PIP'R™
Proximal Interphalangeal Replacement
Operative Technique

Natural Function
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Acknowledgements:

We would like to thank Mr I Trail and the Wrightington Hospital for their valuable contribution to this technique.

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**Introduction**

The PIPR™ has been designed to replace the proximal interphalangeal joints in the hand. Developed between 2002 and 2006, the PIPR™ is the result of extensive research and accurately mimics the kinematics of a healthy PIP joint. The PIPR™ achieves good function through preservation of functioning collateral ligaments and with conforming anatomical bearing design. A size range with limited interchangeability and advanced instrumentation are provided to ensure good fit and aid ligament balancing for joint stability.

The PIPR™ was first used in January 2006 at the Wrightington Hospital, UK and to date more than 1,650 have been implanted worldwide. The PIPR™ has been demonstrated to improve pain, function and range of movement.

Key features include:

- The design of the bearing geometry is based on extensive anatomical research,
- The polyethylene bearing insert is provided preassembled with the middle stem and is designed to permit final rotational alignment on joint reduction for improved range of motion and implant longevity (through reduction of contact stresses),
- The coupling of the polyethylene insert enables normal functional rotation as exhibited by a healthy PIP joint,
- Stem geometries are based on normal anatomy,
- The patented CoCr middle component design is designed to preserve the collateral ligament attachments so that joint stability is not compromised,
- The PIPR™ is a cementless device, with precise instrumentation to provide a press fit, and with HA coating to expedite bone integration,
- The system allows the middle component to be downsized when required,
- Advanced instrumentation is provided to generate accurate bone cuts and allow balancing of the joint throughout flexion so that the surgeon can ensure stability is provided by the collateral ligaments.

**Indications**

The indication for use of joint replacement prostheses include phalangeal joints with arc of motion >20° pre-operatively where there is painful and disabled joint resulting from 1) osteoarthritis, or 2) rheumatoid arthritis where one or more compartments are involved, and which may result in varus or valgus deformity. Patient selection factors which should be considered include: 1) need to obtain pain relief and improve mobility, 2) ability and willingness of the patient to follow instructions, 3) a good nutritional state of the patient, and 4) the patient must have reached full skeletal maturity.

**Contraindications**

Contraindications include: 1) infection, 2) sepsis, 3) osteoporosis, 4) metabolic disorder, or a condition of marked bone loss which could impair bone formation, 5) vascular insufficiency, muscular atrophy, or neuromuscular disease, 6) uncooperative patient, 7) distant foci of infection (which may cause hematogenous spread to the implant site), 8) incompetent or deficient soft tissue surrounding the joint, 9) pre-operatively stiff fingers with arc of motion <20°.
**Step 1**

An X-ray assessment should be made within the three months before the operation which shows an A-P and true lateral of the involved fingers.

Using the MatOrtho® PIPR™ X-ray template at 3% magnification, assess the size of the prosthesis in the dorsal/palmar view.

Note that the final size of the implant components will be determined by the rasping instruments and trial components.
**Step 2**

**Surgical Exposure**

The following operative technique and instrumentation are suitable for both a lateral and a dorsal approach.

All images shown in this technique reflect the lateral approach.

**A. Lateral Approach**

A lateral approach to the PIP joint is recommended.

For the index, middle and ring fingers, the incision is made on the ulnar side; for the little finger incision is made on the radial side.

Centre the skin incision above the middle of the PIP joint, extending approximately 2cm proximally and 2cm distally.

Reflect the skin and subcutaneous tissue volarward and dorsally and retract the neurovascular bundles anteriorly.

Identify and preserve the lateral band, retracting it dorsally.

Incise the collateral ligament longitudinally and reflect it off the head of the proximal phalanx and base of the middle finger.

Continue the dissection, up to the ulnar third of the central slip and the ulnar third of the volar plate until the joint can be dislocated in a carefully controlled manner.

On dislocation, the radial collateral ligament can be partially released to aid exposure.

**B. Dorsal Approach**

Make a dorsal curved incision. Thereafter, make a longitudinal incision of the extensor tendon, releasing the central slip and retracting the split extensor tendon in both radial and ulnar directions. This should allow exposure and dislocation of the proximal interphalangeal joint.
Step 3
Templating
The Sizing Template is then used to assess the appropriate size of implant. Starting with one of the smaller templates, attempt to fit the forked end, which represents the maximum diameter in the lateral view of the head of the Proximal Component, around the condyles on the head of the proximal phalanx. Repeat using successive sizes until identifying the Template which provides the best fit over both condyles.

The flat end of the Template can be used to assess the fit of the Middle Component on the base of the middle phalanx.

Step 4
Position the Guide Pin in the Middle Phalanx
Insert the 1.8mm Guide Pin into the articular surface of the middle phalanx, to a depth of between 10mm and 20mm. The entry point should be carefully positioned to achieve centralisation of the Pin into the middle phalanx shaft, both in dorsal/palmar and lateral orientation. The Pin should also be aligned with the central axis of the middle phalanx shaft.

The Sizing Template may be used to aid positioning and alignment of the Pin.

Using the Sizing Template: Insert the Template Alignment Rod into one of the three larger holes in the Template and place the flat end of the Template on the base of the middle phalanx. Adjust the position of the Template to align the small hole at its end with the centre of the phalanx shaft. Carefully align the Template Alignment Rod along the phalanx shaft and insert the 1.8mm Guide Pin into the phalanx using the small hole in the Template as a guide. Once the Pin is in place the Sizing Template can be carefully removed.

The position and alignment of the Pin should be verified radiologically.
**Step 5**

**Prepare for Milling**

Assess the size of the Conical Mill required prior to milling (the nominal sizes correspond to the overall width of the implants).

Select the chosen size Conical Mill, mount it in a power drive and slide over the 1.8mm Guide Pin until it meets the articulating surface.

Advance the Conical Mill to just before mill depth taking great care to preserve the collateral ligament attachments.

When milling is completed, both the Mill and Guide Pin can be removed.

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**Step 6**

**Gain Access to the Proximal Phalanx**

Partially flex the joint and gain access to the proximal phalanx intramedullary canal using a standard high speed burr.
Step 7
Rasping the Proximal Phalanx

Select a Proximal Rasp one size smaller than the templated final size and assemble together with the Instrument Handle and Rasp Alignment Guide (if required). Work the Rasp into the cavity, backing off regularly to clear debris, until there are two teeth showing outside the bone; this stage can be facilitated by using a power burr.

Assess the fit and fill and, if necessary, progress to the next size Rasp. Record the final size Rasp used. This will indicate the Proximal Component size.
Step 8
Check the Flexion and Extension Gaps
Optionally, when using a dorsal approach, fully insert the appropriate sized Balancing Trial into the rasped cavity.

Note: When fully inserted, the stem of the Guide should fit the prepared canal and need not necessarily abut the head of the proximal phalanx.

Joint Reduction
Try to reduce the joint so that the Balancing Trial is resting on the middle phalanx surface. If reduced successfully, gently try to move the finger through flexion and extension avoiding excessive force as this may damage the collateral ligaments. Assess the radioulnar stability at this stage.

Problems when reducing the joint
- If the joint cannot be reduced: Mill the middle phalanx further, making sure the ligament attachments are preserved.
- If the joint is too tight in flexion: Mill the middle phalanx further, making sure the ligament attachments are preserved.
- If the joint does not extend to full extension: rasp the proximal phalanx further. If this is not successful, then freehand remove one, and then, if necessary, two millimetres of bone of the articular surface at the end of the proximal phalanx.
- If the joint is too lax in flexion: Consider rasping to the next size up.
Step 9

Cutting the Proximal Phalanx

Select the appropriate sized 3 - Cut Guide and insert into the proximal phalanx.

*Note: When fully inserted, the stem of the Guide should fit the prepared canal and need not necessarily abut the head of the proximal phalanx.*

Using a small power saw with a 0.4 mm blade, make the two intersecting cuts (numbered 1 & 2, inset).

In each instance, first insert the blade between the two opposing guide pillars then gently bias the blade against the distal pillar to bring the blade into contact with both guiding surfaces. Whilst cutting, ensure that the blade remains in contact with both surfaces. Take care that the Guide is supported at all times to ensure that it remains seated.

Still supporting the Guide, make the distal cut (3, inset) either side of the Guide stem. Using the dorsal pillars, ensure the blade remains in contact with both guiding surfaces whilst cutting.

Once all three cuts are complete remove the 3 - Cut Guide.
Step 10

Rasp the Middle Phalanx

Select a Middle Rasp one size smaller than the estimated final size and assemble together with the Instrument Handle and Rasp Alignment Guide (if required). Work the Rasp into the cavity, backing off regularly to clear debris, until the flange seats onto the milled surface. This stage can be facilitated by the use of a power burr.

Assess the fit and fill and, if necessary, progress to the next Middle Rasp size up.

The final Rasp size used (M7, M8, M9, M10, M11) should be recorded as this will indicate the Middle Component size to use.

Refer to the Sizing Chart (page 15) for compatibility with the proximal component.
Step 11
The Middle Phalanx Trial

a) Select the required size Middle Implant Trial and insert it into the middle phalanx in flexion, noting the flat on the palmar side of the Trial as illustrated (detail right).

b) Insert the required size Proximal Implant Trial into the proximal phalanx, also in flexion. This will enable a full trial reduction. If necessary, use a power burr to break the edge of the cavity to allow the trial to be properly seated.

c) Gently move the finger to evaluate the full range of motion and stability. At this stage, the joint should be stable in extension with free movement between 0 and 90 degrees. It is of utmost importance that the joint is not “overstuffed” and tight. If this is the case, then the surgeon should return to step 7. If the collateral ligaments and volar plate are intact, it is unlikely that instability will be a problem.
**Step 12**
Wash the prepared bone surfaces with saline lavage and dry thoroughly.

a) Insert and impact the Middle Component in flexion using the correct size plastic Middle Impactor observing the correct orientation (detail right).

b) Insert and impact the Proximal Component in flexion using the plastic Proximal Impactor.

c) Gently move the finger to evaluate the full range of motion and stability.
Step 13

Implant Salvage

Should it become necessary to remove a MatOrtho® PIPR™ Implant, Extraction Pliers are provided. These should be carefully closed between the implant and bone, gripping and prising it away from the bone.

Note: Implant components retrieved in this way should NOT be re-used.

Step 14

Close the Wound

If required (dorsal approach), repair the extensor apparatus re-anchoring it to the base of the proximal phalanx.

Close the skin with an interrupted suture.
**PIPR™ Sizes**

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**Complete Joint Sizes**

- **Size P7**: Complete Joint Size 7
  - 1 BOX - 186 031
- **Size M7**: Complete Joint Size 7
  - 1 BOX - 186 031
- **Size P8**: Complete Joint Size P8, M7
  - 1 BOX - 186 022
- **Size M7**: Complete Joint Size P8, M7
  - 1 BOX - 186 022
- **Size M8**: Complete Joint Size 8
  - 1 BOX - 186 032
- **Size P8**: Complete Joint Size 8
  - 1 BOX - 186 032
- **Size M9**: Complete Joint Size P9, M8
  - 1 BOX - 186 023
- **Size M8**: Complete Joint Size P9, M8
  - 1 BOX - 186 023
- **Size P9**: Complete Joint Size 9
  - 1 BOX - 186 033
- **Size M9**: Complete Joint Size 9
  - 1 BOX - 186 033
- **Size P10**: Complete Joint Size P10, M9
  - 1 BOX - 186 024
- **Size M9**: Complete Joint Size P10, M9
  - 1 BOX - 186 024
- **Size P10**: Complete Joint Size 10
  - 1 BOX - 186 034
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- **Size P11**: Complete Joint Size P11, M10
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- **Size M10**: Complete Joint Size P11, M10
  - 1 BOX - 186 025
- **Size P11**: Complete Joint Size 11
  - 1 BOX - 186 035
- **Size M11**: Complete Joint Size 11
  - 1 BOX - 186 035
Operative details will dictate the exact nature of postoperative management.

**Influencing Factors**

- Preoperative deformity
- Postoperative stability of joint
- Collateral ligament repair
- Quality of extensor mechanism
- Intraoperative fracture
- Individual patient factors

Any, or a combination, of these factors may require an initial period of 3 weeks immobilisation followed by controlled/protected mobilisation dependant on individual circumstances.

In the absence of contraindications **Early Mobilisation** is the treatment of choice.

**Potential Problems**

- Dorsal dislocation of joint
- Angulation of joint
- Rupture of extensor mechanism
- Stiffness

**Therapy Objectives**

- Stable joint
- Functional arc of movement - 20/60 degrees
- Pain free

**Routine Management**

**Immediate Post-Op**

Volar slab to finger tips.

**Day 1**

- Elevation
- Neurovascular observations
- Pain relief
- Antibiotics x 3

**Early Mobilisation**

If the joint is stable with good reattachment of the extensor mechanism and there are no patient specific problems.

**Day 2-4**

- Reduce dressing
- Wound inspection and application of light dressing to facilitate movement.
- Commence active mobilisation of PIP joint – three treatment options depending on whether single or multiple fingers, the amount of oedema and the patient’s ability and comprehension.

**Method 1**

1. Hand/arm resting splint for all digits. Worn between exercises and at night (wrist neutral / 20 degrees extension; metacarpophalangeal (MCP) joints neutral; proximal interphalangeal (PIP) joints 30 degrees flexion)
2. Hand based MCP joint blocking splint used during exercise to direct active movement to PIP joint.

**Method 2**

1. Finger based dorsal blocking splint with integral MCP block; PIP joint positioned at 20-30 degrees.
2. Active PIP joint flexion 10-20 repetitions hourly.
3. Resting splint, as method 1, at night.

**Method 3**

This is the treatment of choice for those patients with preoperative boutonniere deformities.

1. Dynamic extension splint during day.
2. Active flexion within splint.
3. Assisted extension from elastic recoil of splint.
4. Tension 20 degrees.

For all methods; functional use of the involved digit(s) should be discouraged.
Early Mobilisation Continued...

3-4 weeks
Evaluate Progress.

Extensor Lag
1. Introduce extension assist splints and active extension to neutral.
2. Continue with flexion exercise and splints if necessary.

Poor Flexion
1. Introduce flexion assist splints.
2. Continue active flexion.
3. Position PIP joints in flexion at night.
4. Encourage active extension to neutral.
Monitor angulation of PIP joint and DIP (Distal Interphalangeal) joint and correct as necessary.
Discourage power grip and deforming ADLs.

6 Weeks
1. Evaluate Progress.
2. Discontinue protective splints.
3. Continue with extension or flexion assist splints, if appropriate and patient willing.
4. Resume functional use of hand but avoid heavy manual work.

Delayed Mobilisation
Resting splint for 3 weeks (position of joint specific to each individual’s requirements) followed by Method 1, 2 or 3 for the following 6 weeks.

Outcome
Related to preoperative status, previous surgery and extent of injury:
- 20 degrees extension lag and 60 degrees flexion, no angulation, pain reduced from preoperative status = satisfactory / good result.
- Full extension, 75 degrees flexion = excellent result.
### Instrument Tray

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