TenXor
External Fixation System
Operative Technique
In severe trauma cases it is necessary to have a good partnership, whether it is a colleague in the surgical theatre or an effective and trustworthy system that allows you to bring the focus to where it belongs - on the patient.

The TenXor system, a hybrid External Fixator for peri- and intra-articular fractures of the lower extremity is especially designed to fulfill the needs of today’s surgeons. The advanced technology helps to provide simplicity and efficiency of application.

A TenXor hybrid frame is a modular frame construct that allows using Kirschner wires and half pins and combines a circular ring with a unilateral or modular frame fixation. The components deliver technical features like the “Snap Fit” mechanism, adaptation of height from the Wire Post and an unlimited range of motion on the ring to allow an easy adaptation of the system for trauma procedures.

During wire insertion focus can be completely on the fracture and the soft tissues. The TenXor provides the possibility to adapt the frame even for non parallel wires.

Do you have a need to change the frame elasticity during the treatment, the compatibility with the modular Hoffmann II system and the Monotube Triax allows adaptation of frame elasticity to the healing process.

The TenXor system is a part of the Hoffmann II family. The combination of simplicity and versatility solves your daily challenges in the surgical theatre more effectively.
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Indications & Contraindications

Relative Indications

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 judgement must be relied upon to choose the most appropriate device and treatment for each individual patient.

If uncertainty exists with regard to the anatomic location of the neurovascular structures due to post-traumatic destruction, the device should be used with extreme caution. Under these circumstances, the wires and pins should be inserted under direct vision.

• Severe multi fragmentary tibia plateau fractures, e.g. Schatzker type 5, 6
• Severe multi fragmentary pilon fractures, e.g. Rüedi & Allgöwer type 2, 3
• Secondary fixation after failure or infection of primary fixation
• Less complex fracture pattern with severe soft tissue damage, e.g. Tscherne type C2, C3, Gustillo Andersen type (2), 3

Relative Contraindications

• Patients with compromised immune system
• Non compliant patients who would not be able to ensure proper wire and pin care
• Pre-existing internal fixation that prohibits proper wire or pin placement
• Bone pathology precluding pin fixation
Operative Technique

General Guidelines

Patient positioning
The patient positioning for the Tenxor Hybrid Frame is surgeon dependent. However it is recommended that the patient is positioned supine on the fracture table with the uninjured leg in an elevated leg support in order to gain access to both the antero-lateral and the posterio-medial corners of the knee. This in order to facilitate the introduction of the hybrid pins into these entry-points. The positioning of the uninjured leg in a leg support will also allow for easy access with the fluoroscope to get good, unhindered AP- and mediolateral projections during surgery.

The patient is furthermore positioned so that the popliteal fossa is positioned over the hinge of the leg-plate in the operating table. In this way it will be possible to flex the knee during surgery and thus gain access to the joint surfaces during open reposition of the fracture.

Reduction
The reduction of the fracture is sometimes possible through closed or percutaneous methods. However this is usually only possible in more simple fracture configurations. In the more complex fractures of the proximal tibia, classification Schatzker 5 and 6, it is normally necessary to perform open reduction and limited internal fixation of the epiphysis before application of the hybrid frame.

Incision
In the cases where open reduction is called for, the choice of incision is ultimately decided by the surgeon. However, the straight anterior approach usually allows for good access to both the lateral and medial joint surfaces. This incision can also be used at a later date, should the patient develop post-traumatic arthritis and thus develop a need for a later knee arthroplasty.
Operative Technique

Components

**Carbon Ring:**
The open carbon rings are available in three sizes (150mm, 180mm and 210mm) to provide the best patient comfort. The high technology carbon material provides a better radiolucency and the open ring simplifies the choice of the ring size.

**Wires:**
Wires with a diameter of 1.5mm or 2.0mm with or without olive. The wires with olive are etched on one end for an easy extraction without additional x-ray control.

**Wire Post:**
Up to 2.5 cm adaptation of height with 20° of angulation in the wire post and an unlimited range of motion on the ring provide an easy wire insertion.

**Hoffmann II clamp:**
The compatibility of wire post and pin post to the Hoffmann II system provides a modular solution for the connection to the shaft.

**Pin Post:**
Additional independent half pin placement with “Snap Fit” technology.

**Monotube Triax ring to tube clamp:**
The ring to tube clamp offers the possibility to combine the TenXor system with a Monotube Triax.
Operative Technique

Wire Placement Proximal Tibia

In general it is with any External Fixation device important to avoid the risk of injuring tendons and neurovascular elements in the respective areas during K-wire insertion.

For the wire placement of the proximal tibia the head of the fibula is an important landmark, but as the peroneal nerve passes posterior to it care should be taken to avoid transfixation of the nerve bundle. When in doubt concerning this it might be advisable to make a small exploration down to the fibular head, especially in adipose patients.

The K-wires should be placed at least 14mm below the joint line to avoid capsular penetration. It may be desirable to pass a K-wire through the head of the fibula or just anteriorly. Greater care should be taken with wires near the neck of the fibula as this is where the branching of the peroneal nerve takes place. The wires are inserted from posterolaterally to anteromedially and from posteromedially to anterolaterally. It is recommended to use the oscillating mode of the power tools when inserting the K-wires. It is also recommended that the angle between the two pins should be at least 70 degrees in order to give an anteroposterior stabilization.

Transfixation of the patellar tendon by the anterolateral to posteromedial wire must be avoided as this will cause pain and restricted motion. The cross wire is inserted just anterior to the anterior-lateral compartment muscles, it should not violate the joint space, or the gastrocnemius muscle. Care should be taken not to place this too anteriorly as this can cause damage to the hamstring attachment.

Furthermore it is recommended that the third placed pin should be placed slightly posterior in the tibia so that the pins don’t cross each other in the same point. This posterior placement of the pin has been shown to give superior stabilization of the proximal fragment. Transfixation of the muscle leads to discomfort and restricted mobility. Should it be necessary to transfix the muscle, the muscle should be stretched prior to insertion of the wire.
Operative Technique

Wire Placement Distal Tibia

In general it is with any External Fixation device important to avoid the risk of injuring tendons and neurovascular elements in the respective areas during K-wire insertion.

For the wire placement of the distal tibia the following anatomic areas should be considered.

The posterior tibial artery and a vein and the tibial nerve remain posterior to the tibia, traversing medially as they approach the ankle joint.

The anterior tibial artery and vein, and the deep peroneal nerve, are on the lateral surface of the tibia in proximal Zone D. They lie on the anterior surface of the tibia in distal Zone D.

The saphenous nerve and greater saphenous vein are on medial side of the tibia throughout Zone D.

The superficial peroneal nerve has divided into its terminal branches in this zone. However it is advisable to make a small exploration anterolaterally when the K-wire emerges in order to avoid damage to this nerve.

The wires are inserted from posterolaterally to anteromedially and from posteromedially to anterolaterally. It is recommended to use the oscillating mode of the powertools when inserting the K-wires.
Operative Technique

Pin Placement

In order to avoid soft tissue problems over the anteromedial facet it might be advisable to introduce the diaphyseal apex pins through the anterior ridge of the tibia pointing slightly medially posteriorly. In this way the entry hole for the apex pin will lay in close proximity to the anterolateral muscle group which might reduce the risk for healing problems after removal of the pin. This positioning of the pin also gives a longer and better purchase of the Apex Pin in the bone.
Operative Technique

Frame Configurations

These are the most common frames used with Tenxor. Please see operative steps for Proximal Tibia frame on page 10–17 and for Distal Tibia frame on page 18–21.
Operative Technique

Frame 1  Proximal Tibia Fracture

Components

Material Used:

1. 1 × Open Ring
2. 8 × Ring Clamp
3. 1 × Wire Post
4. 1 × Pin Post
5. 3 × Wires
6. 1 × Apex Pin
7. 1 × Hoffmann II 10-Hole Pin Clamp
8. 2 × Hoffmann II 30° Angled Post
9. 4 × Hoffmann II Rod/Rod Coupling
10. 2 × Hoffmann II Pin/Rod Coupling
11. 3 × Carbon Connecting Rods

Instruments Used:

A. TenXor Wire Tensioner
B. Wire Cutting and Bending Pliers
C. 13mm Quick Capture Spanner Wrench
D. Split Wire Sleeve
E. Stabilization Wrench
F. 7mm T-Wrench
G. 7mm Cardan Wrench
H. Apex Drill Brace
I. Soft Tissue Protector
Operative Technique

Step 1:
The surgical technique utilizes a limited open approach for wire and half pin insertion. Make an incision at least 14mm distal to the joint surface. Insert the first wire by using the Split Wire Sleeve as soft tissue protector and guidance tool. Insert the two other wires the same way. To provide better stability try to create an angle of about 70° between the outer wires.

Note:
For wire placement we refer to section Wire Placement on page number. Make sure that the skin around the wire is not tensioned, to avoid skin problems. If possible use three 2.0mm wires to create a better frame stiffness.

Step 2:
Connect the wire post and the ring clamp by lining up the stainless steel marker of the wire posts with the alignment mark on the ring clamp. After that push the wire post completely to the end and turn it by one quarter. By turning the post it is secured and can not fall off the ring clamp.

Step 3:
Assemble the ring clamp with the connected wire post on the carbon ring by “Clicking” it on and repeat step 2 and 3 for all the wire connections.
**Operative Technique**

**Step 4:**
Adjust the ring clamp to the position of the wires and connect the wires in the wire posts with a "Click".

**Step 5:**
Adapt the height of the wire post and make sure that you have the best access possible for locking the screws on the wire posts.

**Note:**
It is important that the wires are not bend in any direction. If wires need additional adjusting they can removed from the wire post by pushing the inner plate of the post towards the 7mm screw and "unclick" the wire.

**Step 6:**
Align the carbon ring approximately 90° to the long axis of the bone with enough space for soft tissue swelling. Adjust the ring clamp/wire posts with non bend wires and hand tighten the 13mm nuts on the ring clamp. Lock them completely by using the 13mm spanner wrench and holding the ring by hand.

**Note:**
Adaptation of height or repositioning of the wire posts and ring clamps on the ring can be done by unlocking the 13mm nut.
Operative Technique

**Step 7:**
For tensioning the wires, one end must be locked in place into the wire post. Tighten the screw by using the 7mm wrench and the stabilization wrench as a counter part. Repeat this step for the other two wires.

**Note:**
To tension the wires you need at least 70mm of wire at the tensioning side. By using Olive wires the side of the Olive must be locked first.

**Step 8:**
Open the tensioner completely by turning the T-handle anti clockwise. Slide it over the wire until it makes contact with the wire post.

**Note:**
Do not start tensioning the wires before all wires are in satisfactory position.

**Step 9:**
Turn the T-handle clockwise until the desired mark on the tensioner is reached. This is done by the tensioners body sliding towards the ring markers on the tensioner. The first ring indicates 50kg load and is recommended for 1.5mm K-wires. The second ring indicates 100kg load and is recommended for 2.0mm k-wires.
Operative Technique

Step 10:
Leave the tensioner in position and lock the screw by using the 7mm wrench and the stabilization wrench.

Step 11:
Remove the tensioner by opening the T-handle completely (turn the T-handle anti clockwise). Repeat step 9 to 11 for the other two K-wires.

Note:
If the Tensioner can not be removed, the T-handle is not completely open.

Step 12:
To complete the frame two (or more) Apex half pins are placed in the diaphyseal area of the tibia. Make an incision and insert the first pin manually by using the soft tissue protector and the Apex Drill Brace. Make sure that the pin is inserted with bi-cortical purchase.

Note:
For pin insertion guide lines we recommend introduction of the pins through the anterior ridge of the tibia pointing straight dorsally. For a more detailed description please refer to the the section Wire and Pin Placement on Page 8.
Operative Technique

Step 13:
Insert a second half pin parallel to the first half pin so it will correspond to one of the holes in the multi pin clamp. This can be achieved by using a half pin insertion guide assembly, or by inserting the pin through the clamp itself.

Note:
Try to get the largest pin spread in the multi pin clamp to provide maximum stability. It might be advisable to use the Hoffmann II 10 pin clamp in the diaphyseal fixation in order to contain a better rotational stability in this fragment.

Step 14:
Position the multi pin clamp approximately two finger-breadths away from the skin. Lock the position of the multi pin clamp by tightening the screw with the 7mm wrench.

Step 15:
Assemble two Hoffmann II posts on each side of the multi pin clamp and lock the posts by tightening the screws by using the 7mm wrench.
Operative Technique

**Step 16:**
Connect the Hoffmann II rod to rod couplings on the posts and the TenXor wire post and assemble the connecting rods.

**Note:**
Repeat that step for all your couplings and connecting rods.

**Step 17:**
Assemble a pin post into a ring clamp and connect it to the TenXor ring by a “click”.

**Step 18:**
Make an incision and insert a half pin manually by using the soft tissue protector. Make sure that the pin is inserted with bi-cortical purchase.
Operative Technique

Step 19:
Assemble a Pin Post to a Ring Clamp and attach the assembled Ring Clamp on the carbon ring. Connect the pin post to the pin by “clicking” it on the half pin. Lock the screw by using the 7mm wrench and the stabilization wrench.

Step 20:
Lock all the Hoffmann II couplings by tightening the screw with the 7mm wrench.

Note:
Counter the locking force by holding the component, preferably with the stabilization wrench.

Step 21:
After checking the whole frame cut the wires by using the cutting and bending pliers about leaving about 4cm of wire. Bend the wires so that the tip of the wire will lay against the clamp.
Operative Technique

Frame 2  Distal Tibia Fracture

Components

Material Used:

1. 1 x Open Ring
2. 7 x Ring Clamp
3. 6 x Wire Post
4. 1 x Pin Post
5. 3 x Wires
6. 3 x Apex Pin
7. 1 x Hoffmann II 10-Hole Pin Clamp
8. 2 x Hoffmann II 30° Angled Post
9. 4 x Hoffmann II Rod/Rod Coupling
10. 2 x Hoffmann II Pin/Rod Coupling
11. 3 x Carbon Connecting Rods

Instruments Used:

A. TenXor Wire Tensioner
B. Wire Cutting and Bending Pliers
C. 13mm Quick Capture Spanner Wrench
D. Split Wire Sleeve
E. Stabilization Wrench
F. 7mm T-Wrench
G. 7mm Cardan Wrench
H. Apex Drill Brace
I. Soft Tissue Protector
Operative Technique

Step 17
For wire placement we refer to section Wire Placement on page number. For the frame building guidelines begin the frame construction with step 1 to step 17 of the proximal tibia frame pages number to number and from step 18 follow the guidelines below.

Step 18
Make an incision and insert the half pin proximal from the ring manually by using the soft tissue protector. Make sure that the pin will be inserted parallel to the pin group in the diaphyseal area.

Step 19
Assemble a Pin Post to a Ring Clamp and attach the assembled Ring Clamp on the carbon ring. Connect the pin post to the pin by “clicking” it on the half pin.
Operative Technique

Step 20
Assemble a Pin Post to a Ring Clamp and attach the assembled Ring Clamp on the carbon ring. Connect the pin post to the pin by “clicking” it on the half pin. Lock the screw by using the 7mm wrench and the stabilization wrench.

Step 21:
Connect two Hoffmann II pin to rod couplings. One on the single pin, one on the distal pin in the diaphyseal area and connect them with a rod.

Step 22:
Lock all the Hoffmann II couplings by tightening the screw with the 7mm wrench.

Note:
Counter the locking force by holding the component, preferably with the stabilization wrench.
Operative Technique

**Step 23:**
After checking the whole frame cut the wires by using the cutting and bending pliers about leaving about 4cm of wire. Bend the wires so that the tip of the wire will lay against the clamp.
Operative Technique

General Recommendations:

- K-wires are extremely sharp and should be handled with care. Eye protection when using K-wires is recommended.
- K-wires should be placed to allow the maximum possible angle between the two outermost wires without damaging important soft tissue structures.
- Ensure that all components are fully open (unscrewed) before frame assembly.
- Place the wire and pin posts so that the 7mm screw is pointing toward, which makes it more readily.
- Wires may be removed from the wire post by depressing the tongue and “unclicking” the wires.
- We recommend the wires to be inserted from posterolaterally to anteromedially and from posteromedially to anterolaterally.
- It is recommended to use the oscillating mode of the powertools when inserting the K-wires.
- In order to avoid skin infection problem and to allow drainage make sure the skin incision is big enough (approx. 6−7mm).
- K-wires are extremely sharp and should be handled with care. Eye protection when using K-wires is recommended.

Trouble Shooting:

- Unable to remove K-wire from wire post → Push the inner plate of the wire post and “unclick” the wire
- Unable to bring the Tensioner to the wire post → The T-handle is not completely open, turn the T-handle anti clockwise
- Ring clamp, pin or wire posts or Hoffmann II couplings don’t “click” → The nut or screw of the component is not sufficiently open
- Tensioner always flips off during tensioning → The tensioner should be in an 90° angle to the Wire Post.
# Ordering Information – Instruments

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<td>4936-1-320</td>
<td>Wire etched, with olive, 1.5mm</td>
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<td>4936-1-340</td>
<td>Wire etched, with olive, 2.0mm</td>
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