Surgical Technique

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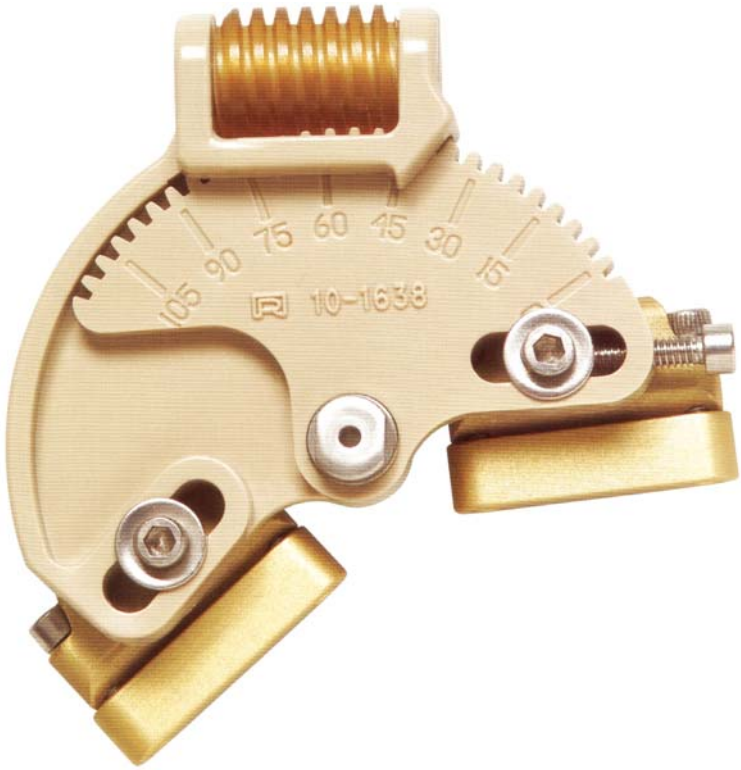
COMPASS® PIP

Proximal Interphalangeal Joint Hinge



Compass◇ PIP Proximal Interphalangeal Joint Hinge

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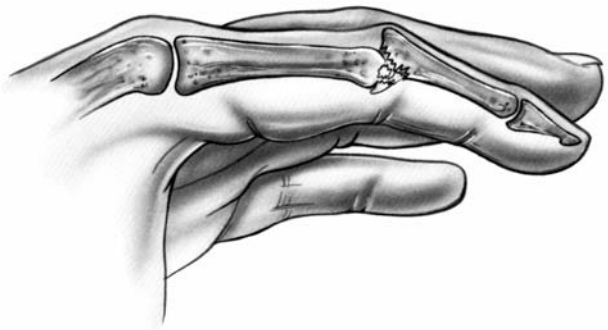
Table of Contents

Nota Bene: The technique description herein is made available to the healthcare professional to illustrate the author's suggested treatment for the uncomplicated procedures. In the final analysis, the preferred treatment is that which addresses the needs of the specific patient.



Injury to the Proximal Interphalangeal (PIP) joint of the digit is common in sporting activities and falls. Although most of these injuries can adequately be treated with traditional means of closed treatment, internal fixation, or splinting, there are some injuries that remain difficult to effectively manage. Post-traumatic arthritis and disabling contracture of the PIP joint of the digit may develop if early mobilization and accurate reduction are not achieved. Stiffness may preclude effective grip, or likewise, flexion contracture may prevent functional extension for effective grasp.

In an effort to improve the outcome of complex injuries and contractures of the PIP joint, we have developed a unilateral external hinge that attaches with skeletal fixation to either side of the joint with smooth stainless steel K-wires. The design permits controlled passive motion with or without distraction to allow early protected motion.

Indications

The indications for use of the Compass PIP joint hinge include the following:

1. Acute trauma with instability (e.g., dorsal fracture dislocations with comminution).

2. In combination with volar plate arthroplasty.

3. Delayed treatment of trauma to the PIP joint requiring passive mobilization and joint protection.

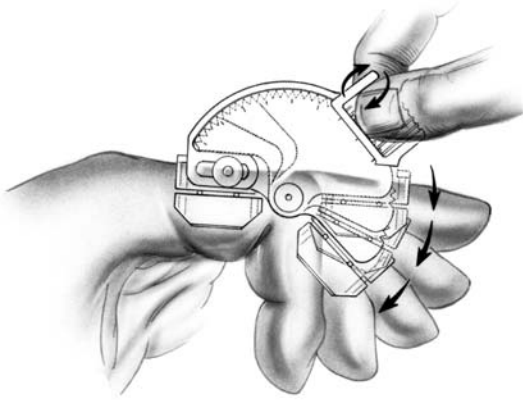
4. Contracture of the PIP joint with or without extensor tendon reconstruction and/or tenolysis.

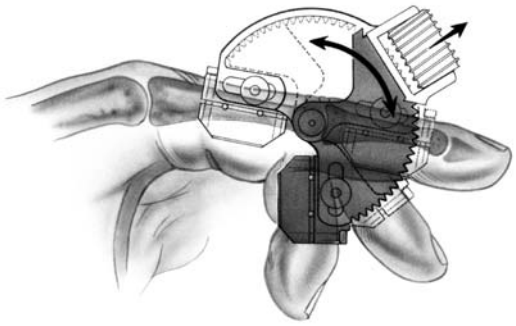
Design Rationale

The PIP joint of the digit functions as a ginglymus or hinge. Only slight movement of the instant center of rotation occurs (in contrast to the metacarpophalangeal joint).

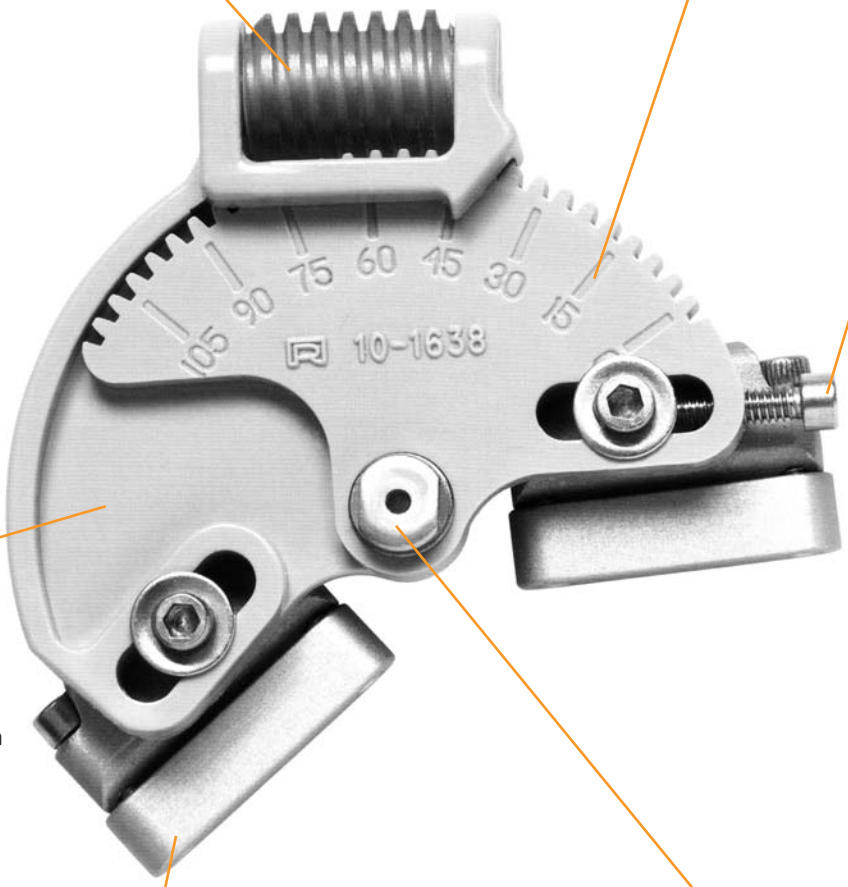
The Compass hinge takes advantage of this by centering the mechanical axis of the external hinge at the axis of the joint. Because the hinge body is fabricated from radiolucent plastic (Ultem®), the metallic rotational bearing can be radiologically aligned with the mechanical axis of the PIP joint.

To regain or maintain motion during healing and scar formation, the device is equipped with a worm gear that creates passive motion through the hinge. The gear mechanism may be disengaged by the patient for active motion to maintain tendon excursion and in the later phases of treatment.





Design Features



Worm gear can be engaged or disengaged to allow for either active or passive motion.

Graduated markings display amount of flexion/extension.

Distraction screw permits distraction of the joint.

Radiolucent material allows accurate alignment of mechanical and anatomic axes, and allows visualization of fracture site.

Cannulated axis screw allows placement of hinge over axis wire.

Pin blocks allow for independent adjustment during manipulation.

Surgical Technique

Preoperative Planning

Before placing the hinge on a patient, it is helpful to discuss with the patient the rationale and use of the device. Even in the emergency situation, information about the length of treatment, potential problems, and complications should be discussed with the patient.

Fractures

For comminuted fractures of the middle or proximal phalanx, the surgeon should carefully plan internal fixation placement, assess the potential need for bone graft, and determine optimal surgical exposure.

Screw fixation, tension band wire, and smooth K-wire fixation can be used in combination with the PIP hinge.

Each fracture or dislocation must be managed individually. Some patients tolerate motion at an early point in treatment, others have more swelling and pain. By slowing increasing the amount of flexion or extension, using incremental passive displacement, gains in range of motion can usually occur.

Volar Plate Arthroplasty

When using the hinge with volar plate arthroplasty, the principles as stated by Eaton must still be followed. The collateral ligaments should be excised as part of the procedure. The suture through the volar plate, securing it to the button on the dorsum of the digit, should not be tied until the PIP hinge is properly aligned and tightened. Once the joint is reduced and the hinge is in place, the finger can be slightly flexed and the knot through the button secured.

The joint is held in nearly full extension without flexion for the first two weeks. Then, gentle flexion is initiated, incrementally increasing the range of flexion over the subsequent weeks. Try to increase the amount of flexion of the frame by approximately 20° to 30° per

week. When not moving the joint passively or actively, the joint is held in nearly full extension. It is also important to check lateral X-rays on a weekly basis to ensure reduction of the joint.

Before frame removal, try to achieve as much flexion as possible.

Contractures

For patients with contractures of the joint, tenolysis may need to be considered as part of the treatment. If there is doubt as to the degree of tendon adherence, it may be advantageous to perform the capsular release first, regaining requisite passive motion, and delay the tenolysis or reconstruction. There are occasions where a small zone of flexor adherence is present and tenolysis could be performed as a part of the contracture release and hinge placement.

The extensor mechanism may be attenuated in patients with long-standing flexion contractures of greater than 50°. In this situation, a boutonniere reconstruction may be needed to provide an active extensor mechanism.

For active boutonniere reconstructions, the hinge should be left in an extended position for at least three weeks. From then, a gradual and incremental program of passive flexion is started, preventing full flexion for six weeks. When not flexing the joint, the hinge should be left in full extension, especially overnight. Each week, 10-20° of flexion are added to the program. Active flexion and extension should be cautiously initiated to limit attenuation of the reconstructed extensor mechanism. Some permanent extensor lag should be expected in all of these patients.

Application of the Hinge

Introduction:

As previously stated, there are situations such as volar plate arthroplasty where the application of the hinge should be performed before the completion of the commonly prescribed procedure. In other settings, such as contracture release, application of the hinge may be the last part of the operation. The timing of hinge application is individually variable.

Equipment Needed:

- Small image intensifier
- K-wire driver

Equipment Provided in Kit:

- PIP hinge
- Pin blocks (two large)
- .045 K-wires (six included)
- Hex driver

The usual order of pin insertion is illustrated (Figure A). Once the axis pin is placed, the proximal phalanx is attached, followed by fixation to the middle phalanx.

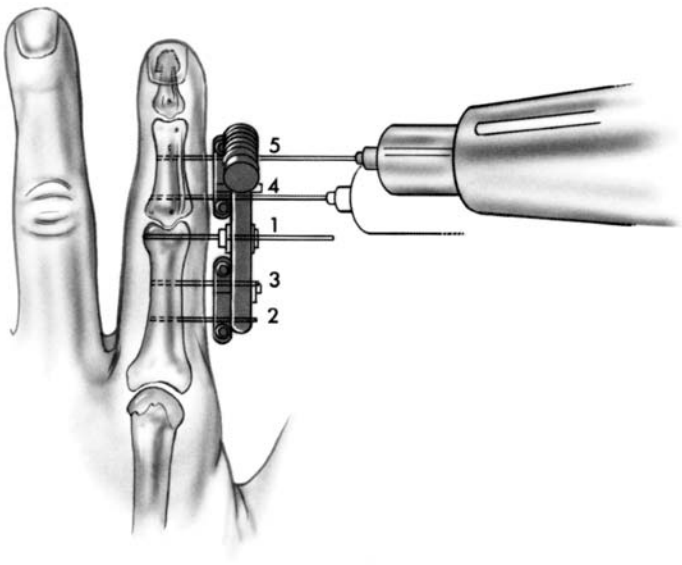


Figure A

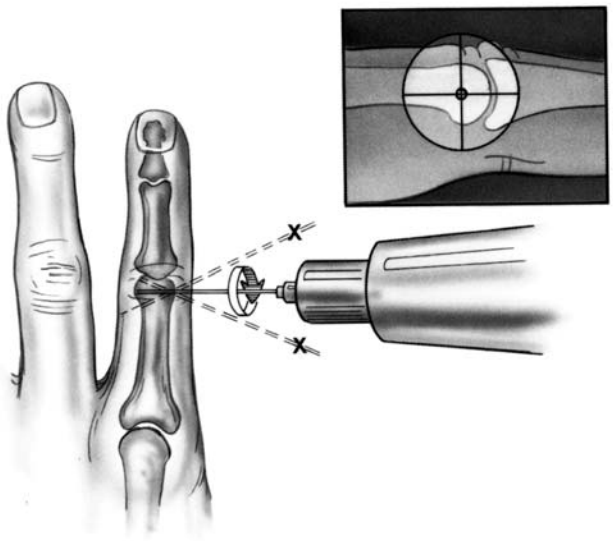


Figure B

1. Axis Pin Insertion (Figure B)

The small image intensifier should be draped for sterile use. Once a true lateral of the proximal phalanx is obtained, a .035 or .045 K-wire should be placed in the axis of rotation. This pin should be placed as accurately as possible. If the axis pin is poorly placed or angulated, the hinge will not function properly. If the joint is open for other reasons, the pin may be placed under direct visualization. The axis pin should be checked by fluoroscopy in both the lateral and A-P views.

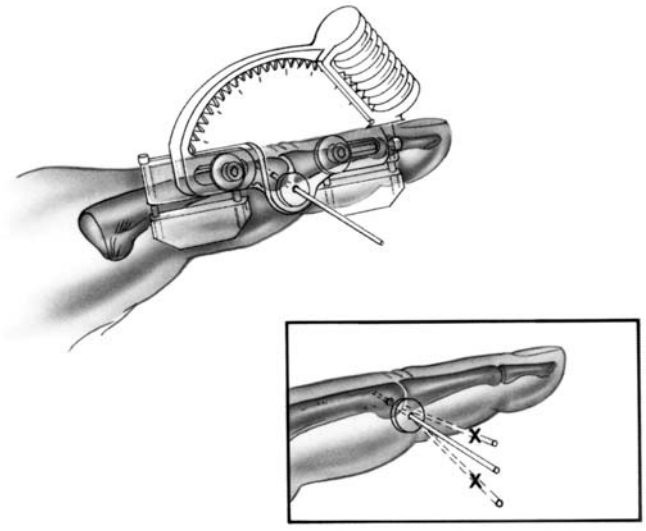


Figure C

2. Proximal Block Fixation

Once the axis pin is in place, slide the hinge over the pin (Figure C). The pin blocks should be loose and maneuverable. If the hinge is between two digits (long or ring) the smaller pin blocks should be used on the proximal phalanx. There is less impingement with the shorter block in the web space.

A .035 or .045 K-wire is then inserted in the most proximal portion of the proximal block (Figure D). Care should be taken to place the pin as proximally as the joint or skin will permit, but still not creating impingement of the block on the adjacent fingers. This pin needs to be parallel to the axis pin when viewed in the longitudinal plane (Figure D Inset). There is latitude for error in the angulation in the A-P plane, but this should be minimal. The proximal block should be aligned parallel with the hinge. It may be helpful, once the wire is resting on the bone (not fully inserted), to gently tighten the pin block to the frame. The pin holding clamp should not be tightened during K-wire insertion.

The K-wire should be inserted under power near the midaxial line of the skin. The bone tends to be more dorsal than is first expected. It is important not to angulate the pin to engage bone, but instead adjust the pin block and its relationship to the hinge.

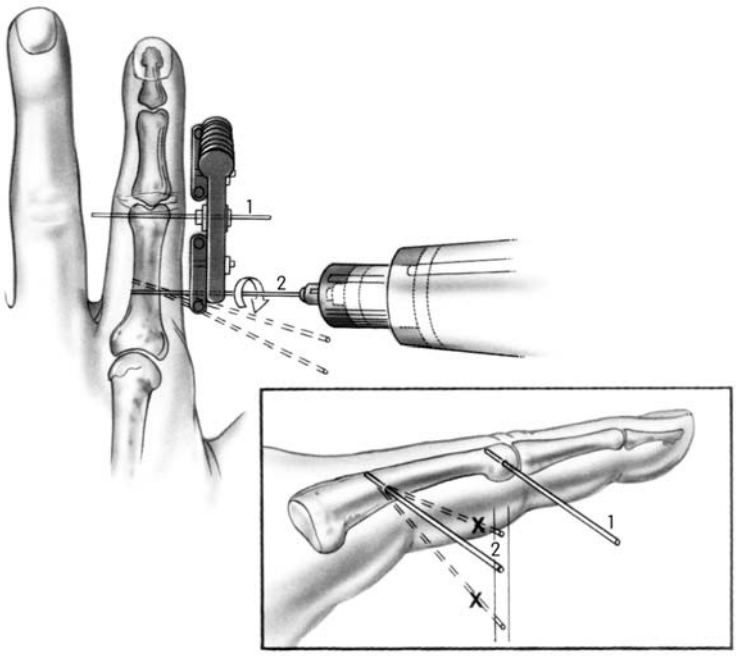


Figure D

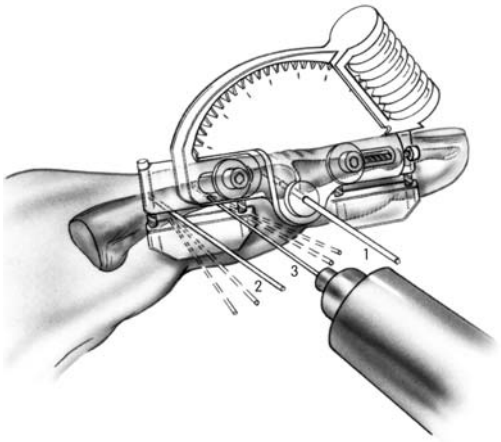


Figure E

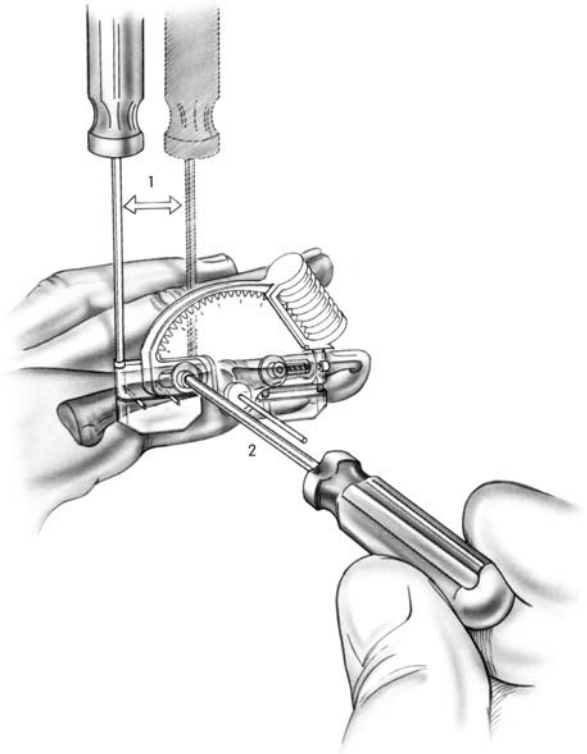


Figure F

After placing the first wire, the pin block can be gently (temporarily) tightened to the hinge. The second wire (0.35 or .045) is then inserted in the distal position of the proximal block (Figure E). The spacing between the blocks should be maximized. Again, care should be taken not to angulate the pin to engage bone, but rather the block adjusted as needed.

Next, the two threaded bolts of the pin holding clamp are tightened (Figure F , Number 1). Each side should be tightened in an alternating fashion so that the blocks secure the pins slowly. If one side is tightened completely before the other is advanced, the pin clamp could fracture. This is analogous to tightening the head gasket on a car engine.

Once the pin clamp is tight, the block itself is tightened to the frame (Figure F, Number 2). The wires can be cut flush with the outer portion of the hinge. Before cutting the wires, check to see that the hinge is not too close to the skin. Some swelling is bound to occur in the postoperative period.

When first using this device, it is helpful to check pin placement by fluoroscopy. Sometimes a pin can be subperiosteal without being obvious.

3. Distal Block Fixation

The distal block fixation is more difficult than the proximal block. In cases of dislocation or fracture, instability may be present. It is helpful to hold the middle phalanx in the reduced position during K-wire placement.

If the joint is flexed at this point, position the hinge to match the amount of flexion (by turning the worm gear on the top). By doing this, the block will be parallel with the bone and the hinge will subtend the full range of motion possible once in use. If some distraction is anticipated, ensure that the distal block is in a more proximal position to allow travel along the distraction screw (Figure G).

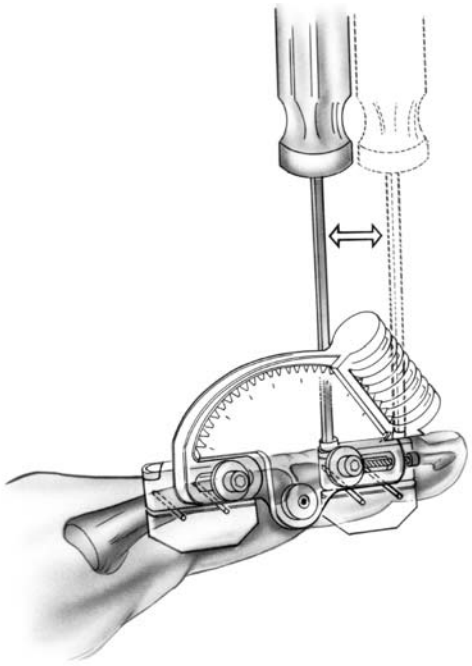


Figure G

Once the pin block is parallel with the hinge and the diaphysis of the middle phalanx, insert the proximal wire. As with the proximal block, ensure that the pins are parallel to the axis pin when viewed from proximal to distal (Previous Page, Figure D, Inset). The insertion technique is otherwise identical to the proximal block pin placement (Figure G).

Once secured to the middle phalanx, the hinge should be parallel to the digit (Figure H).

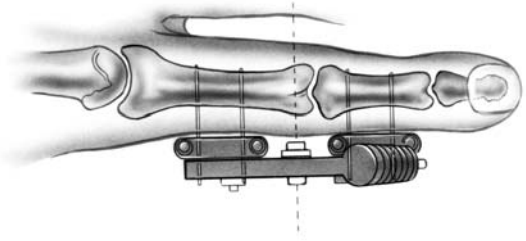


Figure H

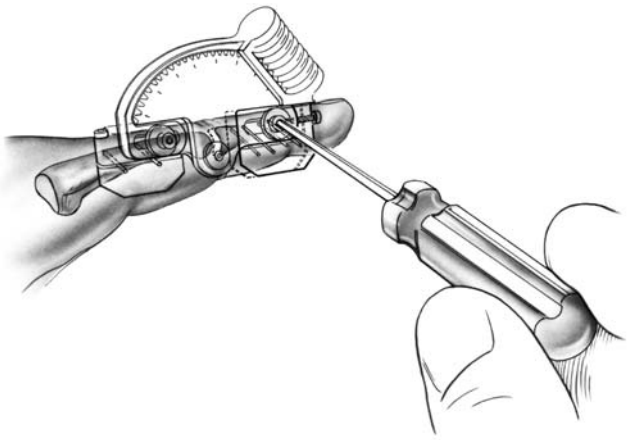


Figure I

4. Joint Reduction

If the joint is reduced at this point, the distal pin block can be tightened to the hinge (Figure I). If the joint is slightly subluxated (usually dorsally) the joint can be reduced manually, then the block secured to the hinge. In cases of dorsal fracture dislocations, the joint can often be reduced by slightly extending the distal pin block relative to the hinge frame. A palmar directed force is also generally needed.

Once the distal pin block is secured to the hinge (Figure I) the distraction mechanism cannot be used.

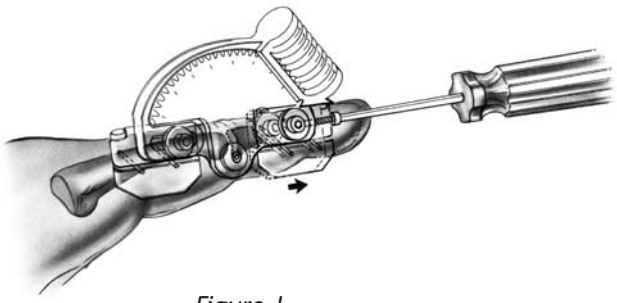


Figure J

5. Distraction

If you wish to apply distraction, leave the distal pin block unsecured to the hinge. Distract using the threaded screw in the distal portion of the distal block (Figure J). Because the distal pin block is not secured to the hinge, there is rotational freedom between the hinge and the pin block. Therefore, as the joint is distracted, the joint must be checked for proper reduction. Not all injuries or conditions require distraction and this should be used sparingly.

6. Hinge Operation

Once the hinge has been applied, it is helpful to check the reduction in both the A-P and lateral views by fluoroscopy. The mobility of the joint and the operation of the hinge should also be checked. If the joint is reduced and the axis is in the proper position, motion should not be impeded by the hinge. The worm gear mechanism should roll smoothly, meeting resistance only at the extremes of motion. However, if the hinge is not in parallel to the joint, excessive resistance will be encountered. In addition, if too much distraction is attempted

and creates malalignment, the hinge will also no operate smoothly.

The axis pin can be removed at this time.

7. Postoperative Care

In most instances, the patients are operated on in an ambulatory setting. A light dressing of gauze and a 2" Ace® or Coban® is lightly wrapped around the finger. Most injuries are initially held in as much extension as is safe for the particular patient or injury.

The dressing may be removed in three days and then hand washed in clean water and soap. Either light gauze or no dressing is used after three days.

Postoperative Hinge Operation

Motion may be initiated in a graduated, controlled fashion, and tailored to the particular needs of the patient and his or her injury. In most cases, the first week is spent in full extension (or as much as is tolerated by the particular circumstance). Once swelling has begun to decrease, the passive gear drive may be used to initiate flexion and extension. Most patients understand the operation of the hinge. The usual goal is to achieve maximal extension and flexion by six weeks. An indelible marker may be used to mark limits or goals on the hinge itself. Before active motion is started, tendon gliding may be enhanced by using the place-and-hold technique. Most patients should initially be seen on a weekly basis to ensure maintenance of reduction and expected progress.

Active motion may begin as tolerated. The patient needs to be shown how to disengage the worm gear drive by popping it up and ranging the finger. As advances in the range of motion are made, the hinge may be used to enhance the terminal motion where more passive resistance is usually encountered.

The hinge is usually used for six weeks. In a few instances, the device was left on for eight weeks because of fears of potential instability. None of the devices required removal before six weeks.

Potential Complications

1. Loss of Reduction

If the joint shows signs of subluxation or dislocation, X-rays should be taken. True lateral films are essential, centered over the PIP joint.

First check to see that the distal pin block has not loosened from the hinge. If this is not the case, the axis should be examined for movement. In most cases, the adjustments needed can be made without returning to the operating room or reinserting K-wires. Digital block anesthesia may be needed.

2. Pin Tract Infection

At some point in the treatment, one or more of the K-wires may become inflamed and infected. In those circumstances, we usually prescribe oral antibiotics for 7-10 days, as with any K-wire infection. If drainage or inflammation persists, the pin may need to be exchanged if it is early in the course of treatment. In initial clinical trials, only 1.25% of pins needed to be removed during treatment.

3. Decreased PIP Motion

In most of the chronic cases, the extensor mechanism is not normal, and some loss of PIP joint motion is present. The application of the PIP hinge can temporarily reduce the mobility of the DIP joint. During treatment, attention should be paid to passive and active mobilization of the DIP joint. We have observed that once the frame is removed, motion returns.

4. Pin Loosening

After the hinge has been in place for several weeks, the K-wires may begin to loosen. Since this usually occurs at the end of treatment, it does not require pin reinsertion.

Removal of the Hinge

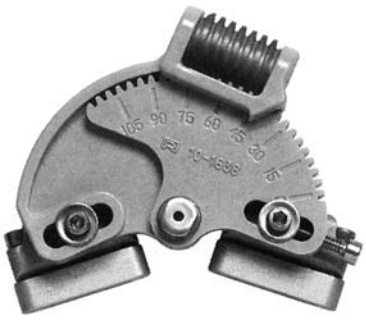
The hinge may be removed in the office setting by simply releasing the pin holding clamps and sliding the hinge off. The K-wires are removed in a routine fashion.

In many cases, the patients will need further hand therapy to optimize outcome. Some do not, and are able to begin a home program of continued stretching and strengthening. A resting extension splint and a dynamic flexion splint may be needed. The continued use of Coban or edema reducing materials is recommended for several weeks.

Components

PIP Fixation Kit (with 2 large pin blocks)

Cat. No. 10-1638



Kit includes:

0.45 x 5 K-wires
(6 included)

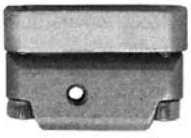
1 Hex Driver

Also available:

0.35 x 5 K-wires
Cat. No. 12-8020

Small Pin Support Block

Cat. No. 7106-1639



Notes

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