Veterinary Instrumentation

# Surgery Guide

## Linear External Skeletal Fixation

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# Linear External Skeletal Fixation

**External Skeletal Fixation (ESF) is a very good technique for fracture repair and osteotomy stabilisation. It can be used for long bone fractures, spinal fractures and luxations, trans-articular immobilisation for joint instability, arthrodesis, angular limb deformity correction, and limb lengthening (distraction osteogenesis).**

**There are four main types of ESF:**

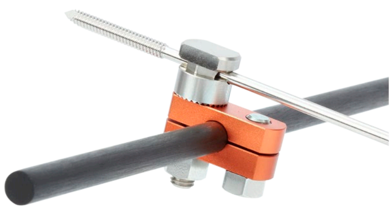
- **Linear**
- **Free-form**
- **Circular**
- **Hybrid**

**Vi supply equipment for both linear and freeform ESF. The FESSA system is also available, which is ideal for very small patients and exotics.**

## Contents



**Standard Fixator Construct**



**KE Plus Construct**

**FESSA Construct**

## Types of External Skeletal Fixator

### Linear ESF

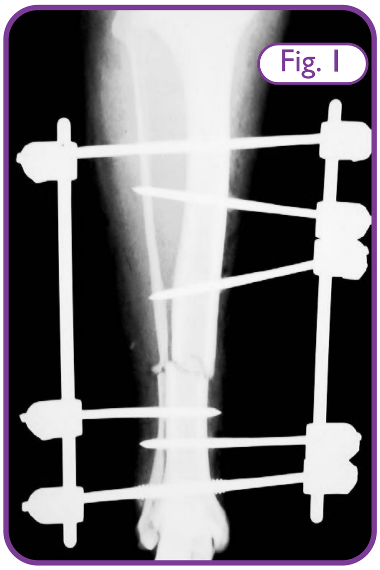


Fig. 1

Linear ESFs have three components; pins, clamps and connecting bars. Pins penetrate the bone and are secured externally by clamps onto the connecting bar. The connecting bars give the ESF frame its length and structural rigidity. Linear ESF components are readily available and linear ESF is the most widely used, the simplest and easiest type of ESF to learn and apply (Fig. 1).

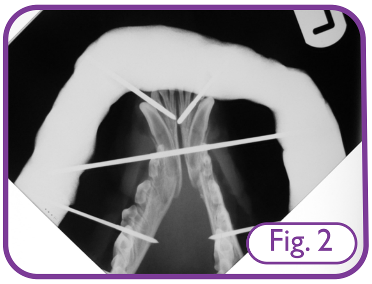


Fig. 2

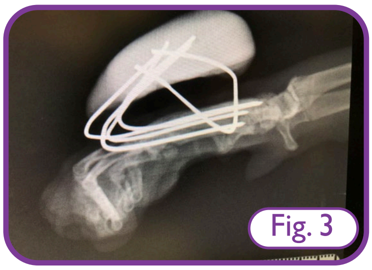


Fig. 3

### Free-form ESF

Free-form ESFs are a subtype of linear ESFs; the clamps and connecting bar are replaced by epoxy putty. This gives the freedom to design the 3 dimensional shape of the ESF with more options than are accommodated by a single straight connecting bar. For most long bone fractures, free-form ESFs are not used, but the flexibility of pin placement is very useful in mandibular (Fig. 2) and maxillary fracture, digit fractures or luxations (Fig. 3), and specific examples such as radial fractures in cats. Although highly adaptable, these frames have the disadvantage that they cannot be adjusted once the putty has set.

### Circular ESF (cESF) and Hybrid ESF

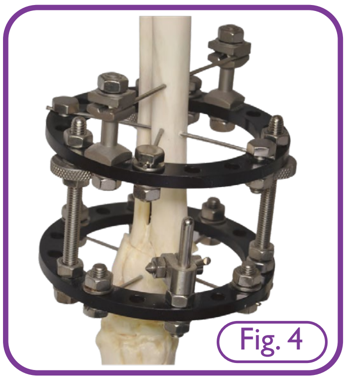


Fig. 4

Fig. 5

Circular ESFs (cESF) also called ring fixators, are constructed using thin wires 1.0-1.6mm in diameter that are driven across the bone; the wires are held in position by a ring (or circle) that encircles the bone and limb. Connecting bars are placed that connect the rings; this gives the frame its length and structural rigidity. cESFs are more adaptable and versatile than linear ESFs but cESFs are more complex to construct, and more demanding to manage. Because cESFs are more complex, they are usually reserved for more demanding applications e.g. complex juxta-articular fractures, angular limb deformity corrections and distraction osteogenesis (Fig. 4).

Hybrid ESF is an ESF construct that is a hybrid usually of a linear frame proximally, and a circle frame distally. This is particularly useful for juxta-articular fractures where there is a very short bone segment and little bone stock for implant purchase. The single distal circle is attached to one or more linear connecting bars. Proximally, the connecting bars connect to the bone using clamps and linear ESF pins. These frames take advantage of the benefits of both linear and circular frame types in a single frame construct (Fig. 5).

## Advanatages and Disadvantages of ESF

### Advantages

- ESFs can be applied using 'closed' or 'open' approaches i.e. zero to no surgical approach, or a standard open surgical approach. A limited approach minimises surgical dissection and trauma and can reduce surgical time, although working "blind" can be more challenging.

- ESFs are very adaptable; an infinite combination of frame and pin types can be constructed therefore the ESF can be adapted to many different types of fractures. Frame and construct stiffness can also be varied.

- Using epoxy putty extends the range of adaptability of ESF frames even further.

- ESFs are well suited for fracture repair configurations where reconstruction is not intended and construct stiffness and rigidity is low i.e. the bone is intended to heal by secondary (indirect) bone healing i.e. callus formation.

- ESFs are ideal for open fractures and shear injuries because metalwork can be placed away from the injury site thus providing stability to the bone or joint, whilst simultaneously allowing access for wound management including wound flushing, debridement and dressing application.

- ESFs do not involve permanent implants; the metalwork is eventually removed. This makes them particularly suitable for contaminated surgical sites such as open fractures or shear injuries.

- ESFs can be used for other applications other than fracture repairs e.g. joint stabilisation, angular limb deformity correction, or distraction osteogenesis/limb lengthening.

- ESFs can be combined with other implants such as an intra-medullary pin, orthopaedic wire, lag screws, positional screws and K-wires.
- ESF systems are relatively inexpensive.

- Most systems are modular therefore kits can be easily modified and augmented as required.

- Applying an ESF is relatively straightforward therefore the beginner surgeon can reasonably apply an ESF to a simple fracture,so long as the rules and principles are understood and followed.

- ESFs can be adjusted post-operatively to improve the alignment of the fractured bone and if necessary, to modify load sharing with bone.

- ESFs are adaptable and can be good for tricky fractures with very small pieces of bone e.g. fractures close to joints. This is because the frame can be built to maximise the number of pins that can be placed in a very small piece of bone, which might otherwise be very difficult to impossible to achieve with plates and screws.

- ESF can be used to place a number of pins in a very small area of bone, maximising the number of contact points with a bone fragment, but care must be taken not to weaken the bone with multiple pin tracts.

When an Ex Fix is applied, the bone fracture is not usually fully reduced (for example a comminuted fracture), or when the fixation is relatively flexible, small amounts of movement may occur at the fracture site. Under this circumstance, bone heals by secondary bone healing or callus formation i.e. there is a gradual transformation at the fracture site from fracture haematoma to granulation to fibrous to cartilaginous tissue, and finally to bone which then remodels over time. Callus healing is much quicker than primary bone healing (which is achieved with rigid internal fixation such as lag screws or axial (dynamic) compression), but callus healing is disadvantageous in particular fracture scenarios such as articular fractures and spinal fractures.

## Disadvantages

- Like all techniques, successful application with minimal subsequent complications requires experience and "mastering the art".
- ESFs have their own unique set of associated complications.
- The most common complications are pin tract discharge, infection and pin loosening. These can be difficult for owners to manage,and when these occur, pin management is necessary and pin revision may be required.
- ESFs may not be the best choice for a fracture that is likely to take a long time to heal. This is because the chance of complications such as pin discharge or loosening is likely to occur before bone healing is complete.
- An uncommon complication of ESFs is fracture of the bone through the pin tract, before or after frame removal.
- ESFs are not applicable to all fractures. In particular, applications to the femur, humerus and radius are constrained by limitations of safe corridors, or the shape of the bone.
- ESFs are not appropriate for fractures where construct stiffness and fracture rigidity needs to be high so as to achieve primary bone union and avoid callus formation. For example ESFs would generally not be suitable for articular or spinal fractures.
- It is not possible to apply axial (dynamic) compression to a fracture using a linear ESF.
- ESFs can get caught on external objects such as cage bars, furniture, other animals or the owner. This can lead to further complications such as ESF dislodgment from the bone and/or damage to property.
- Rarely, animals have been known to self-remove their ESF frame.

## ESF Terminology

### Half Pins and Full Pins

- **Half pins** enter the skin and are connected to the connecting bar on one side of the limb only (Fig. 6). The pin is driven through the bone and stops so that the pointed tip of the pin is just exiting the trans (far) cortex. A threaded half pin has a thread on the end and is also called an end-threaded pin.
- **Full pins** enter through the skin on one side of the limb, go all the way through the bone, exit the skin on the other side, and are attached to a connecting bar on both sides (Fig. 6). A threaded full pin has the thread in the centre, also called centrally threaded or mid-threaded.

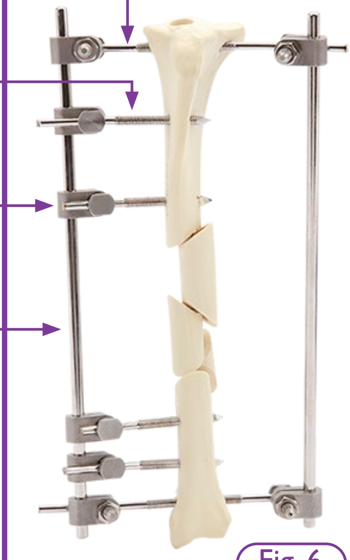


Fig. 6

### Pin Thread

There are various types of pin thread configuration:


Fig. 7

### Positive Thread

- The thread on the pin is a slightly wider diameter than that of the pin shaft. These pins have excellent holding power in bone (Fig. 7).

### Negative Thread

- The thread is cut into the shaft i.e. the shaft is narrower over the threaded portion. The shaft is relatively stiff compared with the threaded section. This creates stress concentration at the shaft-thread interface that may result in premature pin failure. Unicortical pins, also called Ellis pins (Fig. 8) pins only have a short threaded section. The thread engages only with the trans (far) cortex and the smooth part of the pin engages with the cis (near) cortex leaving the thread-shaft intersection positioned within the medullary canal where the point of weakness is better protected from premature failure.


Fig. 8

### No Thread

- Most frequently with a trochar point (Fig. 9). The pin has a sharp tip on the end but no thread. This gives the weakest and least reliable purchase at the pin/bone interface, and has very low resistance to pin pull-out.


Fig. 9

### End Threaded

- The thread is at the end of the pin (also known as a half pin) (Fig. 10).


Fig. 10

### Centrally/Mid Threaded

- The thread is at the centre of the pin (also known as a full pin) (Fig. 11).


Fig. 11

### Pin Diameter

- Pins are labelled according to either the diameter of the shaft for non-threaded or negative threaded pins, or the diameter of both the shaft and the thread for positive threaded pins. For any given pin size, the thread diameter of a positive threaded pin is slightly greater than the shaft diameter. For a negative threaded pin, the thread diameter is the same as the shaft diameter and the core diameter is slightly narrower over the threaded portion.

## Pre-Operative Guidance

- Make sure you complete a full clinical and orthopaedic examination of the patient.
- Only attempt fracture repair when the patient is stable and ready for an anaesthetic.
- Take orthogonal radiographs of the fractured bone i.e. craniocaudal and mediolateral views (Fig. 12). Inspect the radiographs very carefully; make sure you understand the fracture configuration fully. For example: Is the fracture simple or comminuted? Are there fissures?

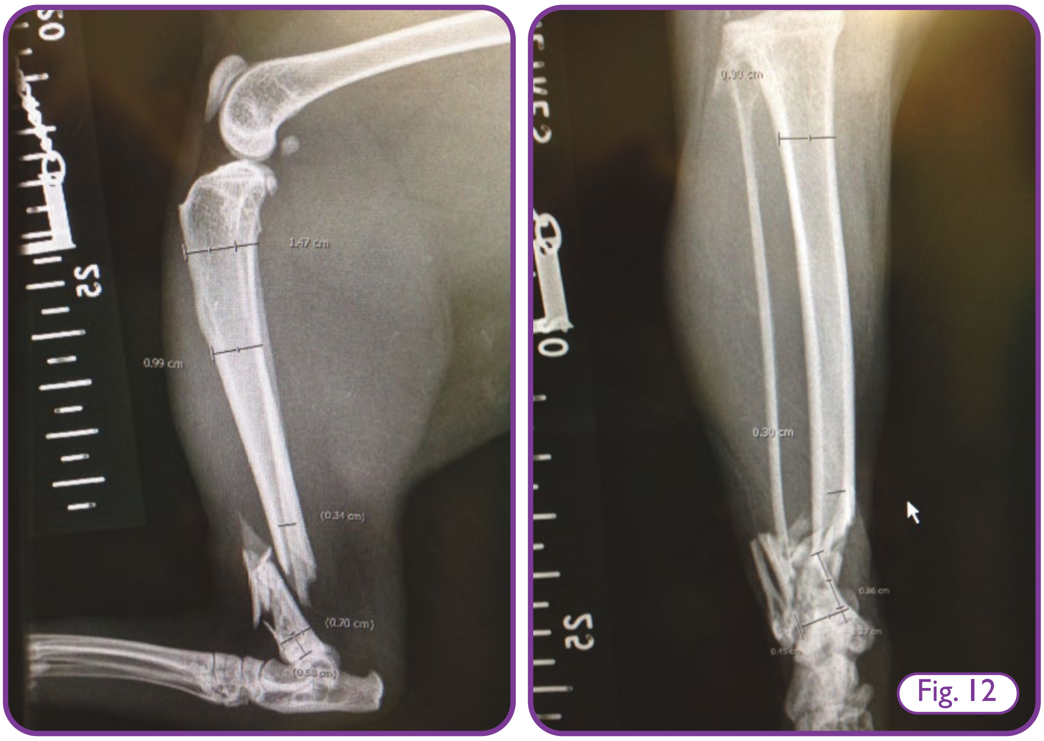


Fig. 12

- Plan the surgery carefully. Specifically for ESF application:
    - In each fragment of bone, is there enough space for at least 2, and ideally 4 pins?
    - There should be no fissures in the bone where ESF pins are to be placed.
    - The minimum distance between ESF pins and the end of bone should be half the bone diameter.
    - What is the external diameter of the bone at each intended site of ESF pin placement? Pin diameter should be 20-25% bone diameter and no more than 30% bone.
    - Which ESF clamps take this size of pin? This helps to indicate the size of ESF system to be used. Refer to Appendix 1 for pin and clamp sizing.
    - Are you intending to place an intramedullary pin in addition to the ESF? If so, measure the internal diameter of the bone; the size of intramedullary pin should be 30-50% the size of the medullary canal at the narrowest point to allow ESF pins to pass alongside.

- Patient positioning: using a hanging limb preparation before fracture surgery helps to overcome fracture over-riding caused by muscle contraction (Fig. 13). During surgery, the hanging limb preparation helps to maintain correct length and alignment of the fracture fragments. This is particularly useful for minimally invasive surgery.


Fig. 13

## Surgical Technique - ESF Rules

### 1. Use Aseptic Technique

Although the ESF connecting bars, clamps and most of the pins are external, placement of an ESF is no different to any other surgery in that strict aseptic technique must be used when preparing the patient, operating room, surgical equipment, surgeon and post-operative care.

### 2. Use Safe Corridors for Pin Placement

Safe corridors are bone locations where pins can be placed that minimise risk of damage to soft tissue structures such as vessels, nerves and muscles. Safe pin corridors are the only locations that ESF pins should be placed.

| | |
|---|---|
| Radius: | Distal = craniomedial and medial |
| | Proximal = craniolateral and lateral |
| Humerus: | Distal = medial and lateral |
| | Proximal = craniolateral |
| | Avoid the mid diaphysis |
| Femur: | Distal = medial and lateral |
| | Proximal = lateral |
| | Avoid the mid diaphysis |
| Tibia: | Entire length = medial or cranial |

### 3. Frame Type

Select and use the ESF frame type that is most appropriate to the fracture type. In most cases, this is a type IA or type IB frame. Rarely is it necessary to place a type II ESF, and almost never is a type III frame necessary.

In increasing order of stiffness they are:

**Type IA = Unilateral, Uniplanar (Fig 14)**. A single connecting bar is used; all the pins are half pins. The connecting bar is usually placed medially on the tibia, or laterally on the femur and humerus.

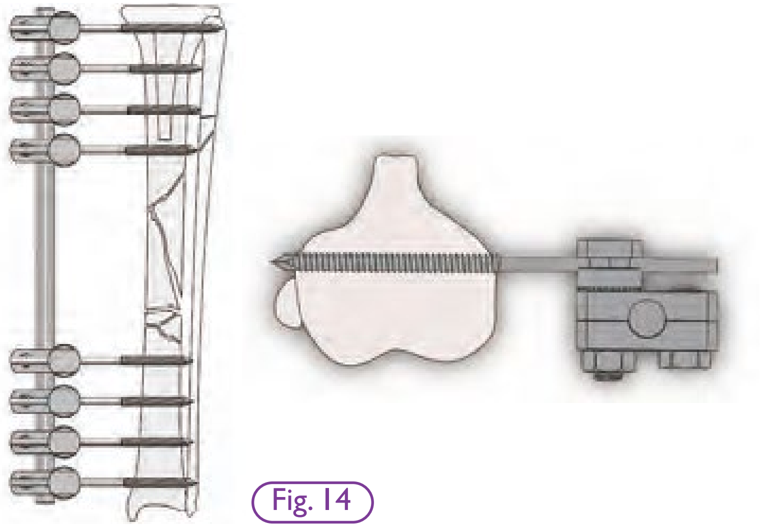


Fig. 14

**Type IB = Unilateral, Biplanar. (Fig. 15).** This is two Type IA frames adjacent to each other but in different planes. Two connecting bars are used. The connecting bars may be linked together which makes the construct stiffer. It is near impossible to apply type 1B fixators to the humerus and femur whilst still achieving safe corridors, because of the cranial and caudal muscle bellies.

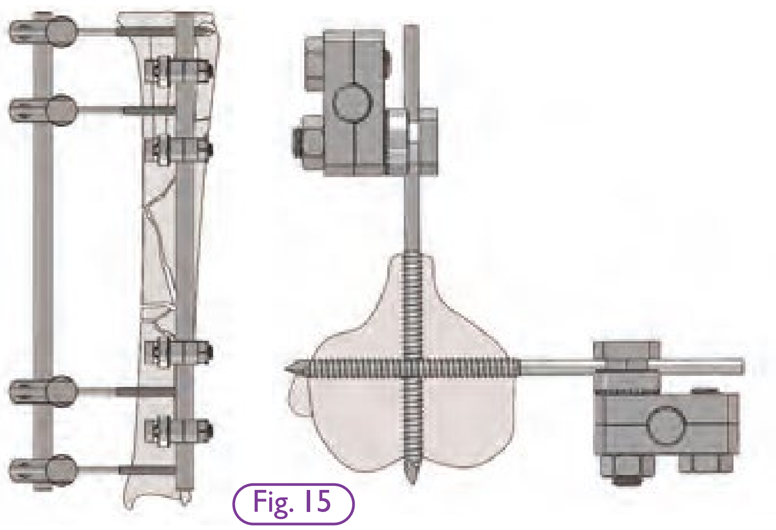


Fig. 15

**Type II modified (type IIB): Bilateral, Uniplanar with full and half pins. (Fig. 16).**

Two connecting bars are used; usually one lateral and one medial to the bone, hence bilateral. This ESF construct is in a single mediolateral plane; hence uniplanar. The most proximal and distal pins are full pins and the pins in-between are half pins.

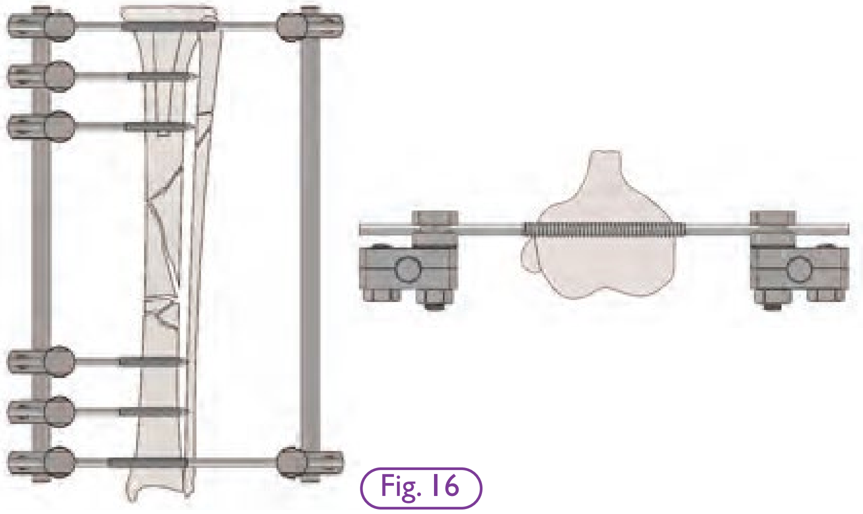


Fig. 16

**Type II (type IIA): Bilateral, Uniplanar with only full pins. (Fig. 17).**

This is the same as the type II modified/ type B frame except that there are no half pins; all the pins are full pins. This makes the type II frame more rigid than the type IIB frame, but it is more difficult to achieve because aiming the pins from one connecting bar to line up with the connecting bar on the other side is very challenging.

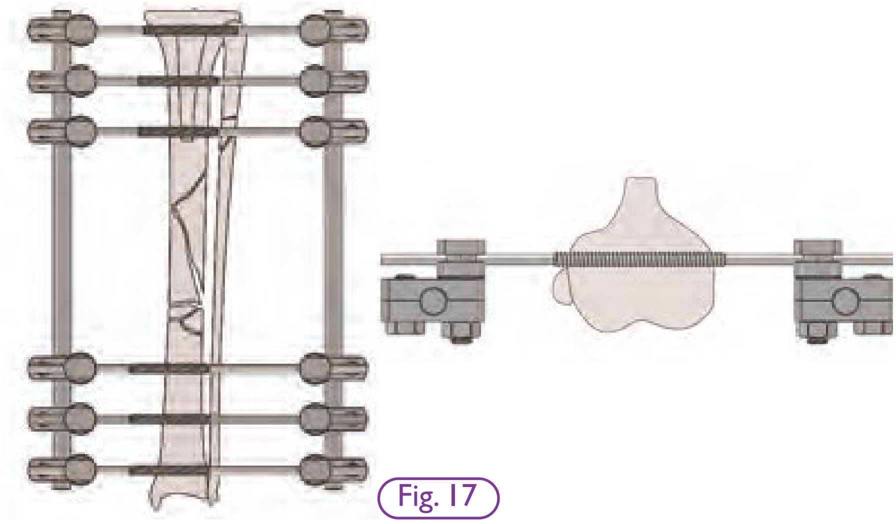


Fig. 17

**Type III: Bilateral, Biplanar. (Fig. 18).**

This is the application of a Type IA and a Type II frame together plus extra connecting bars to attach the two frames together. This is a big and heavy frame type; it is rarely necessary to apply such a rigid frame.

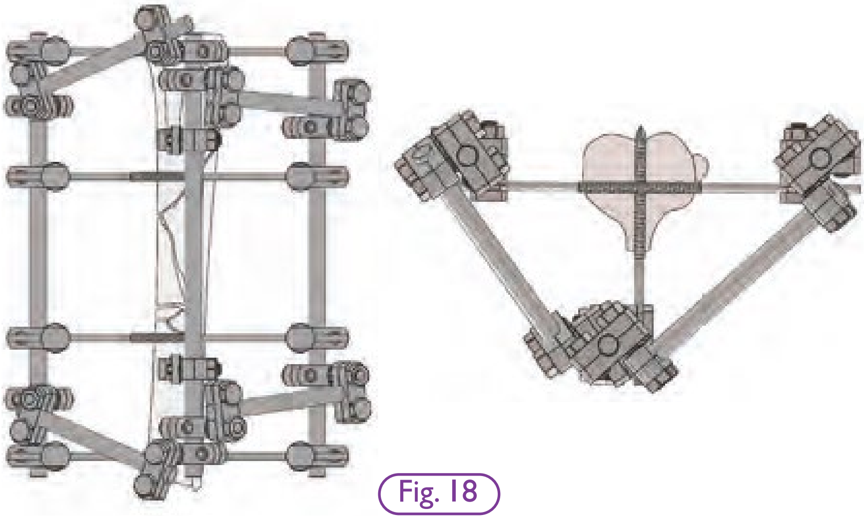


Fig. 18

## 4. Fixator Pins

### Aim for 4 pins per bone segment.

The absolute minimum is 2 pins per bone segment (Fig 19a). Increasing pin numbers increases construct stability and decreases stress at the pin-bone interface. High stress at the pin-bone interface leads to bone resorption and pin loosening. Increasing the number of pins reduces the pin-bone interface stress of each pin but there is little beneficial effect beyond 4 pins; the ideal number is 4 pins (Fig. 19b).

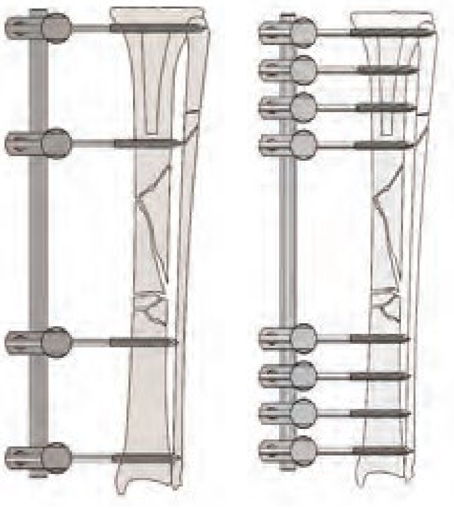


Fig. 19a Fig. 19b

### Use the Far-Near-Near-Far Principle.

In each bone segment, place pins as far away from the fracture and as near to the fracture as possible (Fig.20). This maximises bone (fragment) stability by reducing the lever arm on the fixator, and by shortening the working length of the connecting bar i.e. the distance between the central 2 clamps. The minimum distance between ESF pin and end of the bone or fracture is half the bone diameter.

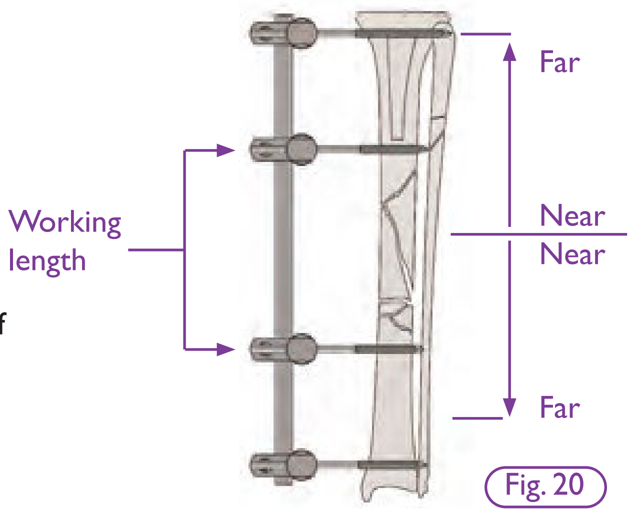



Fig. 20

### Space pins as widely as possible.

Increasing pin spacing increases the bending stiffness of the frame; space the pins out as much as possible (Fig. 21a). Uneven pin spacing reduces the bending stiffness of the construct (Fig 21b).

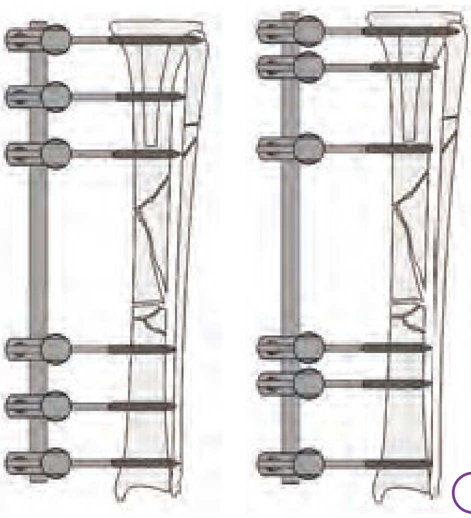


Fig. 21a Fig. 21b

## Use threaded pins.

Threaded pins are the most reliable (Fig. 22a) as they have much better holding power and pull-out resistance than smooth pins by a factor of at least x10. Because of this, pin angulation is not important. Smooth non-threaded trochar pins have little inherent resistance to pull-out. If smooth pins must be used, they should be inserted at different angles to each other, ideally placing them at 70 degrees to the long axis of the bone because this increases the pull-out resistance of the pins (Fig.22b). However, the use of smooth pins should be avoided where possible.

It is advisable that at least one, and preferably all, threaded pins are used per fragment. Mounting smooth pins on alternate sides of the connecting bar may also help to resist pull-out. Negative threaded pins (Ellis pins) are weakest at the junction of the pin shank and thread because this zone acts as a stress concentrator i.e. where the shank diameter gets narrower. Therefore the shank/thread junction should ideally be buried within the bone beyond the cis cortex to protect it from failure (Fig. 22c). This does not apply to positive threaded pins as the shank diameter is continuous therefore there is no stress concentration.

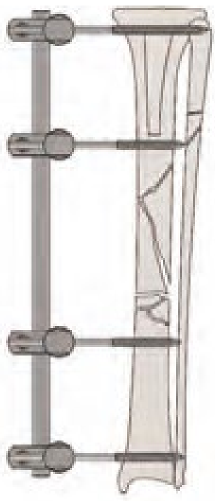


Fig. 22a

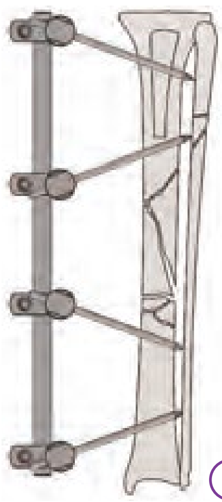


Fig. 22b

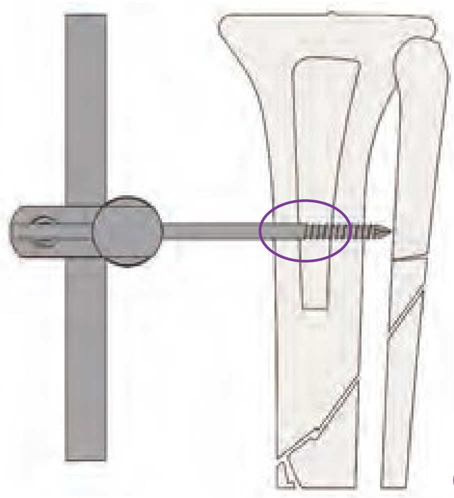


Fig. 22c

## Pin size should be 20-25% bone diameter.

Thicker pins are stiffer than small pins, and small increases in pin diameter result in a disproportionate increase in pin stiffness. However, larger pins require larger holes in the bone, and larger holes in the bone weaken the bone which could then fracture. Pin thread diameter should not exceed 30% bone diameter (Fig. 23).

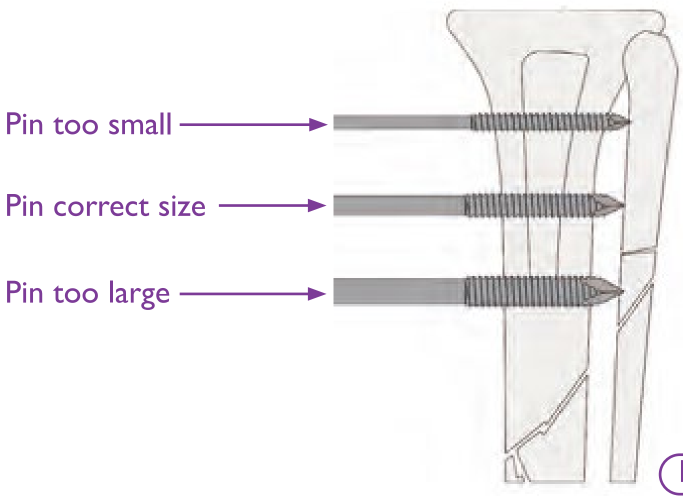



Fig. 23

## Pin length.

Pin stiffness is inversely proportional to pin length i.e. a shorter pin is stiffer than a longer pin. The working length is the length of pin between the bone and the ESF clamp. The clamps and connecting bar should be about 1cm or a finger's width from the skin (Fig. 24); this is optimal clearance allowing for wound maintenance and postoperative swelling, whilst keeping the ESF construct as stiff as possible. In cases of severe soft tissue trauma and swelling, it may be better to place the connecting bar and clamps further away whilst the initial swelling subsides, and to then adjust and place closer at a later date.

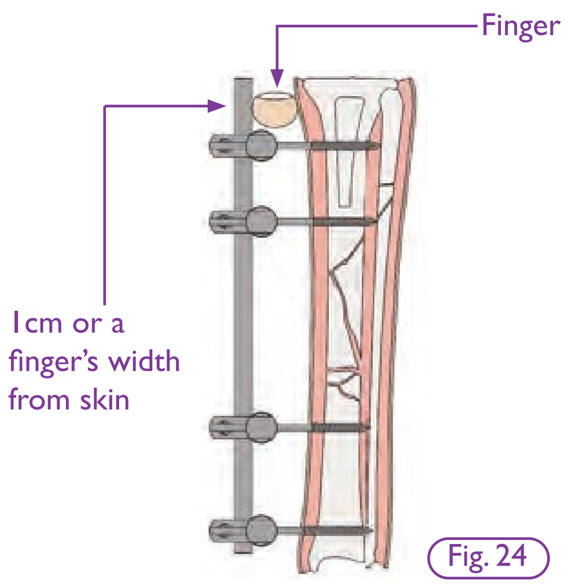


Fig. 24

## Clamp orientation.

Orienting the ESF clamps so that the clamp mechanism is on the inside (Fig. 25a) rather than the outside (Fig. 25b) of the connecting bar also reduces the working length of the pin: this makes the construct stiffer.

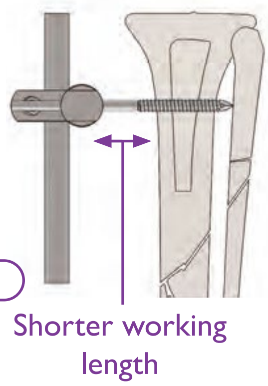


Fig. 25a

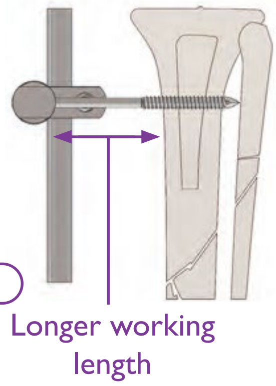


Fig. 25b

## Pin placement.

- Use safe corridors to minimise risk of neurovascular damage, and to minimise the depth of soft tissue structures that are penetrated. If penetration of a muscle belly cannot be avoided, use haemostats to bluntly tunnel through the muscle belly.
- Place pins through fresh stab incisions using a #11 blade through fresh healthy skin. Do not place pins through the surgical incision or traumatic wound.
- Pre-drill the pin hole to minimise heat production and potential thermal bone necrosis during pin insertion. Pre-drill using a drill bit about 10% smaller than the pin shank diameter. For ease of application, use a drill guide and K-wire to maintain the position of the pin hole after withdrawal of the drill and before introduction of the ESF pin.
- To drive each pin, use a power drill at <150rpm to minimise heat production and bone necrosis; an electric drill driven slowly is ideal. Do not use a hand chuck as this creates wobble during pin insertion, which reduces the quality of the pin-bone interface and may predispose to premature pin loosening.
- Place the most proximal and distal pins first, and then apply the connecting bar and clamps.
- Pre-drill the pin holes into the bone through clamps placed on the connecting bar. This ensures that the pre-drilled holes (and therefore the ESF pins that are subsequently placed) line up with the clamps. This is not necessary for the most proximal and distal ESF pins that are placed first, as these dictate the position of the ESF.
- Ensure that pins are placed through both cortices of the bone (cis cortex and trans cortex). Correct pin placement (depth) can be gauged by:
    - The change in drill pitch noise as the pin enters and then exits the cis and then the trans cortex.
    - Placing another pin alongside the implanted pin and checking length and position.
    - Sometimes the pin tip exiting the bone can just be palpated if soft tissue cover is minimal.

## 5. Frame Stiffness

Increasing connecting bar stiffness decreases the load at the fracture site and the load on the pins. However, if the connecting bars or construct are too stiff, this may stress protect the fracture and delay fracture healing.

Frame stiffness can be increased by:

- Increasing the diameter of the connecting bar i.e. using a larger ESF system - but this may necessitate using larger pins,which may break the rule that pin size needs to be approximately 20-25% bone diameter. Larger connecting bars may also be excessively heavy or bulky for the patient.
- Adding a second connecting bar adjacent to the first (Fig. 26).
- For type IB or type III frames, link the connecting bars using double clamps.
- Use a different type of (stiffer) connecting bar. In order of decreasing strength/weight ratio: Carbon Fibre > Titanium Alloy > Aluminium Alloy > Stainless Steel

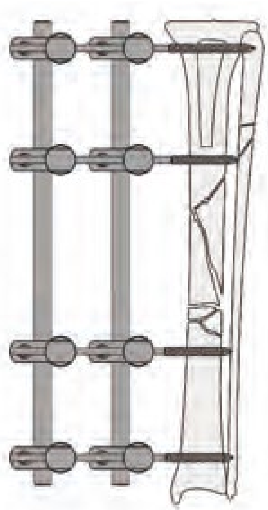


Fig. 26

## 6. Frame Size

The ESF frame size is dictated by the size of ESF pins that are placed. The size of ESF pins that are placed are dictated by the size of the bone. At each pin location, the diameter of the bone should be measured and pins that are 20-25% the diameter of the bone should be placed. The ESF frame size is then worked backwards from the pin diameter. Refer to Appendix 1 for pin and clamp sizing.

## 7. Use of an Intramedullary Pin

Using an intramedullary pin enables the fracture to be distracted and aligned, and the position of the proximal and distal bone fragments to be maintained whilst the ESF is applied. The intramedullary pin allows this to be accomplished relatively quickly and atraumatically, and minimises the amount of fracture manipulation that is necessary. When tied-in to the ESF construct, an intramedullary pin also increases the fixator construct strength and stiffness.

Choosing an intramedullary pin that is 30-50% of the diameter of the intramedullary canal increases frame stiffness and rigidity whilst still allowing ESF pins to be placed adjacent to the intramedullary pin.

## Summary Step-By-Step ESF Frame Application

Ensure the fractured bone is correctly aligned and distracted to the right length; consider using an intramedullary pin and/or a hanging limb preparation to achieve this.

**1.** Place the most proximal and distal pins first. Remember to pre-drill the hole in the bone using a drill bit 10% smaller than the ESF pin diameter. Placing a small K-wire or A-wire into the hole will help maintain access and confirms hole alignment prior to pin placement.

**2.** Attach the connecting bar to the most proximal and distal pins using clamps. If using the KE Plus system, remember to pre-place all the clamps on the connecting bar(s) as it will not be possible to add extra clamps later without taking everything off and starting from the beginning. With the SF system, clamps can be easily added or removed at any stage.

**3.** Place all remaining pins in the proximal and distal segments. Pre-drill using a drill guide and through the pin hole of the clamp.

**4.** Ensure that bone alignment and length is correct, then tighten all clamps.

**5.** Take post-operative radiographs; adjust if necessary i.e. if pins need inserting further, then slacken the appropriate clamp, adjust the depth of the pin, and re-tighten the clamp. However, care should be taken when adjusting ESFs at post-op x-rays; much time can be spent adjusting ESF clamps and pins, but often to little improvement to fracture alignment.

**6.** Once satisfied, tighten all clamps.

**7.** Cut all ESF pins as close to the connecting bar as you can, using a suitable implant cutter. Take care to keep hold of the pin ends as they are cut to minimize the risk of the cut portion flying off.

**8.** If necessary, place a dressing to control soft tissue swelling and absorb discharge.

**9.** Dress the ESF apparatus using cohesive bandaging material or similar so that all sharp edges are covered and the patient cannot damage themselves, the owners, or their surroundings.

With thanks to Gareth Arthurs PGCertMedEd MA VetMB CertVR CertSAS DSAS(Orth) FHEA FRCVS RCVS Recognised Specialist in Small Animal Surgery (Orthopaedics) for his invaluable assistance with the revised version (2023) of this Surgery Guide.

# Appendix I

## Pin Reference Chart

| | Bar Diameter | Small 3.2mm 1/8" | Medium 4.8mm 3/16" | Large 8mm 5/16mm | Mini 3.2mm 1/8" | Small 6.3mm 1/4" | Large 9.5mm 1/3" |
|---|---|---|---|---|---|---|---|
| | Clamp Style | KE Plus | KE Plus | KE Plus | Standard SF | Standard SF | Standard SF |
| Code | Shaft Diameter | | | | | | |
| **Positive Threaded Pins - End Thread** | | | | | | | |
| CET0013 | Positive End Thread Pin 1.0mm Shank 1.3mm Thread 65mm Long | | | | | | |
| CET0014 | Positive End Thread Pin 0.8mm Shank 1.1mm Thread 60mm Long | | | | | | |
| CET0015 | Positive End Thread Pin 1.2mm Shank 1.5mm Thread 65mm Long | | | | | | |
| CET0016 | Positive End Thread Pin 1.2mm Shank 1.6mm Thread 70mm Long | | | | | | |
| CET0017 | Positive End Thread Pin 1.4mm Shank 1.8mm Thread 70mm Long | | | | | | |
| CET0018 | Positive End Thread Pin 1.6mm Shank 2mm Thread 70mm Long | ● | ● | | ● | | |
| CET0026 | Positive End Thread Pin 1.8mm Shank 2.2mm Thread 80mm Long | ● | ● | ● | ● | ● | |
| CET0019 | Positive End Thread Pin 2mm Shank 2.4mm Thread 85mm Long | ● | ● | | ● | ● | |
| CET0020 | Positive End Thread Pin 2.4mm Shank 3.2mm Thread 100mm Long | ● | ● | ● | | ● | |
| CET0020A | Positive End Thread Pin 2.7mm Shank 3.5mm Thread 110mm Long | ● | ● | ● | | ● | |
| CET0020B | Positive End Thread Pin 3mm Shank 3.8mm Thread 120mm Long | | ● | ● | | ● | ● |
| CET0021 | Positive End Thread Pin 3.2mm Shank 4mm Thread 130mm Long | | ● | ● | | ● | ● |
| CET0022 | Positive End Thread Pin 4mm Shank 4.8mm Thread 150mm Long | | ● | ● | | | ● |
| CET0024A | Positive End Thread Pin 3.5mm Shank 4.3mm Thread 130mm Long | | ● | ● | | | ● |
| **Positive Threaded Pins - Mid Thread** | | | | | | | |
| CMT0013 | Positive Mid Thread Pin 0.8mm Shank 1.1mm Thread 85mm Long | | | | | | |
| CMT0014 | Positive Mid Thread Pin 1.1mm Shank 1.4mm Thread 85mm Long | | | | | | |
| CMT0015 | Positive Mid Thread Pin 1.2mm Shank 1.5mm Thread 85mm Long | | | | | | |
| CMT0016 | Positive Mid Thread Pin 1.4mm Shank 1.8mm Thread 85mm Long | | | | | | |
| CMT0017 | Positive Mid Thread Pin 1.6mm Shank 2mm Thread 85mm Long | ● | ● | | ● | | |
| CMT0018 | Positive Mid Thread Pin 1.6mm Shank 2mm Thread 85mm Long | ● | ● | | ● | | |
| CMT0018A | Positive Mid Thread Pin 1.8mm Shank 2.2mm Thread 90mm Long | ● | ● | | ● | | |
| CMT0019 | Positive Mid Thread Pin 2mm Shank 2.4mm Thread 105mm Long | ● | ● | | ● | ● | |
| CMT0019A | Positive Mid Thread Pin 2.2mm Shank 2.6mm Thread 105mm Long | ● | ● | | | ● | |
| CMT0023 | Positive Mid Thread Pin 2.4mm Shank 3.2mm Thread 105mm Long | ● | ● | ● | | ● | |
| CMT0023A | Positive Mid Thread Pin 2.7mm Shank 3.5mm Thread 115mm Long | ● | ● | ● | | ● | |
| CMT0023B | Positive Mid Thread Pin 3mm Shank 3.8mm Thread 120mm Long | | ● | ● | | ● | ● |
| CMT0024 | Positive Mid Thread Pin 3.2mm Shank 4mm Thread 130mm Long | | ● | ● | | ● | ● |
| CMT0024A | Positive Mid Thread Pin 3.5mm Shank 4.3mm Thread 140mm Long | | ● | ● | | | ● |
| CMT0025 | Positive Mid Thread Pin 4mm Shank 4.8mm Thread 150mm Long | | ● | ● | | | ● |
| **Trochar Pins** | | | | | | | |
| 001556 | Trochar Pin 2.0mm | ● | ● | | ● | ● | |
| 001557 | Trochar Pin 3.0mm | ● | ● | ● | | ● | ● |
| 001558 | Trochar Pin 4.0mm | | ● | ● | | ● | ● |

# Pin Reference Chart Continued

| | Bar Diameter | Small 3.2mm 1/8" | Medium 4.8mm 3/16" | Large 8mm 5/16mm | Mini 3.2mm 1/8" | Small 6.3mm 1/4" | Large 9.5mm 1/3" |
|---|---|---|---|---|---|---|---|
| | Clamp Style | KE Plus | KE Plus | KE Plus | Standard SF | Standard SF | Standard SF |
| Code | Shaft Diameter | | | | | | |
| **Cortical Negative Threaded Pins - Ellis Type** | | | | | | | |
| 001528 | Ellis Pin 1.1mm | ● | | | ● | | |
| 001529 | Ellis Pin 1.6mm | ● | | | ● | | |
| 001533 | Ellis Pin 1.8mm | ● | ● | | ● | | |
| 001550 | Ellis Pin 2.0mm | ● | ● | | ● | ● | |
| 001530 | Ellis Pin 2.4mm | ● | ● | ● | ● | ● | |
| 001550A | Ellis Pin 2.7mm | ● | ● | ● | | ● | |
| 001551 | Ellis Pin 3.0mm | ● | ● | ● | | ● | ● |
| 001531 | Ellis Pin 3.2mm | ● | ● | ● | | ● | ● |
| 001551A | Ellis Pin 3.5mm | ● | ● | ● | | ● | ● |
| 001552 | Ellis Pin 4.0mm | ● | ● | ● | | ● | ● |
| **Bicortical Fine Negative Threaded Pins** | | | | | | | |
| BCNET08 | 0.8mm Bicortical Pin Negative End Thread Pin 70mm | | | | | | |
| BCNET10 | 1mm Bicortical Pin Negative End Thread Pin 70mm | ● | | | ● | | |
| BCNET11 | 1.1mm Bicortical Pin Negative End Thread Pin 70mm | ● | | | ● | | |
| BCNET13 | 1.4mm Bicortical Pin Negative End Thread Pin 70mm | ● | | | ● | | |
| BCNET15 | 1.5mm Bicortical Pin Negative End Thread Pin 70mm | ● | | | ● | | |
| BCNET16 | 1.6mm Bicortical Pin Negative End Thread Pin 70mm | ● | | | ● | | |
| BCNET18 | 1.8mm Bicortical Pin Negative End Thread Pin 85mm | ● | ● | | ● | | |
| BCNET20 | 2mm Bicortical Pin Negative End Thread Pin 85mm | ● | ● | | ● | ● | |
| BCNET24 | 2.4mm Bicortical Pin Negative End Thread Pin 100mm | ● | ● | ● | ● | ● | |
| BCNET27 | 2.7mm Bicortical Pin Negative End Thread Pin 110mm | ● | ● | ● | | ● | |
| BCNET30 | 3mm Bicortical Pin Negative End Thread Pin 130mm | ● | ● | ● | | ● | ● |
| BCNET35 | 3.5mm Bicortical Pin Negative End Thread Pin 130mm | ● | ● | ● | | ● | ● |
| BCNET40 | 4mm Bicortical Pin Negative End Thread Pin 150mm | | ● | ● | | ● | ● |
| BCNET50 | 5mm Bicortical Pin Negative End Thread Pin 150mm | | ● | ● | | ● | ● |

# Featured Products

Please note, the following featured products are only a selection of those available in the range.

## Standard Fixators (SF)

| | |
|---|---|
| **0017695SC** | SF Full Kit With Steel/Carbon Bars |

Please contact a member of the Vi team for a list of the contents of these kits.

### SF Mini Range

| | |
|---|---|
| **001740** | Mini Single Clamp |
| **001743** | Mini Double Clamp |
| **001595** | Mini 1/8" (3.2mm) Bar x 30mm Stainless Steel |
| **001559** | Mini 1/8" (3.2mm) Bar x 50mm Stainless Steel |
| **001590** | Mini 1/8" (3.2mm) Bar x 75mm Stainless Steel |
| **001596** | Mini 1/8" (3.2mm) Bar x 100mm Stainless Steel |
| **001573** | Mini 1/8" (3.2mm) Bar x 125mm Stainless Steel |
| **001560** | Mini 1/8" (3.2mm) Bar x 150mm Stainless Steel |
| **001574** | Mini 1/8" (3.2mm) Bar x 175mm Stainless Steel |
| **001575** | Mini 1/8" (3.2mm) Bar x 200mm Stainless Steel |
| **SL2015** | Insert Drill Sleeve 2.0mm O/D 1.5mm I/D |
| **SL2418** | Insert Drill Sleeve 2.4mm O/D 1.8mm I/D |
| **001566** | Spanner 7mm |

### SF Small Range

| | |
|---|---|
| **001741** | Small Single Clamp |
| **001744-A** | Small Double Clamp |
| **001862C** | Small 1/4"(6.3mm) Bar x 100mm Carbon |
| **001863C** | Small 1/4"(6.3mm) Bar x 150mm Carbon |
| **001864C** | Small 1/4"(6.3mm) Bar x 200mm Carbon |
| **001865C** | Small 1/4"(6.3mm) Bar x 250mm Carbon |
| **001866C** | Small 1/4"(6.3mm) Bar x 300mm Carbon |
| **001862TI** | Small 1/4"(6.3mm) Bar x 100mm Ti |
| **001863TI** | Small 1/4"(6.3mm) Bar x 150mm Ti |
| **001864TI** | Small 1/4"(6.3mm) Bar x 200mm Ti |
| **001865TI** | Small 1/4"(6.3mm) Bar x 250mm Ti |
| **SL3525** | Insert Drill Sleeve 3.5mm o/d 2.5mm I/D |
| **001565** | Spanner 8mm |

### SF Large Range

| | |
|---|---|
| **001742** | Large Single Clamp |
| **001745** | Large Double Clamp |
| **001870C** | Large 3/8"(9.5mm) Bar x 100mm Carbon |
| **001871C** | Large 3/8"(9.5mm) Bar x 150mm Carbon |
| **001872C** | Large 3/8"(9.5mm) Bar x 200mm Carbon |
| **001873C** | Large 3/8"(9.5mm) Bar x 250mm Carbon |
| **001874C** | Large 3/8"(9.5mm) Bar x 300mm Carbon |
| **001870TI** | Large 3/8"(9.5mm) Bar x 100mm Aluminium |
| **001871TI** | Large 3/8"(9.5mm) Bar x 150mm Aluminium |
| **001872TI** | Large 3/8"(9.5mm) Bar x 200mm Aluminium |
| **001873TI** | Large 3/8"(9.5mm) Bar x 250mm Aluminium |
| **001874TI** | Large 3/8"(9.5mm) Bar x 300mm Aluminium |
| **SL4532** | Insert Drill Sleeve 4.5mm O/D 3.2mm I/D |
| **001564** | Spanner 10mm |

## KE Plus

| | |
|---|---|
| **001579ND** | Boxed Full KE+ Kit No Doubles |
| **001579NDP** | Full KE+ Kit In Stainless Steel Box |

Please contact a member of the Vi team for a list of the contents of these kits.

### KE Plus Small Range

| | |
|---|---|
| **001527** | Small Single KE Plus Clamp |
| **001594** | Small Double Clamp |
| **001595** | Small Connecting Bar 1/8" (3.2mm) x 30mm |
| **001559** | Small Connecting Bar 1/8" (3.2mm) x 50mm |
| **001590** | Small Connecting Bar 1/8" (3.2mm) x 75mm |
| **001596** | Small Connecting Bar 1/8" (3.2mm) x 100mm |
| **001573** | Small Connecting Bar 1/8" (3.2mm) x 125mm |
| **001560** | Small Connecting Bar 1/8" (3.2mm) x 150mm |
| **001574** | Small Connecting Bar 1/8" (3.2mm) x 175mm |
| **001575** | Small Connecting Bar 1/8" (3.2mm) x 200mm |
| **001597** | ESF Hinge Joint Small |
| **001566** | Spanner 7mm |

### KE Plus Medium Range

| | |
|---|---|
| **001526** | Medium Single KE Plus Clamp |
| **001592** | Medium Double Clamp |
| **001588** | Medium Connecting Bar 3/16" (4.8mm) x 75mm |
| **001576** | Medium Connecting Bar 3/16" (4.8mm) x 100mm |
| **001587** | Medium Connecting Bar 3/16" (4.8mm) x 150mm |
| **001589** | Medium Connecting Bar 3/16" (4.8mm) x 200mm |
| **001589XL** | Medium Connecting Bar 3/16" (4.8mm) x 250mm |
| **001589XXL** | Medium Connecting Bar 3/16" (4.8mm) x 300mm |
| **001598** | ESF Hinge Joint Medium |
| **001565** | Spanner 8mm |

### KE Plus Large Range

| | |
|---|---|
| **001525** | Large Single KE Plus Clamp |
| **001584** | Large Double Clamp |
| **001547L** | Large Split Clamp Single |
| **001586** | Large Connecting Bar 5/16" (8mm) x 100mm |
| **001563** | Large Connecting Bar 5/16" (8mm) x 150mm |
| **001585** | Large Connecting Bar 5/16" (8mm) x 240mm |
| **001549** | Large Connecting Bar 5/16" (8mm) x 340mm |
| **001564** | Spanner 10mm |

# FESSA External Fixation

## FESSA External Fixation - Stainless Steel

015500 FESSA 6 & 8mm Set With 10 of Each Screw

6mm FESSA

015502 FESSA Tube 6mm x 30mm
015504 FESSA Tube 6mm x 45mm
015506 FESSA Tube 6mm x 65mm
015508 FESSA Hex Driver Allen Key Type 1.5mm
015509 FESSA 6mm (1.5 Hex) Grub Screws (10)
015534 FESSA 6mm Hinge

8mm FESSA

015510 FESSA Tube 8mm x 100mm
015512 FESSA Tube 8mm x 150mm
015514 FESSA Tube 8mm x 200mm
SDHS20-1 1.5/2.0/2.4mm Hex Screwdriver & Screw Holding Sleeve
015517 FESSA Hex Driver Allen Key Type 2.0mm
015520 FESSA 8mm (2.0 Hex) Grub Screws (10)
015536 FESSA 8mm Hinge

12mm FESSA

015540 FESSA Tube 12mm x 125mm
015542 FESSA Tube 12mm x 175mm
015544 FESSA Tube 12mm x 225mm
015545 FESSA 12mm (2.5 Hex) Grub Screws (10)
SDHS35POM-C 2.5mm Hex Screwdriver + Sleeve With PTFE Handle

## FESSA Ultra-Lightweight Titanium FESSA

015530 Titanium FESSA Set In Stainless Steel Box

Components:

015521 5mm x 30mm Titanium FESSA
015522 5mm x 45mm Titanium FESSA
015509 FESSA 5mm (1.5 Hex) Locking Screws (10)
015508 1.5 Hex Allen Key
BCNET08 0.8mm Bicortical Negative Pins
BCNET10 1.0mm Bicortical Negative Pins
BCNET15 1.5mm Bicortical Negative Pins

Please contact a member of the Vi team for a list of the contents of these kits.

## Spanners

| Clamp Type | Clamp Size | Clamp Code | Spanner Size | Spanner Code |
|---|---|---|---|---|
| KE+ | Small | 001527 | 7mm | 001566 |
| | Medium | 001526 | 8mm | 001565 |
| | Large | 001525 | 10mm | 001564 |
| KE+ Split Clamps | Large | 001547L | 10mm | 001564 |
| KE+ Split Clamps | Medium | 001598 | 8mm | 001565 |
| SF Clamps Single | Mini | 001740 | 7mm | 001566 |
| | Small | 001741 | 8mm | 001565 |
| | Large | 001742 | 10mm | 001564 |
| SF Clamps Double | Mini | 001743 | 7mm | 001566 |
| | Small | 001744 | 8mm | 001565 |
| | Large | 001745 | 10mm | 001564 |

## Pre-Drilling ESF Pin Tracts

H090202 1.9mm Pre-Drill For 2.0mm Shank Positive Pin
H090203 2.3mm Pre-Drill For 2.4mm Shank Positive Pin
H090205 3.0mm Pre-Drill For 3.2mm Shank Positive Pin
H090207 3.8mm Pre-Drill For 4.0mm Shank Positive Pin
H090101 1.5mm Pre-Drill For 2.0mm Shank Negative Pin
H090102 2.0mm Pre-Drill For 2.4mm Shank Negative Pin
H090104 2.7mm Pre-Drill For 3.2mm Shank Negative Pin
H090106L 3.5mm Pre-Drill For 4.0mm Shank Negative Pin

## Epoxy ESF Putty


EPOXY1 Epoxy ESF Putty 55G
EPOXY2 Epoxy ESF Putty 110G

# ESF Pins

Please refer to the Vi catalogue for further information on each pin type.

## Positive Threaded Pins - Cortical

End Thread

| | |
|---|---|
| **CET0014** | 0.8mm Shank 1.1mm Threads 60mm Long - End Thread |
| **CET0013** | 1.0mm Shank 1.3mm Threads 65mm Long - End Thread |
| CET0015 | 1.2mm Shank 1.5mm Threads 65mm Long - End Thread |
| **CET0016** | 1.2mm Shank 1.6mm Threads 70mm Long - End Thread |
| **CET0017** | 1.4mm Shank 1.8mm Threads 70mm Long - End Thread |
| **CET0018** | 1.6mm Shank 2.0mm Threads 70mm Long - End Thread |
| **CET0026** | 1.8mm Shank 2.2mm Threads 80mm Long - End Thread |
| **CET0019** | 2.0mm Shank 2.4mm Threads 85mm Long - End Thread |
| **CET0020** | 2.4mm Shank 3.2mm Threads 100mm Long - End Thread |
| **CET0020A** | 2.7mm Shank 3.5mm Threads 110mm Long - End Thread |
| **CET0020B** | 3.0mm Shank 3.8mm Threads 120mm Long - End Thread |
| **CET0021** | 3.2mm Shank 4.0mm Threads 130mm Long - End Thread |
| **CET0024A** | 3.5mm Shank 4.3mm Threads 130mm Long - End Thread |
| **CET0022** | 4.0mm Shank 4.8mm Threads 150mm Long - End Thread |

Mid Thread

| | |
|---|---|
| **CMT0013** | 0.98mm Shank 1.1mm Threads 85mm Long - Mid Thread |
| **CMT0014** | 1.1mm Shank 1.4mm Threads 85mm Long - Mid Thread |
| **CMT0015** | 1.2mm Shank 1.5mm Threads 85mm Long - Mid Thread |
| **CMT0016** | 1.4mm Shank 1.8mm Threads 85mm Long - Mid Thread |
| **CMT0017** | 1.6mm Shank 2.0mm Threads 85mm Long - Mid Thread |
| **CMT0018** | 1.6mm Shank 2.0mm Threads 85mm Long - Mid Thread |
| **CMT0018A** | 1.8mm Shank 2.2mm Threads 90mm Long - Mid Thread |
| **CMT0019** | 2.0mm Shank 2.4mm Threads 105mm Long - Mid Thread |
| **CMT0019A** | 2.2mm Shank 2.6mm Threads 105mm Long - Mid Thread |
| **CMT0023** | 2.4mm Shank 3.2mm Threads 105mm Long - Mid Thread |
| **CMT0023A** | 2.7mm Shank 3.5mm Threads 115mm Long - Mid Thread |
| **CMT0023B** | 3.0mm Shank 3.8mm Threads 120mm Long - Mid Thread |
| **CMT0024** | 3.2mm Shank 4.0mm Threads 130mm Long - Mid Thread |
| **CMT0024A** | 3.5mm Shank 4.3mm Threads 140mm Long - Mid Thread |
| **CMT0025** | 4.0mm Shank 4.8mm Threads 150mm Long - Mid Thread |

CMT0017 has a 16mm thread length.

CMT0018 has a 20mm thread length.

## Positive Threaded Pins – Cancellous

| | |
|---|---|
| **CANET0026** | 2.4mm Shank 3.5mm Threads 115mm Long Cancellous End Thread |
| **CANET0027** | 3.2mm Shank 4.8mm Threads 150mm Long Cancellous End Thread |
| **CANMT0029** | 2.4mm Shank 3.5mm Threads 150mm Long Cancellous Mid Thread |
| **CANMT0030** | 3.2mm Shank 4.8mm Threads 180mm Long Cancellous Mid Thread |

## Trochar Pins

| | |
|---|---|
| **001556** | Trochar Pin 2mm |
| **001557** | Trochar Pin 3mm |
| **001558** | Trochar Pin 4mm |

## Cortical Negative Threaded Pins (Ellis Type)

| | | Pin Diameter | Overall Length |
|---|---|---|---|
| **001528** | Ellis Pin | 1.1mm | 76mm |
| **001529** | Ellis Pin | 1.6mm | 85mm |
| **001533** | Ellis Pin | 1.8mm | 127mm |
| **001550** | Ellis Pin | 2.0mm | 127mm |
| **001530** | Ellis Pin | 2.4mm - (3/32") | 127mm |
| **001550A** | Ellis Pin | 2.7mm - (7/64") | 127mm |
| **001551** | Ellis Pin | 3.0mm | 127mm |
| **001531** | Ellis Pin | 3.2mm - (1/8") | 127mm |
| **001551A** | Ellis Pin | 3.5mm | 127mm |
| **001552** | Ellis Pin | 4.0mm | 127mm |

## Bicortical Negative Threaded Pins

| | Shaft Diameter | Thread Diameter | Thread Length | Overall Length |
|---|---|---|---|---|
| **BCNET08** | 0.8mm | 0.8mm | 8mm | 70mm |
| **BCNET10** | 1.0mm | 1.0mm | 10mm | 70mm |
| **BCNET11** | 1.1mm | 1.1mm | 12mm | 70mm |
| **BCNET13** | 1.3mm | 1.3mm | 12mm | 70mm |
| **BCNET15** | 1.5mm | 1.5mm | 12mm | 70mm |
| **BCNET16** | 1.6mm | 1.6mm | 20mm | 70mm |
| **BCNET18** | 1.8mm | 1.8mm | 24mm | 85mm |
| **BCNET20** | 2.0mm | 2.0mm | 24mm | 85mm |
| **BCNET24** | 2.4mm | 2.4mm | 25mm | 100mm |
| **BCNET27** | 2.7mm | 2.7mm | 30mm | 110mm |
| **BCNET30** | 3.0mm | 3.0mm | 35mm | 130mm |
| **BCNET35** | 3.5mm | 3.5mm | 40mm | 130mm |
| **BCNET40** | 4.0mm | 4.0mm | 45mm | 150mm |
| **BCNET50** | 5.0mm | 5.0mm | 50mm | 150mm |

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