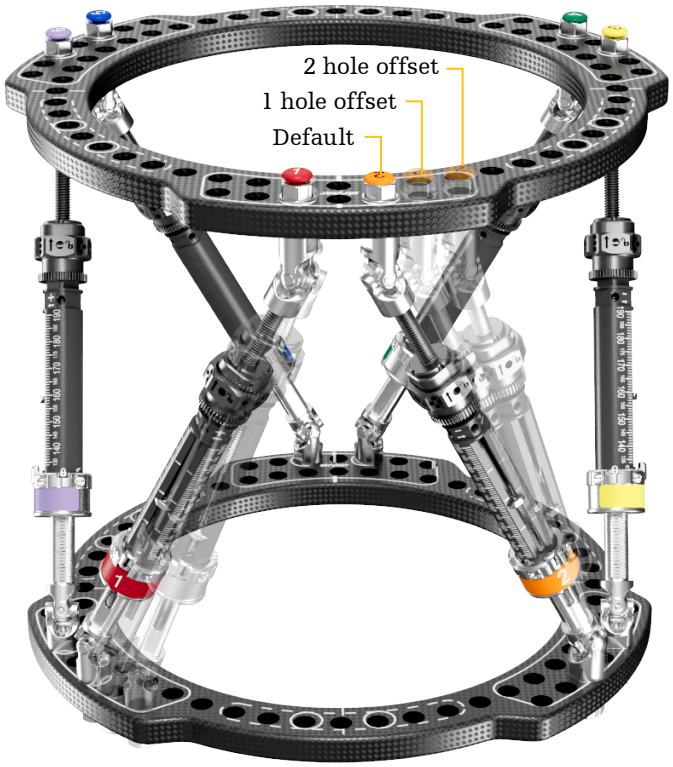


Figure 232

⚠CAUTION

smartHEX struts may be offset into any of the holes within the solid border of the tabbed region. Offsetting holes may vary depending on the ring type and size. Refer to the Hole Offset Worksheet (FA-HLHX-SURGP-3210081) for details on offset capabilities by ring size and type.

Strut offsets can be planned preoperatively using the smartHEX Web Application or performed intraoperatively based on the surgical scenario. All offset parameters must be entered into the application postoperatively to ensure an accurate correction plan.

⚠WARNING

The risk of an unstable frame increases with high (close to 90o degrees at both u-joints) or low (close to 0o at both u-joints) angulation of the struts. If utilizing strut offset variations, especially more substantial offsets, check for an unstable frame throughout the duration of the correction plan.

Hoffmann LRF smartHEX - Strut overview

Strut offset plates

The offset plate allows for closer ring-to-ring distance. Achievable distance will depend on plate size and where it is attached to the ring (distally or proximally). If offset plates are used on both ends of the struts, an even closer ring-to-ring distance is possible.

Strut offset plates are available in two sizes:

- Standard (4936-3-060)
- Long (4936-3-070)

An offset can occur in any direction from the default location, as long as it is within the inner or outer rows of the solid border of the tabbed regions of the ring. Both posts of the offset plate must sit within the solid border.

Struts are attached to the surface of the offset plate labeled “Strut Side”. **(Figure 234-235)**



Figure 233

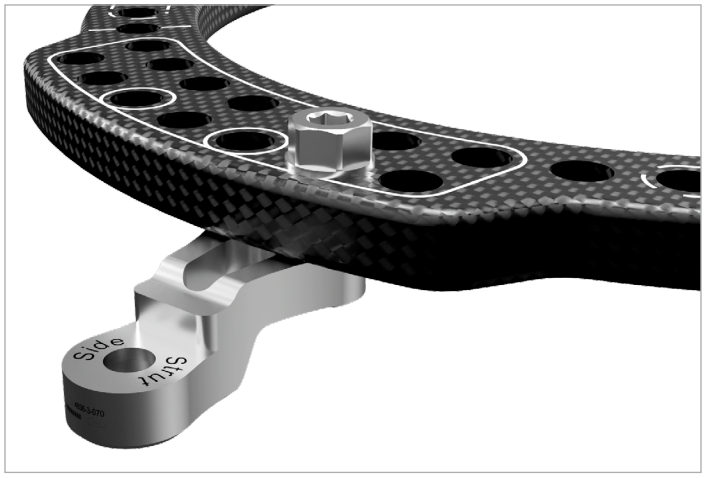


Figure 234

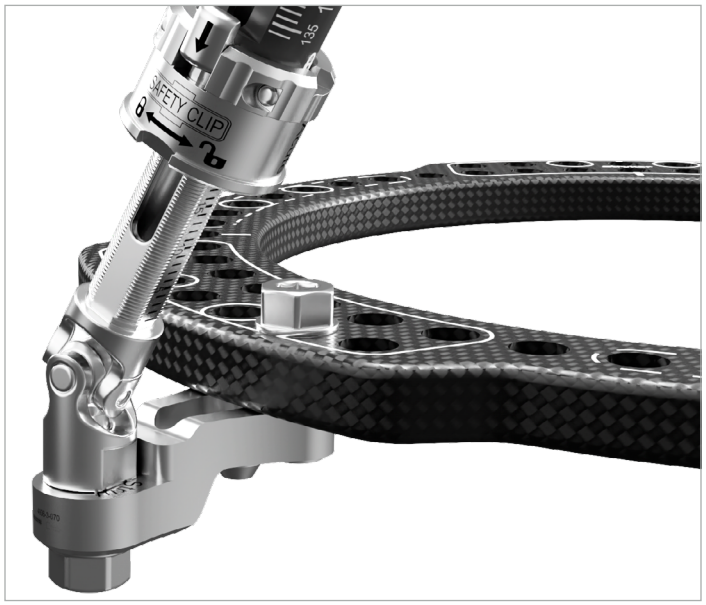


Figure 235

Hoffmann LRF smartHEX - Rings and mounting locations

Applying the smartHEX construct

Mounting the frame

WARNING

In certain circumstances, supplemental fixation should be considered (i.e. obese patients or patients that are ambulatory in the early postoperative phase). Construct design and weight bearing protocols are always at the surgeon's discretion.

Pre-built frame approach

Pre-operative planning and prebuilding frames in deformity correction surgery can allow for better planning of the procedure and reduced intraoperative decision-making (as compared to no planning and building the frame during the procedure). Additionally, plans can be shared and discussed with the care team and patient in advance of surgery.

Steps

1. Choose an appropriate reference ring. If a pre-operative plan was completed in the smartHEX Web Application, use the reference ring that was defined in the app. If an alternate size is required, it must be updated in the post-operative workflow.
2. Choose the appropriate strut sizes. If a pre-operative plan was completed in the smartHEX Web Application, use the size options generated by the software.
3. Attach struts in nominal positions or in accordance with the construct modeled in the preoperative workflow of the smartHEX Web Application. Strut orientation must be uniform for all struts. If utilizing pre-established strut lengths from the smartHEX Web Application, set the strut lengths using the plan's acute and gradual readings prior to mounting the struts to the rings.
4. Attach the moving ring with the master marker oriented directly posterior and opposite (180O) to the master marker on the reference ring.

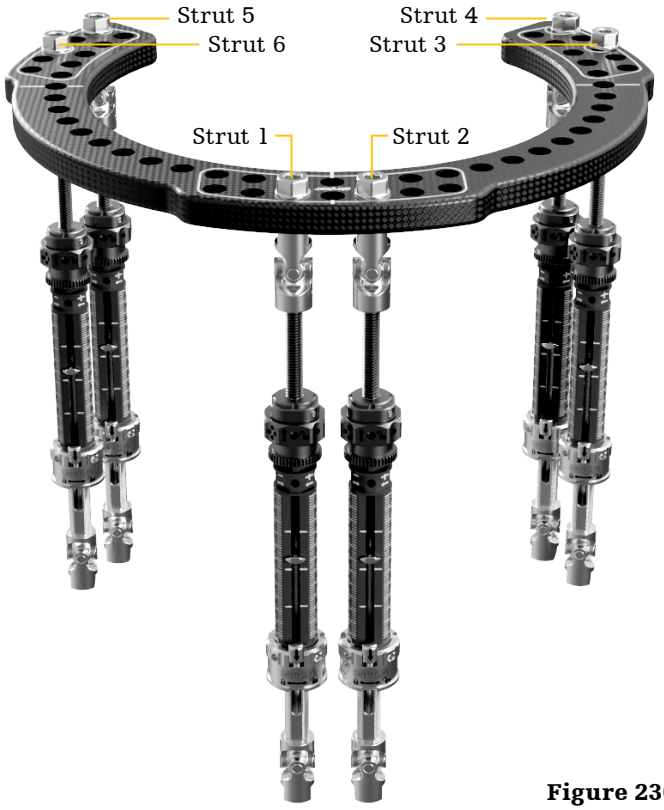


Figure 236



Figure 237

Hoffmann LRF smartHEX - Rings and mounting locations

5. Adjust the strut lengths to the desired position. If a pre-operative plan was completed in the smartHEX Web Application, use the length options generated by the software.

CAUTION

The distal ring should be positioned with the master marker facing posterior (180-degree offset with the proximal master marker). If a rotational deformity needs to be applied, it should be done with respect to this 180-degree offset.

6. Adjust each strut so that the lengthening scale is facing outward.
7. Securely tighten all connection points and lock each strut's quick-release mechanism.

NOTICE

Guidance for sterilization of a pre-built frame construct can be found in **Appendix A: Pre-built frame sterilization guidelines**.

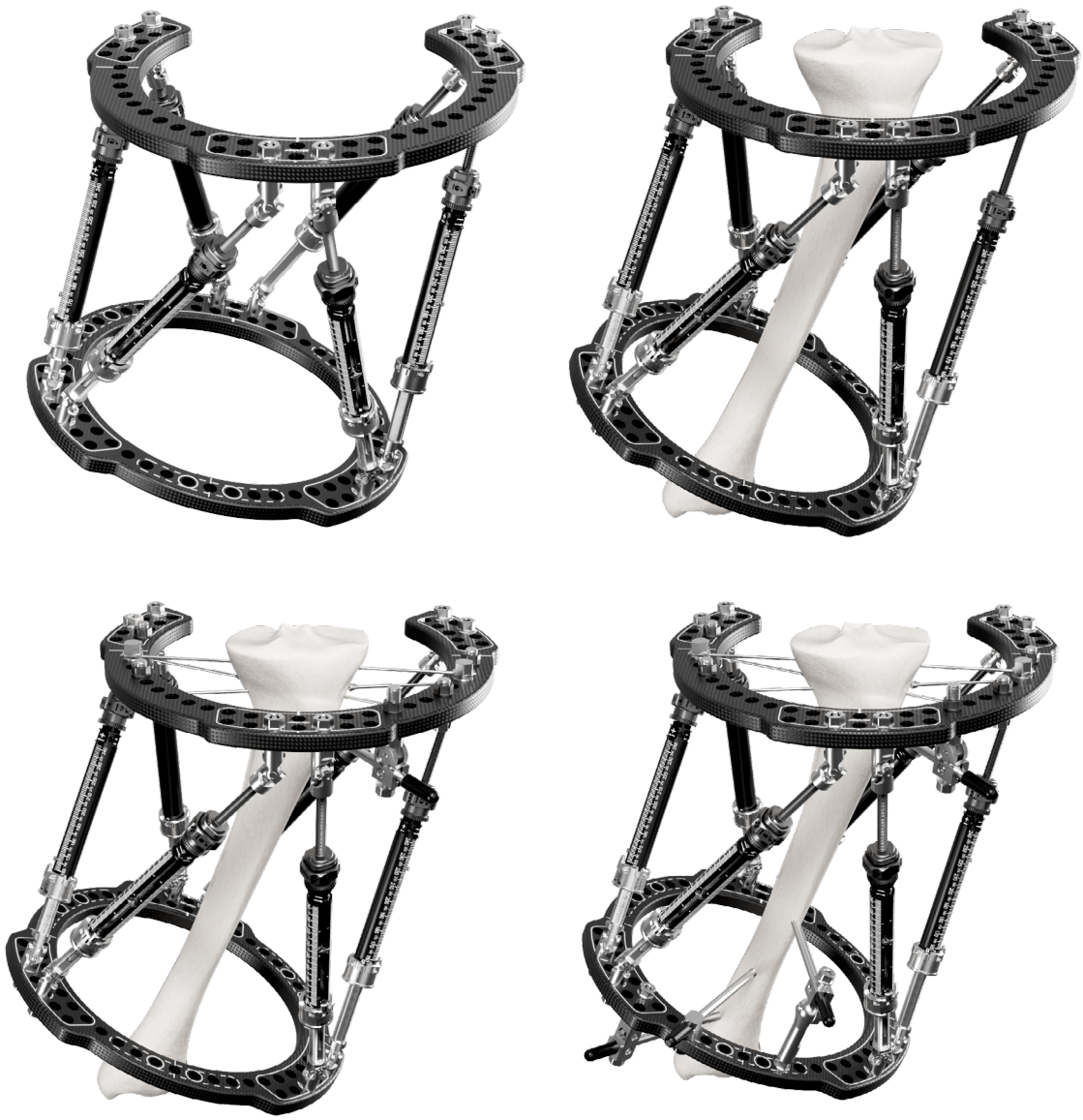


Figure 238

Hoffmann LRF smartHEX - Rings and mounting locations

Rings first approach

With this technique, two rings are mounted to the bone independently utilizing wire or pin fixation. After mounting, the two rings are connected with the appropriate length struts. These steps assume a proximal reference and distal moving ring.

Steps

1. Insert the reference wire or pin: Using a reference wire or pin, the initial location and orientation of the reference ring is established. Be sure to insert the reference wire or pin and attach rings as orthogonally as possible. **(Figure 239)**
2. Attach the proximal ring: The ring is attached with the master marker (indicated by a Stryker logo) aligned with the anterior surface of the bone.

NOTICE

If using a closed proximal ring, it must be mounted prior to mounting the distal ring.

NOTICE

When the frame is assembled around severe rotational deformities, ensure that struts do not impinge on soft tissues. Larger ring diameters can be considered to increase the clearance between the struts and the soft tissue.

3. Using fixation components, fix the reference wire or pin to the ring. When applying fixation, take note of nominal strut attachment sites and avoid placing fixation there if possible.

NOTICE

The choice of fixation type and placement is dictated by surgeon preference and the specific indication being treated. Patient positioning is dictated by indications and surgeon preference.

4. When more than one point of fixation is secured to a ring, the ring orientation is provisionally fixed.



Figure 239

Hoffmann LRF smartHEX - Rings and mounting locations

5. Mount the distal "moving" ring: Mount the moving ring with the master marker placed directly posterior (opposite to the reference ring master marker).
   a. Before inserting fixation for the moving ring, check that ring spacing can accommodate the minimum strut length in the location where the two rings are closest together.
   b. Unless intentionally planning for a non-orthogonal ring placement, the moving ring should be placed orthogonally to the moving fragment.

⚠CAUTION

The master marker on the moving ring should be placed directly posterior. **(Figure 240)** If correcting rotation, a rotary offset of the moving ring may be applied before mounting the ring to the bone.

⚠CAUTION

If using a "rings first" application approach, ring placement must allow for the attachment and desired travel (compression or distraction) of the smartHEX struts with or without offsets. Strategic ring spacing may maximize the travel of each size strut and minimize the need for strut change-outs.

6. Attach the smartHEX struts: On the reference ring, locate the master marker (identified by the Stryker logo) and attach Strut 1 using the hardware connection bolt in the nominal position. The nominal position is the outer row hole directly clockwise to the master marker. **(Figure 241)**
   a. smartHEX Web Application users: If the software has identified a hole offset for Strut 1, attach the strut in this ring hole instead.

⚠CAUTION

For the smartHEX Web Application to perform an accurate calculation, the struts must be installed directly to- the rings within the designated range of holes. Constructing custom outrigger assemblies for strut attachment may cause inaccuracies in the software's generation of the correction plan.



Figure 240

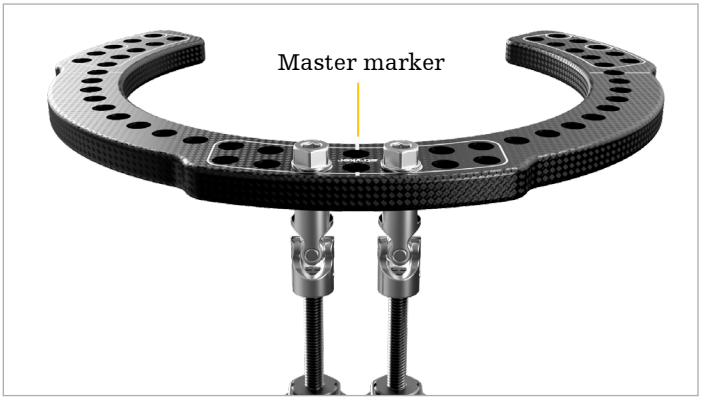


Figure 241

Hoffmann LRF smartHEX - Rings and mounting locations

7. Secure Strut 1 by tightening the hardware connection bolt using a 10mm wrench.
8. Attach the opposite end of Strut 1 to the moving ring using a hardware connection bolt and tighten. Position the strut so that the lengthening scale is facing outward.
9. Repeat for Struts 2-6, moving counterclockwise along the ring, following the markings that indicate where struts may be attached.
   a. smartHEX Web Application users: If the software has identified hole offsets for Struts 2-6, attach each strut in the indicated ring hole.
10. Ensure each strut is securely locked.
11. Confirm construct stability and apply additional fixation if necessary.

⚠CAUTION

- Confirm all nuts, bolts and connections are tightened.
- Confirm all quick-release mechanisms are in the locked position prior to applying the safety clips.

12. If desired, struts can be repositioned to improve physical access and radiographic visibility of the osteotomy. If moved, ensure the strut is securely retightened and reconfirm construct stability.
    a. smartHEX Web Application users:
    If repositioned, input the new location in the post-operative workflow.
13. After confirming all component connections are positioned and tightened properly, dress wounds, and pin and wire sites according to surgeon preference.

⚠CAUTION

To prevent strut adjustment challenges or an unstable frame construct, the smartHEX struts should not be set to an angle beyond 80°.

⚠CAUTION

Once all struts are attached, confirm that struts are correctly identified and securely tightened using counter-torque. Confirm all quick-release mechanisms are in the locked position prior to attaching the safety clips.



Figure 242

Hoffmann LRF smartHEX - Rings and mounting locations

Strut controller trials

The strut controller trials are plastic shells shaped like a smartHEX strut controller that are designed to be used in the operating room as a physical representation of the smartHEX controllers. Use the trials to ensure that there is sufficient space surrounding the controller attachment region on the smartHEX struts to ensure there will not be any interference with other frame components. The actual smartHEX strut controllers are installed post-operatively. The controller trials connect to the struts in one step. **(Figures 243-244)**



Figure 243



Figure 244

Hoffmann LRF smartHEX - Rings and mounting locations

Strut identification post frame build

After each strut is confirmed locked, attach the strut safety clips to Struts 1-6 **(Figure 245)** to reinforce each quick-release mechanism. Safety clips are securely attached when they are correctly aligned and lay flush without the ability to spin. **(Figure 246)** Attach each numbered safety clip in sequential order starting with clips 1 and 2 on either side of the master marker. When facing the patient, work counterclockwise (to the surgeon's right, patient's left) to attach clips 3-6. **(Figure 248)** For smartHEX Web Application users, proper ordering of the numbered strut safety clips in relation to the reference ring is especially important.

The corresponding ID caps will be attached post-operatively.

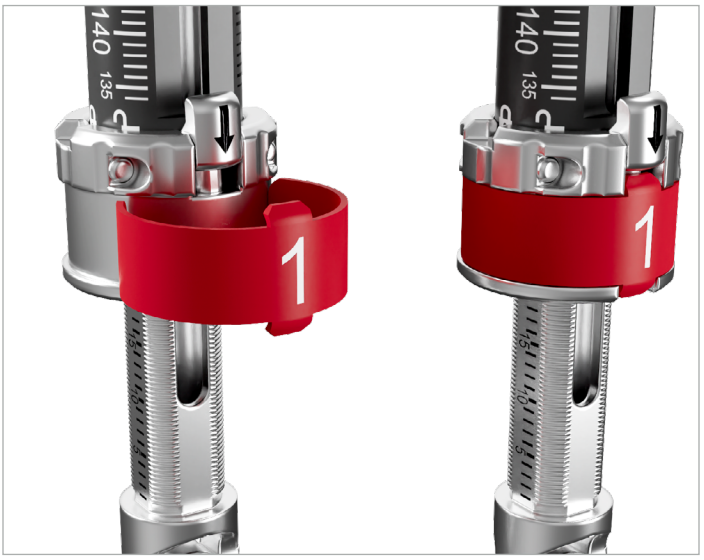


Figure 245

⚠CAUTION

Check that all six strut's safety clips are placed on the correct struts and are sequentially positioned around the ring.

NOTICE

Since the Mini strut does not have a quick-release mechanism, the safety clip cannot be used. Use the ID caps to identify Mini struts.

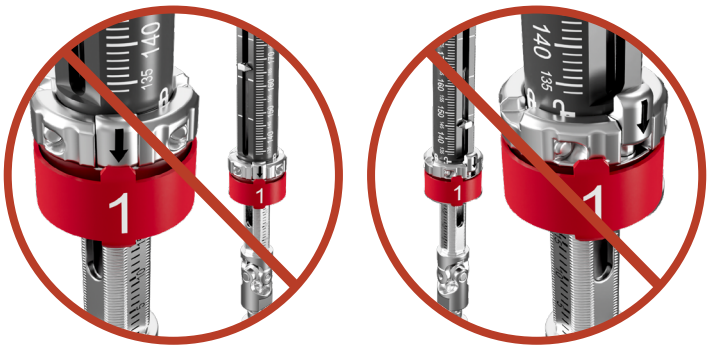


Figure 246



Figure 247

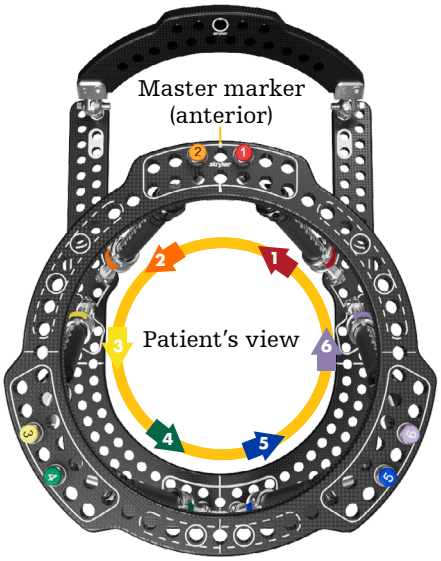


Figure 248

Hoffmann LRF smartHEX - Rings and mounting locations

Performing a corticotomy

After confirming construct stability, a corticotomy may be performed according to surgeon preference, as a condition of the corticotomy site, or in line with the smartHEX Web-Application preoperative correction plan guidance.

Once a corticotomy is completed, manual manipulation of the bone segments may be performed by unlocking one or more smartHEX struts.

⚠CAUTION

Once strut adjustments are complete and desired bone alignment is achieved, re-confirm stability of the construct.

smartHEX web application users

In the post-operative workflow for case management, record the critical software inputs including:

- Ring and strut mounting parameters
- Anterior-posterior and lateral-medial X-rays or other imaging, as required

With these recorded inputs, the web app can be used to generate the final correction plan.



Figure 249

Hoffmann LRF smartHEX - Rings and mounting locations

Post-operative strut adjustments

The smartHEX struts are capable of both manual and controller-assisted gradual adjustments.

Gradual manual adjustments

If a prescribed correction plan calls for manual adjustments during the post-operative correction phase, the patient or designated caregiver may adjust each smartHEX strut using the gradual adjustment knob.

NOTICE

To shorten the strut, the gradual adjustment knob is lifted and then rotated clockwise. To lengthen the strut, the adjustment knob is lifted then rotated counterclockwise. Each turn or "click" of the adjustment knob is ¼mm of adjustment length.

smartHEX Web Application users

The direction of each adjustment is indicated in the Correction Schedule table. Only make adjustments to the prescribed strut. After a full day of adjustment, the correction should be verified by confirming that the strut's length scale reads the appropriate number on the patient correction plan. **(Figure 250)** Patient-specific instructions for making adjustments are located in the smartHEX Patient Guide.

⚠CAUTION

Fast adjustment rates may lead to complications, including soft tissue or neurovascular damage. Slower rates of correction may also lead to complications such as premature consolidation. Rates of correction are indication-specific and may vary by patient.

⚠CAUTION

The strut safety clip should not be removed during routine gradual adjustments. This ensures that unintentional acute adjustment does not occur.



Figure 250

Hoffmann LRF smartHEX - Rings and mounting locations

Strut adjustment, repositioning and change-out procedure

While executing the patient correction plan, there may be a need to perform an acute adjustment, offset, or change-out of one or more struts once maximum distraction or compression has occurred.

For smartHEX Web Application users: the time frame for a strut's acute adjustment or change-out is documented in the patient's correction plan. Date ranges are listed in the Strut Replacement Schedule and highlighted in the Correction Schedule table. Refer to the smartHEX Web Application User Manual for more information.

⚠CAUTION

To execute the patient correction plan accurately, acute adjustments and strut change-outs must occur within the indicated time frame. When performing a strut acute adjustment or change-out, the user must preserve the correction already achieved. Before conducting a repositioning or change-out procedure, the patient should be seated or resting without any load applied to the construct.

⚠CAUTION

The construct must be temporarily reinforced with supplemental fixation components to constrain any unwanted motion.

Reinforce the construct with temporary supplemental fixation

Dedicated components and instruments **(Table 14)** may be utilized to temporarily secure the frame construct during a strut adjustment, repositioning, or changeout procedure.

Table 14: Strut change-out components and instruments

Item #	Description	Req. Qty
4933-1-688	8 × 88mm Posts (long)	2
4933-1-010	Short M8 Connecting Nuts	2
4922-1-015	Multiplanar Delta Coupling	2
4922-8-350	11mm MRI Vectran coated carbon connecting rod	1
4933-9-204	Spanner Wrench 7mm/10mm	2

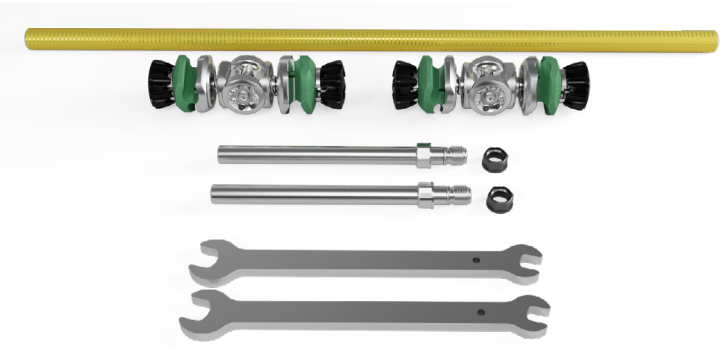


Figure 251

Hoffmann LRF smartHEX - Rings and mounting locations

Steps

1. Identify the strut(s) to be adjusted, repositioned, or exchanged in accordance with the patient's correction plan.
2. Within close proximity to the identified strut, mount an 8mm post on both the proximal and distal rings with short M8 connecting nuts. **(Figure 252)** Use counter-torque to ensure that the connection is secure. Posts may be placed on either the inferior or superior surface of the ring.

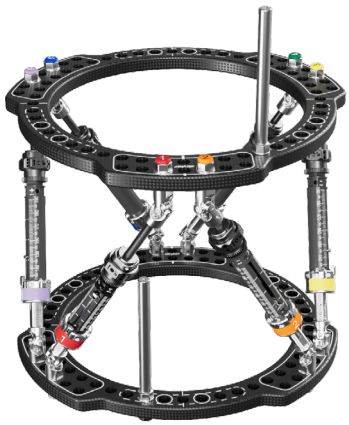


Figure 252

NOTICE

Positioning the posts on one side of the target strut will minimize obstruction during the strut adjustment and reattachment process.

3. Span the proximal and distal posts with the 11 × 350mm Vectron rod and couplings. The removable thumbwheel may be used for provisional tightening. Tighten the clamps with a wrench to secure the assembly. **(Figure 253)**

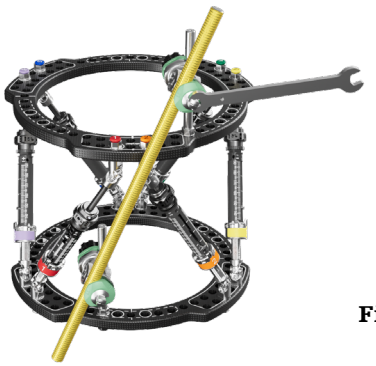


Figure 253

4a. Strut acute adjustment steps

- When the construct is adequately reinforced, adjust the identified strut **(Figure 254)** by detaching one end of the strut from the ring, preferably the acute end of the strut.
- Spin the strut using the strut's directional markings to adjust the gradual reading to the desired length.
- To compensate for the adjusted strut length, adjust the acute length. Proceed to **Step 5**.

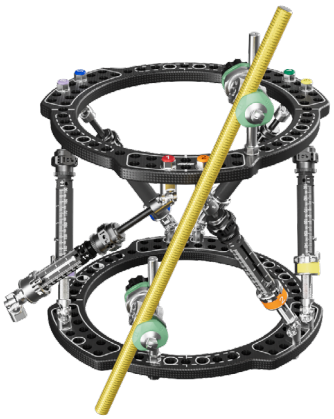


Figure 254

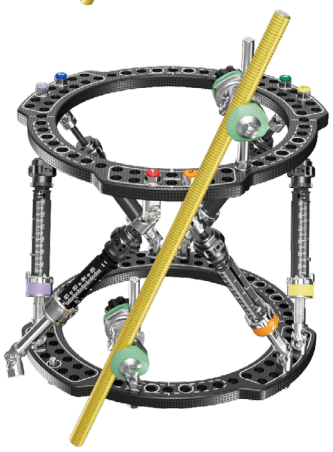


Figure 255

Hoffmann LRF smartHEX - Rings and mounting locations

4b. Strut repositioning or change-out steps:

- When the construct is adequately reinforced, remove or relocate the identified strut. **(Figure 256)** One end or both ends of the strut may be relocated.
- Position the new or relocated strut with the lengthening scale facing outward and secure the strut with hardware connection bolts. Replace the correct numbered and colored safety clip as needed. **(Figure 257)**

5. Review the entire construct to confirm stability with the new strut in place. **(Figure 258)** Ensure that all other struts and fixation components are securely tightened.

NOTICE

For smartHEX Web Application users: If the strut adjustment, repositioning or changeout procedure created a deviation from the established correction plan, the plan must be updated with the new strut placement, size and length parameters. Update the plan by revising the study in the web application.

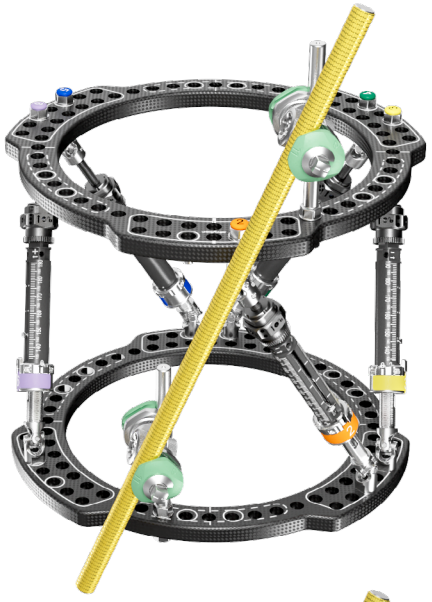


Figure 256

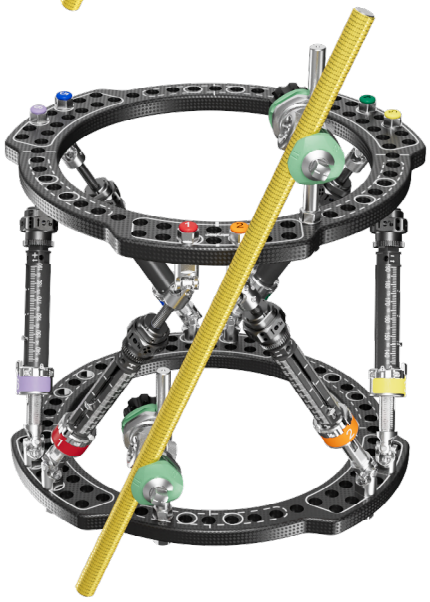


Figure 257



Figure 258

Hoffmann LRF smartHEX - Rings and mounting locations

smartHEX controller-assisted strut adjustments (optional)

Attach the strut controllers

The smartHEX Strut Controllers are installed post-operatively. For easy reference, a quick-start setup guide is printed on the inner lid of each Strut Controller Kit box.

Steps

1. Install the batteries: Rotate the tab on the battery door counterclockwise to open the battery door and insert the CR-2 battery. Turn the battery door clockwise to close it. When the battery is successfully installed, the controller's light ring will illuminate with a solid green light. A green light indicates that the battery is correctly installed, and that the controller is powered on. Repeat for the five remaining controllers.

⚠CAUTION

Only primary CR-2 batteries provided in the strut controller battery multipack (4938-3-203) should be used for the strut controller.

2. Attach the controller to the strut: align the controller's square bracket interface with the square feature on the strut's gradual correction knob **(Figure 260A)** and push the controller into place. This will seat the controller. Check that strut thumb knob does not turn freely.
3. Once the controller is securely seated, firmly tighten the 2.5mm bracket screw utilizing the 2.5mm Hex Key provided with the Strut Controller Kit (4938-0-510). **(Figure 260B)** Repeat for the five remaining controllers.
4. Attach ID caps: Attach each of the six ID caps to the strut controllers. **(Figure 261)** Ensure that each ID cap correctly corresponds to the color and number of the strut safety clip. If the alternative ID stickers are used, they may be applied at this time.



Figure 259

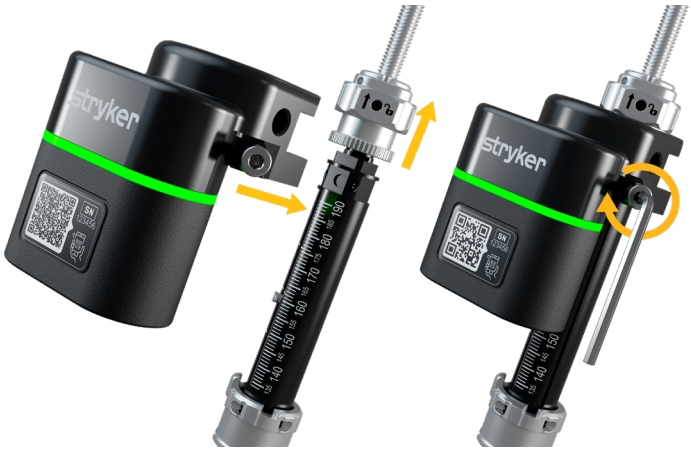


Figure 260A **Figure 260B**

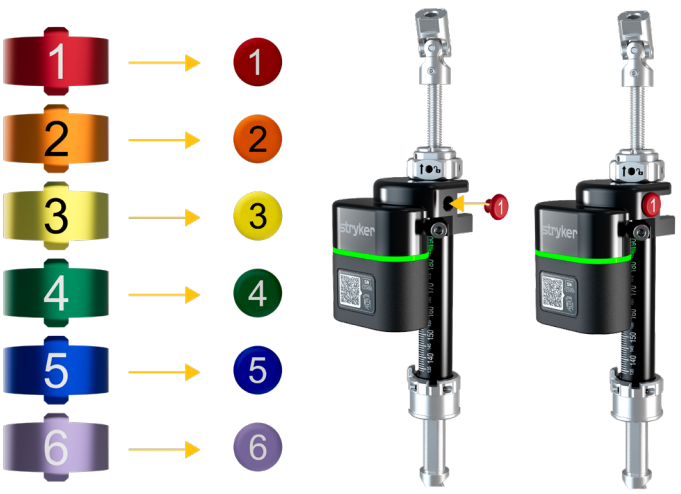


Figure 261

Hoffmann LRF smartHEX - Rings and mounting locations

NOTICE

Because the mini strut size does not include a quick-release mechanism, the safety clip cannot be applied. Refer to the ID caps for identification of mini struts.

NOTICE

Controllers, batteries and 2.5mm Hex Key must not be sterilized or reprocessed

5. After all controllers are securely attached to the frame construct, they are ready to enroll with the patient's mobile phone using the HexConnect Mobile Application.
6. Once the patient's mobile app is enrolled with the controllers, the patient will be able to initiate the controller-assisted strut adjustments in accordance with the correction plan generated in the smartHEX Web Application.

For further instructions on enrolling the controllers and initiating controller-assisted corrections: refer to the smartHEX Controller and Mobile Application User Manual.

Battery changes

For further instructions on battery changes: refer to the smartHEX Controller and Mobile Application User Manual.

Strut controller removal

At any point during the correction plan, the surgeon may decide to discontinue controller-assisted corrections and resume with manual corrections. The smartHEX strut controllers can be removed from the frame by loosening the 2.5mm bracket screw and detaching the controllers from each strut.

For further instructions on strut controller removal: refer to the Hoffmann LRF smartHEX Strut Controller and Mobile Application User Manual.

Appendix A:
Pre-built frame sterilization guidelines

Appendix B:
Hoffmann LRF system components

Appendix C:
Minimum required system components

The information in these sections is not intended to be used for sales and/or promotional purposes. This information is solely intended to be used as a reference for clinical usage.

Appendix A: Pre-built frame sterilization guidelines

The Hoffmann LRF System allows the following non-sterile components to be preassembled on the carbon fiber rings (item codes starting with 4936/4937) and aluminum rings (item codes starting with 4936/4937) for the purposes of building a frame construct prior to sterilization and surgery. For information regarding the Sterilization Parameters please refer to the Hoffmann LRF IFU.

NOTICE

A foot arch may not be used for a pre-built frame construct.

⚠CAUTION

Certain components (Table A.A) must only be tightened with fingers or a thumbwheel wrench (4933-9-203) prior to sterilization; final tightening must be done during surgery.

Table A.A: Non-sterile components for which pre-sterilization tightening must be limited

Item No	Description
4933-0-180	Telescopic strut long, red
4933-0-100	Telescopic strut extra short, black
4933-0-120	Telescopic strut short, yellow
4933-0-140	Telescopic strut medium, blue
4933-1-644	Post, short
4933-1-688	Post, long
4936-3-010	smartHEX strut, mini
4936-3-020	smartHEX strut, extra short
4936-3-030	smartHEX strut, short
4936-3-040	smartHEX strut, medium
4936-3-050	smartHEX strut, long
4933-1-520	Static strut, extra short 20mm
4933-1-530	Static strut, short 30mm
4933-1-540	Static strut, medium 40mm
4933-1-560	Static strut, long 60mm
4933-0-801	Half hinge
4933-0-800	Hinge coupling
4933-0-700	Universal joint
4933-1-710	Washer 1mm, black
4933-1-711	Washer 2mm, yellow
4933-1-712	Washer 4mm, blue
4933-1-713	Washer 7mm, red
4934-1-060	Slotted plate
4938-3-102	MG connection plate, 2 hole
4938-3-103	MG connection plate, 1 hole+1 slot
4938-3-104	MG connection plate, 2 hole+1 slot
4938-3-105	MG connection plate, 3 hole+1 slot
4938-3-002	Twisted plate
4933-1-030	Threaded rod 30mm with or without spherical washer (4933-1-720)
4933-1-060	Threaded rod 60mm with or without spherical washer (4933-1-720)
4933-1-080	Threaded rod 80mm with or without spherical washer (4933-1-720)
4933-1-100	Threaded rod 100mm with or without spherical washer (4933-1-720)
4933-1-120	Threaded rod 120mm with or without spherical washer (4933-1-720)
4933-1-150	Threaded rod 150mm with or without spherical washer (4933-1-720)
4933-1-200	Threaded rod 200mm with or without spherical washer (4933-1-720)
4933-1-250	Threaded rod 250mm with or without spherical washer (4933-1-720)
4933-1-300	Threaded rod 300mm with or without spherical washer (4933-1-720)
4933-1-350	Threaded rod 350mm with or without spherical washer (4933-1-720)
4933-1-400	Threaded rod 400mm with or without spherical washer (4933-1-720)

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Appendix B: Hoffmann LRF system components

Item No	Description
4936-1-080	Aluminum Full Ring Tabbed 80mm Al Alloy unsterile
4936-1-105	Aluminum Full Ring Tabbed 105mm Al Alloy unsterile
4936-1-130	Aluminum Full Ring Tabbed 130mm Al Alloy unsterile
4936-1-155	Aluminum Full Ring Tabbed 155mm Al Alloy unsterile
4936-1-180	Aluminum Full Ring Tabbed 180mm Al Alloy unsterile
4936-1-205	Aluminum Full Ring Tabbed 205mm Al Alloy unsterile
4936-1-230	Aluminum Full Ring Tabbed 230mm Al Alloy unsterile
4936-1-255	Aluminum Full Ring Tabbed 255mm Al Alloy unsterile
4936-1-280	Aluminum Full Ring Tabbed 280mm Al Alloy unsterile
4936-1-305	Aluminum Full Ring Tabbed 305mm Al Alloy unsterile
4937-1-105	Carbon Full Ring Tabbed 105mm Carbon unsterile
4937-1-130	Carbon Full Ring Tabbed 130mm Carbon unsterile
4937-1-155	Carbon Full Ring Tabbed 155mm Carbon unsterile
4937-1-180	Carbon Full Ring Tabbed 180mm Carbon unsterile
4937-1-205	Carbon Full Ring Tabbed 205mm Carbon unsterile
4936-2-080	Aluminum 2/3 Ring Tabbed 80mm Al Alloy unsterile
4936-2-105	Aluminum 2/3 Ring Tabbed 105mm Al Alloy unsterile
4936-2-130	Aluminum 2/3 Ring Tabbed 130mm Al Alloy unsterile
4936-2-155	Aluminum 2/3 Ring Tabbed 155mm Al Alloy unsterile
4936-2-180	Aluminum 2/3 Ring Tabbed 180mm Al Alloy unsterile
4936-2-205	Aluminum 2/3 Ring Tabbed 205mm Al Alloy unsterile
4936-2-230	Aluminum 2/3 Ring Tabbed 230mm Al Alloy unsterile
4936-2-255	Aluminum 2/3 Ring Tabbed 255mm Al Alloy unsterile
4936-2-280	Aluminum 2/3 Ring Tabbed 280mm Al Alloy unsterile
4937-2-105	Carbon 2/3 Ring Tabbed 105mm Carbon unsterile
4937-2-130	Carbon 2/3 Ring Tabbed 130mm Carbon unsterile

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Appendix B: Hoffmann LRF system components

Item No	Description
4937-2-155	Carbon 2/3 Ring Tabbed 155mm Carbon unsterile
4937-2-180	Carbon 2/3 Ring Tabbed 180mm Carbon unsterile
4937-2-205	Carbon 2/3 Ring Tabbed 205mm Carbon unsterile
4936-3-105	Aluminum Half Ring Tabbed 105mm Al Alloy unsterile
4936-3-130	Aluminum Half Ring Tabbed 130mm Al Alloy unsterile
4936-3-155	Aluminum Half Ring Tabbed 155mm Al Alloy unsterile
4936-3-180	Aluminum Half Ring Tabbed 180mm Al Alloy unsterile
4936-3-205	Aluminum Half Ring Tabbed 205mm Al Alloy unsterile
4936-3-230	Aluminum Half Ring Tabbed 230mm Al Alloy unsterile
4936-3-255	Aluminum Half Ring Tabbed 255mm Al Alloy unsterile
4936-6-105	Aluminum Long Foot Ring Tabbed 105mm Al Alloy unsterile
4936-6-130	Aluminum Long Foot Ring Tabbed 130mm Al Alloy unsterile
4936-6-155	Aluminum Long Foot Ring Tabbed 155mm Al Alloy unsterile
4936-6-180	Aluminum Long Foot Ring Tabbed 180mm Al Alloy unsterile
4936-6-205	Aluminum Long Foot Ring Tabbed 205mm Al Alloy unsterile
4937-6-105	Carbon Long Foot Ring Tabbed 105mm Carbon unsterile
4937-6-130	Carbon Long Foot Ring Tabbed 130mm Carbon unsterile
4937-6-155	Carbon Long Foot Ring Tabbed 155mm Carbon unsterile
4937-6-180	Carbon Long Foot Ring Tabbed 180mm Carbon unsterile
4937-6-205	Carbon Long Foot Ring Tabbed 205mm Carbon unsterile
4936-0-105	Aluminum U Plate Tabbed 105mm Al Alloy unsterile
4936-0-130	Aluminum U Plate Tabbed 130mm Al Alloy unsterile
4936-0-155	Aluminum U Plate Tabbed 155mm Al Alloy unsterile
4936-0-180	Aluminum U Plate Tabbed 180mm Al Alloy unsterile
4936-0-205	Aluminum U Plate Tabbed 205mm Al Alloy unsterile
4937-5-105	Carbon Foot Arch Tabbed 105mm Carbon unsterile
4937-5-130	Carbon Foot Arch Tabbed 130mm Carbon unsterile

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Appendix B: Hoffmann LRF system components

Item No	Description
4937-5-155	Carbon Foot Arch Tabbed 155mm Carbon unsterile
4937-5-180	Carbon Foot Arch Tabbed 180mm Carbon unsterile
4937-5-205	Carbon Foot Arch Tabbed 205mm Carbon unsterile
4937-7-105	Carbon Short Foot Ring Tabbed 105mm Carbon unsterile
4937-7-130	Carbon Short Foot Ring Tabbed 130mm Carbon unsterile
4937-7-155	Carbon Short Foot Ring Tabbed 155mm Carbon unsterile
4937-7-180	Carbon Short Foot Ring Tabbed 180mm Carbon unsterile
4937-7-205	Carbon Short Foot Ring Tabbed 205mm Carbon unsterile
4938-4-110S	HA Coated Blunt Half Pin Ø4mm, 175 × 10mm Thread HA/StSt sterile
4938-4-115S	HA Coated Blunt Half Pin Ø4mm, 175 × 15mm Thread HA/StSt sterile
4938-4-120S	HA Coated Blunt Half Pin Ø4mm, 175 × 20mm Thread HA/StSt sterile
4938-4-125S	HA Coated Blunt Half Pin Ø4mm, 175 × 25mm Thread HA/StSt sterile
4938-4-130S	HA Coated Blunt Half Pin Ø4mm, 175 × 30mm Thread HA/StSt sterile
4938-4-135S	HA Coated Blunt Half Pin Ø4mm, 175 × 35mm Thread HA/StSt sterile
4938-4-140S	HA Coated Blunt Half Pin Ø4mm, 175 × 40mm Thread HA/StSt sterile
4938-4-145S	HA Coated Blunt Half Pin Ø4mm, 175 × 45mm Thread HA/StSt sterile
4938-4-150S	HA Coated Blunt Half Pin Ø4mm, 175 × 50mm Thread HA/StSt sterile
4938-5-215S	HA Coated Blunt Half Pin Ø5mm, 225 × 15mm Thread HA/StSt sterile
4938-5-220S	HA Coated Blunt Half Pin Ø5mm, 225 × 20mm Thread HA/StSt sterile
4938-5-225S	HA Coated Blunt Half Pin Ø5mm, 225 × 25mm Thread HA/StSt sterile
4938-5-230S	HA Coated Blunt Half Pin Ø5mm, 225 × 30mm Thread HA/StSt sterile
4938-5-235S	HA Coated Blunt Half Pin Ø5mm, 225 × 35mm Thread HA/StSt sterile
4938-5-240S	HA Coated Blunt Half Pin Ø5mm, 225 × 40mm Thread HA/StSt sterile
4938-5-245S	HA Coated Blunt Half Pin Ø5mm, 225 × 45mm Thread HA/StSt sterile
4938-5-250S	HA Coated Blunt Half Pin Ø5mm, 225 × 50mm Thread HA/StSt sterile
4938-5-260S	HA Coated Blunt Half Pin Ø5mm, 225 × 60mm Thread HA/StSt sterile
4938-5-370S	HA Coated Blunt Half Pin Ø5mm, 250 × 70mm Thread HA/StSt sterile

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Appendix B: Hoffmann LRF system components

Item No	Description
4938-5-380S	HA Coated Blunt Half Pin Ø5mm, 250 × 80mm Thread HA/StSt sterile
4938-5-390S	HA Coated Blunt Half Pin Ø5mm, 250 × 90mm Thread HA/StSt sterile
4938-6-120S	HA Coated Blunt Half Pin Ø6mm, 175 × 20mm Thread HA/StSt sterile
4938-6-125S	HA Coated Blunt Half Pin Ø6mm, 175 × 25mm Thread HA/StSt sterile
4938-6-130S	HA Coated Blunt Half Pin Ø6mm, 175 × 30mm Thread HA/StSt sterile
4938-6-135S	HA Coated Blunt Half Pin Ø6mm, 175 × 35mm Thread HA/StSt sterile
4938-6-140S	HA Coated Blunt Half Pin Ø6mm, 175 × 40mm Thread HA/StSt sterile
4938-6-145S	HA Coated Blunt Half Pin Ø6mm, 175 × 45mm Thread HA/StSt sterile
4938-6-150S	HA Coated Blunt Half Pin Ø6mm, 175 × 50mm Thread HA/StSt sterile
4938-6-220S	HA Coated Blunt Half Pin Ø6mm, 225 × 20mm Thread HA/StSt sterile
4938-6-225S	HA Coated Blunt Half Pin Ø6mm, 225 × 25mm Thread HA/StSt sterile
4938-6-230S	HA Coated Blunt Half Pin Ø6mm, 225 × 30mm Thread HA/StSt sterile
4938-6-235S	HA Coated Blunt Half Pin Ø6mm, 225 × 35mm Thread HA/StSt sterile
4938-6-240S	HA Coated Blunt Half Pin Ø6mm, 225 × 40mm Thread HA/StSt sterile
4938-6-245S	HA Coated Blunt Half Pin Ø6mm, 225 × 45mm Thread HA/StSt sterile
4938-6-250S	HA Coated Blunt Half Pin Ø6mm, 225 × 50mm Thread HA/StSt sterile
4938-6-260S	HA Coated Blunt Half Pin Ø6mm, 225 × 60mm Thread HA/StSt sterile
4938-6-370S	HA Coated Blunt Half Pin Ø6mm, 250 × 70mm Thread HA/StSt sterile
4938-6-380S	HA Coated Blunt Half Pin Ø6mm, 250 × 80mm Thread HA/StSt sterile
4938-6-390S	HA Coated Blunt Half Pin Ø6mm, 250 × 90mm Thread HA/StSt sterile
4940-4-110	Blunt Half Pin Ø4mm, 175 × 10mm Thread StSt unsterile
4940-4-115	Blunt Half Pin Ø4mm, 175 × 15mm Thread StSt unsterile
4940-4-120	Blunt Half Pin Ø4mm, 175 × 20mm Thread StSt unsterile
4940-4-125	Blunt Half Pin Ø4mm, 175 × 25mm Thread StSt unsterile
4940-4-130	Blunt Half Pin Ø4mm, 175 × 30mm Thread StSt unsterile
4940-4-135	Blunt Half Pin Ø4mm, 175 × 35mm Thread StSt unsterile
4940-4-140	Blunt Half Pin Ø4mm, 175 × 40mm Thread StSt unsterile

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Appendix B: Hoffmann LRF system components

Item No	Description
4940-4-145	Blunt Half Pin Ø4mm, 175 × 45mm Thread StSt unsterile
4940-4-150	Blunt Half Pin Ø4mm, 175 × 50mm Thread StSt unsterile
4940-5-215	Blunt Half Pin Ø5mm, 225 × 15mm Thread StSt unsterile
4940-5-220	Blunt Half Pin Ø5mm, 225 × 20mm Thread StSt unsterile
4940-5-225	Blunt Half Pin Ø5mm, 225 × 25mm Thread StSt unsterile
4940-5-230	Blunt Half Pin Ø5mm, 225 × 30mm Thread StSt unsterile
4940-5-235	Blunt Half Pin Ø5mm, 225 × 35mm Thread StSt unsterile
4940-5-240	Blunt Half Pin Ø5mm, 225 × 40mm Thread StSt unsterile
4940-5-245	Blunt Half Pin Ø5mm, 225 × 45mm Thread StSt unsterile
4940-5-250	Blunt Half Pin Ø5mm, 225 × 50mm Thread StSt unsterile
4940-5-260	Blunt Half Pin Ø5mm, 225 × 60mm Thread StSt unsterile
4940-5-370	Blunt Half Pin Ø5mm, 250 × 70mm Thread StSt unsterile
4940-5-380	Blunt Half Pin Ø5mm, 250 × 80mm Thread StSt unsterile
4940-5-390	Blunt Half Pin Ø5mm, 250 × 90mm Thread StSt unsterile
4940-6-120	Blunt Half Pin Ø6mm, 175 × 20mm Thread StSt unsterile
4940-6-125	Blunt Half Pin Ø6mm, 175 × 25mm Thread StSt unsterile
4940-6-130	Blunt Half Pin Ø6mm, 175 × 30mm Thread StSt unsterile
4940-6-135	Blunt Half Pin Ø6mm, 175 × 35mm Thread StSt unsterile
4940-6-140	Blunt Half Pin Ø6mm, 175 × 40mm Thread StSt unsterile
4940-6-145	Blunt Half Pin Ø6mm, 175 × 45mm Thread StSt unsterile
4940-6-150	Blunt Half Pin Ø6mm, 175 × 50mm Thread StSt unsterile
4940-6-220	Blunt Half Pin Ø6mm, 225 × 20mm Thread StSt unsterile
4940-6-225	Blunt Half Pin Ø6mm, 225 × 25mm Thread StSt unsterile
4940-6-230	Blunt Half Pin Ø6mm, 225 × 30mm Thread StSt unsterile
4940-6-235	Blunt Half Pin Ø6mm, 225 × 35mm Thread StSt unsterile
4940-6-240	Blunt Half Pin Ø6mm, 225 × 40mm Thread StSt unsterile
4940-6-245	Blunt Half Pin Ø6mm, 225 × 45mm Thread StSt unsterile

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Appendix B: Hoffmann LRF system components

Item No	Description
4940-6-250	Blunt Half Pin Ø6mm, 225 × 50mm Thread StSt unsterile
4940-6-260	Blunt Half Pin Ø6mm, 225 × 60mm Thread StSt unsterile
4940-6-370	Blunt Half Pin Ø6mm, 250 × 70mm Thread StSt unsterile
4940-6-380	Blunt Half Pin Ø6mm, 250 × 80mm Thread StSt unsterile
4940-6-390	Blunt Half Pin Ø6mm, 250 × 90mm Thread StSt unsterile
4938-5-004	Drill Bit-Short Ø3.05 × 170mm StSt unsterile
4938-5-005	Drill Bit-Short Ø4.05 × 170mm StSt unsterile
4938-5-006	Drill Bit-Short Ø5.05 × 170mm StSt unsterile
4938-7-004	Drill Bit-Long Ø3.05 × 250mm StSt unsterile
4938-7-005	Drill Bit-Long Ø4.05 × 250mm StSt unsterile
4938-7-006	Drill Bit-Long Ø5.05 × 250mm StSt unsterile
4938-2-002	Wire Post-2 Hole For Pin ø4-5-6mm StSt unsterile
4938-2-003	Wire Post-3 Hole For Pin ø4-5-6mm StSt unsterile
4938-2-004	Wire Post-4 Hole For Pin ø4-5-6mm StSt unsterile
4938-2-005	Wire Post-5 Hole For Pin ø4-5-6mm StSt unsterile
4938-1-001	Pin Cube-1 Hole For Pin ø4-5-6mm StSt unsterile
4938-1-002	Pin Cube-2 Hole For Pin ø4-5-6mm StSt unsterile
4938-1-003	Pin Cube-3 Hole For Pin ø4-5-6mm StSt unsterile
4938-1-004	Pin Cube-4 Hole For Pin ø4-5-6mm StSt unsterile
4938-1-005	Pin Cube-5 Hole For Pin ø4-5-6mm StSt unsterile
4938-1-022	Angled Pin Adaptor-Medium For Pin ø4-5-6mm StSt unsterile
4938-1-023	Angled Pin Adaptor-Long For Pin ø4-5-6mm StSt unsterile
4938-1-200	Centering Sleeve For Pin ø4-5-6mm StSt unsterile
4938-1-100	Half Pin Bolt M6x1, 12mm StSt unsterile
4939-9-022	Low Profile Pin Bolt For Pin ø4-5-6mm StSt unsterile
4938-1-300	Hardware Connection Bolt-Short M6x1, 15mm StSt unsterile

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Appendix B: Hoffmann LRF system components

Item No	Description
4938-1-310	Hardware Connection Bolt-Long M6x1, 22mm StSt unsterile
4938-3-102	MG Connection Plate 2 Hole StSt unsterile
4938-3-103	MG Connection Plate 1 Hole+1 Slot StSt unsterile
4938-3-104	MG Connection Plate 2 Hole+1 Slot StSt unsterile
4938-3-105	MG Connection Plate 3 Hole+1 Slot StSt unsterile
4938-3-002	Twisted Plate StSt unsterile
4938-0-060	Clickers 60mm StSt/PTFE unsterile
4938-0-100	Clickers 100mm StSt/PTFE unsterile
4938-0-150	Clickers 150mm StSt/PTFE unsterile
4938-0-200	Clickers 200mm StSt/PTFE unsterile
4938-9-100	Dice Nut StSt unsterile
4938-0-063	Male Hinge Post StSt unsterile
4938-1-050	Disposable End Cap Multipack Ø6mm TPE unsterile
4938-0-500	smartHEX Strut Controller StSt/Cu alloy/PC unsterile
4936-2-301	smartHEX Strut Safety Clip Set Al Alloy unsterile
4938-1-155	Ring Templates 155-205mm PP/StSt unsterile
4938-3-203	smartHEX Strut Controller Battery Li-ion unsterile
4938-0-520	smartHEX Strut Controller Trial PPSU unsterile
4938-1-051	smartHEX ID Cap Kit PC unsterile
4938-0-510	smartHEX Strut Controller Kit N/A unsterile
4938-9-011	Hex Slotted Wire Bolt- Short For Wire ø1.5 to 2.0mm StSt unsterile
4938-9-012	Hex Slotted Wire Bolt- Medium For Wire ø1.5 to 2.0mm StSt unsterile
4938-9-013	Hex Slotted Wire Bolt- Long For Wire ø1.5 to 2.0mm StSt unsterile
4938-9-001	Cannulated Wire Bolt- Short For Wire ø1.5 to 2.0mm StSt unsterile
4938-9-002	Cannulated Wire Bolt-Medium For Wire ø1.5 to 2.0mm StSt unsterile
4936-3-010	smartHEX Strut, Mini StSt/Al Alloy/PTFE/Peek unsterile
4936-3-020	smartHEX Strut, Extra Short StSt/Al Alloy/PTFE/Peek unsterile

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Appendix B: Hoffmann LRF system components

Item No	Description
4936-3-030	smartHEX Strut, Short StSt/Al Alloy/PTFE/Peek unsterile
4936-3-040	smartHEX Strut, Medium StSt/Al Alloy/PTFE/Peek unsterile
4936-3-050	smartHEX Strut, Long StSt/Al Alloy/PTFE/Peek unsterile
4938-1-024	Low Profile Angled Pin Adaptor For Pin ø4-5-6mm StSt unsterile
4938-0-537	Wire Guide, Al Rings For Wire ø1.5 to 2.0mm StSt unsterile
4936-3-060	smartHEX Strut Offset Plate, S 44 × 23 × 22mm StSt unsterile
4936-3-070	smartHEX Strut Offset Plate, L 51 × 23 × 42mm StSt unsterile
4938-0-538	Wire Guide, C Rings For Wire ø1.5 to 2.0mm StSt unsterile
4938-1-021	Angled Pin Adaptor-Short For Pin ø4-5-6mm StSt unsterile
4938-3-205	smartHEX Android Mobile App
4938-3-200	smartHEX Web Application
4938-3-201	smartHEX iOS Mobile App
4934-7-140	Medium Rocker Shoe Short, 140mm
4934-7-180	Long Rocker Shoe Short, 140mm
4934-8-100	Small Rocker Shoe Long, 100mm
4934-8-140	Medium Rocker Shoe Long, 140mm
4934-8-180	Long Rocker Shoe Long, 140mm
4933-0-100	Telescopic Strut Extra Short
4933-0-120	Telescopic strut short
4933-0-140	Telescopic strut medium
4933-0-180	Telescopic strut long
4934-0-190	Motor strut – extra short
4934-0-210	Motor strut – short
4934-0-270	Motor strut – medium
4934-0-360	Motor strut – long
4934-1-150	Universal hinge strut – extra short
4934-1-130	Constrained hinge strut – extra short

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Appendix B: Hoffmann LRF system components

Item No	Description
4933-0-401	Safety clip (Bone Transport strut
4933-0-402	Bone Transport strut end cap
4933-0-400	Transport strut
5101-1-450	K-wire, Ø1.5 × 450mm, (diamond point)
4933-8-010	K-wire, Ø1.8 × 450mm, (diamond point)
5101-2-450	K-wire, Ø2 × 450mm
4933-8-020	K-wire with olive, Ø1.5 × 450mm, (diamond point)
4933-8-030	K-wire with olive, Ø1.8 × 450mm, (diamond point)
4933-8-040	K-wire with olive, Ø2.0 × 450mm, (diamond point)
390018	Washer
4933-1-030	Threaded Rod, 30mm
4933-1-060	Threaded Rod, 60mm
4933-1-080	Threaded Rod, 80mm
4933-1-100	Threaded Rod, 100mm
4933-1-120	Threaded Rod, 120mm
4933-1-150	Threaded Rod, 150mm
4933-1-200	Threaded Rod, 200mm
4933-1-250	Threaded Rod, 250mm
4933-1-300	Threaded Rod, 300mm
4933-1-350	Threaded Rod, 350mm
4933-1-400	Threaded Rod, 400mm
4933-1-004	Wire bolt offset adaptor – short
4933-1-005	Wire bolt offset adaptor – long
4933-1-010	Connecting nut M8 – short
4933-1-011	Connecting nut M8 – long
4933-1-022	Apex pin bolt
4933-1-520	Static strut, extra short

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Appendix B: Hoffmann LRF system components

Item No	Description
4933-1-530	Static strut, short
4933-1-540	Static strut, medium
4933-1-560	Static strut, long
4933-1-644	Post, short
4933-1-688	Post, long
4922-1-020	Hoffmann 3 pin to rod coupling
4933-0-801	Half hinge
4933-0-800	Hinge coupling
4933-0-700	Universal joint
4933-1-701	Ring / threaded rod connecting nut
4933-0-802	Self locking nut
SEF90002	PIN T-Handle
4934-1-008	Hinge bolt – medium
4934-1-016	Hinge bolt – long
4933-1-710	Washer 1mm, black
4933-1-711	Washer 2mm, yellow
4933-1-712	Washer 4mm, blue
4933-1-713	Washer 7mm, red
4933-1-720	Spherical washer
4934-1-060	Slotted plate
5057-2-600	Trocar, for pin Ø6mm
5057-2-601	Tissue protection sleeve – short, for pin Ø6mm
5057-2-602	Tissue protection sleeve – long, for pin Ø6mm
4933-9-100	Wire tensioner
4933-9-110	Wire tensioner nose, short
4933-9-111	Wire tensioner nose, long
4933-9-201	Wire bolt wrench

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Appendix B: Hoffmann LRF system components

Item No	Description
4933-9-202	Ratchet wrench, hex 10mm
4933-9-203	Thumbwheel for ratchet wrench, hex 10mm
4933-9-204	Spanner wrench 7mm / 10mm
4933-9-205	Spanner wrench 5mm
4933-9-206	L-socket wrench
4933-9-207	Telescopic strut wrench
4933-9-208	Thumbwheel for telescopic struts
4920-9-020	Removable thumbwheel, 7mm / 5mm
5150-9-125	Biocompression wrench – red, 25mm
4940-9-030	5mm wrench / 3mm – 4mm pin inserter
4936-9-020	Cutting and bending pliers
702430	Pin T-Handle
5057-6-300	Apex pin cutter
4922-8-350	H3 Connection Rod
4933-9-301	HLRF Ruler
4922-1-015	H3 Multiplanar Clamps
200343	Hex Key, 5mm

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Appendix C: Minimum required system components

Table A.C defines the minimum system components required to complete a basic surgery using the Hoffmann LRF System.

- The Universal Components Tray and Instrument and Implants Tray are required for any surgery using Hoffmann LRF.
- The smartHEX Tray, Bone Transport Tray, and Gradual Correction Tray are only required if doing a smartHEX, bone transport/lengthening, or gradual correction surgery, respectively.

Table C: Minimum required system components by tray Universal Components Tray

Universal components tray

Item No	Description	Minimum quantity
4933-1-010	M8 Connecting Nut, Short	14
4933-1-011	M8 Connecting Nut, Long	0
4933-1-701	M6 Connecting Nut	16
4933-1-710	Washer 1mm, black	0
4933-1-711	Washer 2mm, yellow	0
4933-1-712	Washer 4mm, blue	0
4933-1-713	Washer 7mm, red	0
4938-1-200	Centering Sleeve	0
4938-9-100	Dice Nut	0
4938-9-011	Hex Slotted Wire bolt, Small	3
4938-9-012	Hex Slotted Wire bolt, Medium	3
4938-9-013	Hex Slotted Wire bolt, Large	3
4938-1-100	Half Pin Bolt	6
4939-9-022	Low profile pin bolt	0
4938-1-300	Small Hardware Connection Bolt	6
4938-1-310	Larger Hardware Connection Bolt	6
4922-1-010	H3 Rod to Rod Coupling	2
4933-1-688	H3 Connection Post, long	1
4933-1-644	H3 Connection Post, short	1
4938-1-021	Angulated Pin Adapter, Short	1
4938-1-022	Angulated Pin Adapter, Medium	1
4938-1-023	Angulated Pin Adapter, Large	1
4938-1-024	Low profile Angled pin Adaptor	0
4933-1-022	Apex Pin Bolt	3
4933-1-004	Wire Bolt offset Adapter, Short	1
4933-1-005	Wire Bolt offset Adapter, Large	1
4938-3-002	Twisted Plates	0
4938-3-102	MG Connection Plates, 2 Holes	0
4938-3-103	MG Connection Plates, 1 Holes +1 slot	0
4938-3-104	MG Connection Plates, 2 Holes +1 slot	0

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Appendix C: Minimum required system components

Universal components tray

Item No	Description	Minimum quantity
4938-3-105	MG Connection Plates, 3 Holes +1 slot	0
4938-9-001	Hex Cannulated Wire Bolt, Short	6
4938-9-002	Hex Cannulated Wire Bolt, Medium	6
4938-2-002	Wire Posts, 2 Hole	1
4938-2-003	Wire Posts, 3 Hole	1
4938-2-004	Wire Posts, 4 Hole	1
4938-2-005	Wire Posts, 5 Hole	1
4938-1-001	Pin Cubes, 1 Hole	1
4938-1-002	Pin Cubes, 2 Hole	1
4938-1-003	Pin Cubes, 3 Hole	1
4938-1-004	Pin Cubes, 4 Hole	1
4938-1-005	Pin Cubes, 5 Hole	1

Instrument and implant tray

Item No	Description	Minimum quantity
390018	Washer 7mm	0
4933-8-010	K-wire, Ø1.8 × 450mm, (diamond point)	6
5101-2-450	K-wire, Ø2 × 450mm	0
4933-8-030	K-wire with olive, Ø1.8 × 450mm, (diamond point)	6
4933-8-040	K-wire with olive, Ø2.0 × 450mm, (diamond point)	0
4933-9-100	Wire Tensioner	1
4933-9-111	Tensioner Nose Long	1
4933-9-110	Tensioner Nose Short	1
5150-9-125	Tensioner Wrench	1
4933-9-301	HLRF Ruler	1
4933-9-204	Spanner Wrench 7/10mm	1
4933-9-206	L-Socket Wrench	1
200343	Hex key -Wrench 5mm	1
4933-9-202	Ratchet Wrench	1
4933-9-201	Wire Bolt Wrench	1
4933-9-203	Thumb Wheel for Ratchet Wrench	1
4920-9-020	Thumb Wheel Removable thumbwheel 5mm/7mm	1

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Appendix C: Minimum required system components

Instrument and implant tray

Item No	Description	Minimum quantity
4933-9-205	Spanner Wrench 5mm	1
4936-9-020	Cutting Pliers	1
4933-9-207	Telescopic Strut Wrench	1
4940-9-030	5mm wrench / 3mm – 4mm pin inserter	1
4938-0-537	Wire guide-Al	1
4938-0-538	Wire guide-C	1

Half pin tray

Item No	Description	Minimum quantity
4940-5-225	HLRF Half Pin - 225mm - 5mm Pin - 25mm thread	2
4940-5-230	HLRF Half Pin - 225mm - 5mm Pin - 30mm thread	2
4940-5-235	HLRF Half Pin - 225mm - 5mm Pin - 35mm thread	2
4940-5-240	HLRF Half Pin - 225mm - 5mm Pin - 40mm thread	2
4940-6-125	HLRF Half Pin - 175mm - 6mm Pin - 25mm thread	2
4940-6-130	HLRF Half Pin - 175mm - 6mm Pin - 30mm thread	2
4940-6-135	HLRF Half Pin - 175mm - 6mm Pin - 35mm thread	2
4940-6-140	HLRF Half Pin - 175mm - 6mm Pin - 40mm thread	2
5057-2-601	Short Tissue Sleeve	1
5057-2-602	Long Tissue Sleeve	1
5057-2-600	Trocar 6mm	1
4938-1-050	End Caps	6
4938-5-004	HLRF Half Pin Short Drill Bit - 4mm	1
4938-5-005	HLRF Half Pin Short Drill Bit - 5mm	1
4938-5-006	HLRF Half Pin Short Drill Bit - 6mm	1
4938-7-004	HLRF Half Pin Long Drill Bit - 4mm	1
4938-7-005	HLRF Half Pin Long Drill Bit - 5mm	1
4938-7-006	HLRF Half Pin Long Drill Bit - 6mm	1
702430	Pin T-Handle	1
SEF90002	Pin T-Handle	1

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Appendix C: Minimum required system components

smartHEX tray

Item No	Description	Minimum quantity
4936-2-301	Strut Safety Clips Colored	6
4938-1-300	Small Hardware Connection Bolt	6
4936-3-060	Strut Off Set Plate, Standard	1
4936-3-070	Strut Off Set Plate, long	1
4936-3-010	smartHEX Strut, Mini	6
4936-3-020	smartHEX Strut, Extra Short	6
4936-3-030	smartHEX Strut, Short	6
4936-3-040	smartHEX Strut, Medium	6
4936-3-050	smartHEX Strut, Long	6

Struts and components tray

Item No	Description	Minimum quantity
4938-1-300	Small Hardware Connection Bolt	6
4934-1-008	Hinge Bolts - Short	0
4934-1-016	Hinge Bolts - Long	0
4938-0-063	Male Hinge Post	0
4933-0-802	Self Locking Nut	0
4933-1-520	Static Struts	4
4933-1-530	Static Struts	4
4933-1-540	Static Struts	4
4933-1-560	Static Struts	4
4933-0-801	Female Half Hinges	0
4933-0-800	Hinge Coupling	0
4933-1-720	Spherical Washers	0
4933-0-700	Universal Joint	0
4938-9-100	Dice Nuts	0
4933-1-060	Threaded Rods	4
4933-1-080	Threaded Rods	4
4933-1-100	Threaded Rods	4
4933-1-120	Threaded Rods	4
4933-1-150	Threaded Rods	4
4933-1-200	Threaded Rods	4

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Appendix C: Minimum required system components

Struts and components tray

Item No	Description	Minimum quantity
4933-1-250	Threaded Rods	4
4933-1-300	Threaded Rods	4
4933-1-350	Threaded Rods	4
4933-1-400	Threaded Rods	4
4933-9-208	Thumb Wheels for Telescopic Strut	1
4934-1-060	Slotted Plates	4
4938-0-100	Clicker	4
4938-0-150	Clicker	4
4938-0-060	Clicker	4
4938-0-200	Clicker	4
4933-0-180	Long Telescopic Strut	4
4933-0-100	Extra Short Telescopic Strut	4
4933-0-120	Short Telescopic Strut	4
4933-0-140	Medium Telescopic Strut	4

Home run ring tray

Item No	Description	Minimum quantity
4936-1-155/4937-1-155	Full Ring, 155mm	2
4936-1-180/ 4937-1-180	Full Ring, 180mm	2
4936-1-205/4937-1-205	Full Ring, 205mm	2
4936-6-155/4937-6-155	Long Foot Ring, 155mm	0
4936-6-180/4937-6-180	Long Foot Ring, 180mm	0
4936-6-205/4937-6-205	Long Foot Ring, 205mm	0
4937-5-155	Foot Arch, 155mm	0
4937-5-180	Foot Arch, 180mm	0
4937-5-205	Foot Arch, 205mm	0

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Appendix C: Minimum required system components

Half ring and U-plate tray

Item No	Description	Minimum quantity
4936-3-155	Half Ring, 155mm	0
4936-3-180	Half Ring, 180mm	0
4936-3-205	Half Ring, 205mm	0
4936-0-155/4937-7-155	U-Plate, 155mm / Short carbon foot ring	0
4936-0-180/4937-7-180	U-Plate, 180mm / Short carbon foot ring	0
4936-0-205/4937-7-205	U-Plate, 205mm / Short carbon foot ring	0
4936-2-155/4937-2-155	2/3 Ring, 155mm	0
4936-2-180/4937-2-180	2/3 Ring, 180mm	0
4936-2-205/4937-2-205	2/3 Ring, 205mm	0

Small ring tray

Item No	Description	Minimum quantity
4936-1-105/4937-1-105	Full Ring, 105mm	0
4936-1-130/4937-1-130	Full Ring, 130mm	0
4936-3-130	Half Ring, 130mm	0
4936-3-105	Half Ring, 105mm	0
4936-2-105/4937-2-105	2/3 Ring, 105mm	0
4936-2-130/4937-2-130	2/3 Ring, 130mm	0
4936-6-105/4937-6-105	Long Foot Ring, 105mm	0
4936-6-130/4937-6-130	Long Foot Ring, 130mm	0
4937-5-105	Carbon Foot Arch, 105mm	0
4937-5-130	Carbon Foot Arch, 130mm	0

Bone transport tray

Item No	Description	Minimum quantity
4933-0-400	Transport Strut	4
4933-1-702	Ring Connection Bolt	12
4933-0-401	Safety Clip (Bone Transport Strut)	4
4933-0-402	Bone Transport Strut End Cap	8
4933-1-701	Ring/Threaded Rod Connecting Nut M6 × 6mm	3
4933-1-010	Connecting Nut - Short M8 × 6mm	0
4933-0-300	Lengthening Ruler	1
4933-9-204	Spanner Wrench 7/10mm	0

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Appendix C: Minimum required system components

Gradual correction tray

Item No	Description	Minimum quantity
934-1-150	Universal hinged strut, extra short 4	2
4934-1-130	Constrained hinged strut, extra short 4	2
4934-0-190	Telescopic motor strut, extra short 2	2
4934-0-210	Telescopic motor strut, short 2	2
4934-0-270	Telescopic motor strut, medium 2	2
4934-0-360	Telescopic motor strut, long 2	2
4933-0-800	Constrained hinge coupling	2
4933-0-700	Universal hinge coupling 8	2
9 4934-1-008	M6 hinge bolt, medium 4	2
10 4934-1-016	M6 hinge bolt, long 4	2
11 4933-1-720	Spherical washer	4

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700004267559-EN Rev AC
FA-HLHX-SURGP-3530100_REV-1_en_us

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