Surgical Technique

- Chevron Osteotomy
- Akin Osteotomy
- Basal Osteotomy
- 1st MTPJ Cheilectomy
- Distal Metatarsal Osteotomy
- Calcaneal Osteotomy

MICA

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Ordering Information
Minimally Invasive (MI) surgical techniques have gained popularity in many areas of surgery. As technology has advanced, so the possibilities to operate and achieve an objective with less invasive techniques have broadened. This surgical technique brochure is intended to act as an introduction to minimally invasive / percutaneous forefoot techniques and is intended to compliment attendance at one of the specialised cadaveric training courses in these techniques.

These MI techniques are intended to compliment the open surgical options in the management of a variety of forefoot and hindfoot pathologies in what is an expanding and rapidly evolving area of orthopaedic surgery.
Patient Positioning & Set Up

- Patient positioning equipment set-up is extremely important when performing any MICA procedure.
- The patient’s feet should be positioned off the end of the end of the table, enabling ease of access for the image intensifier thereby ensuring consistent x-rays throughout the procedure.
- The image intensifier itself should come in from the patient's right and should be rotated to a slight oblique angle.
- The Burr Machine can then be positioned to the patient’s left.
- This set-up enables free movement around the patient’s feet, to either stand at the side or the end of the table as the operation demands. The position of the equipment is independent of whether the operative side is left or right.
**Indications**
Mild to moderate Hallux valgus deformity

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**Lateral Release**

- This is performed through a beaver blade stab incision.

- The beaver blade incision is made over the lateral 1/3rd of the dorsal aspect of the 1st MTP joint line (Figure 1).

- The blade is angled parallel to the joint so as not to damage the articular surfaces as the blade is deepened towards the plantar lateral aspect of the 1st MTPJ (Figure 2).

- The lateral attachment of the Flexor hallucis brevis (lateral sesamophalangeal ligament) is divided on the plantar aspect of the joint (Figure 3). This is a thickening of the plantar lateral capsule of the joint (plantar plate) and has a gritty quality when cut.

- The image intensifier may help to guide the knife positioning and a varus movement of the Hallux against the correctly positioned knife completes the cut.

- Image intensifier views are helpful to confirm the release by observing a static lateral sesamoid on varus movement of the hallux.

- In mild to moderate Hallux valgus deformities, this is usually sufficient release of the lateral soft tissues.

- With greater deformities, the adductor hallucis can also be divided and if there is substantial uncovering of the lateral sesamoid then it may also be possible to divide the sesamoid-metatarsal ligament.
CHEVRON OSTEOTOMY

Surgical Approach

- The stab incision is placed over the medial aspect of the proximal edge of the ‘flare’ of the medial eminence. The placement of this incision is vital.

- Firstly the incision must avoid the dorsomedial cutaneous nerve to the Hallux; if palpable, this nerve should be marked before placing the incision. The incision must also allow a sufficiently dorsal entry point into the 1st metatarsal; consideration must be given to the proposed plane of your cut before making skin incision. This is important to achieve a chevron osteotomy with a stout and long tailed distal fragment.

- Once the incision is made then the periosteal elevator is used to carefully create a working area for the burr. This can be done over the dorsal surface of M1 but not on the plantar surface as this may risk damage to the blood supply of the M1 head.

Osteotomy with Burr

2 mm x 20 mm Shannon Burr

- The plane of the osteotomy is first defined by the entry cut of the burr into the metatarsal. It is from this entry cut that the dorsal and plantar limbs of the chevron are then made.

- It must be noted that the cut will remove 2 mm of bone. This needs to be accounted / compensated for in the choice of plane of the osteotomy in both sagittal and coronal planes. In general it is preferable to aim for no less acute angle than perpendicular to the 2nd metatarsal and a slightly exaggerated plantar direction, compared to open techniques. It is wise to also view the initial entry cut under image intensifier to check the position and planes (Figure 4).
The dorsal limb of the osteotomy is the first limb to be created (Figure 5). Rotation of the burr driver pencil rather than translation movement is vital if thermal injury / maceration of the portal is to be avoided. In other words think of the skin incision / portal as the fulcrum about which the burr can rotate.

The plantar limb of the chevron is made shallower so as to create a longer cut and more osteotomy stability (Figure 5). Beware of overdoing this as it will make exiting the bone / completing the osteotomy difficult.

Once the cut has been completed, as confirmed by motion at the osteotomy site, then the osteotomy is displaced along its defined path / plane. This can be achieved by placing a 2 mm k-wire through the skin portal, into the diaphysis of the proximal fragment and levering the distal fragment laterally (Figure 6). During this manoeuvre care must be taken to avoid fracturing the medial cortex of the proximal fragment. This is unlikely to occur if k-wire is advanced into proximal metaphysis of proximal fragment before levering. The other pitfall is to elevate the distal fragment whilst performing this manoeuvre and this is avoided by ensuring that the k-wire remains on the dorsal aspect of the medial eminence during displacement. Additional displacement may be achieved by driving an additional 2 mm k-wire into the distal fragment. This acts as a joystick and is also useful in controlling the distal metatarsal articular angle.
The decision as to which method of fixation is used will depend upon the dimensions of the osteotomy achieved and surgeon preference. Once satisfactory position of the guidewire has been confirmed on the image intensifier the wire can be measured to determine screw length.

The guidewire is then driven through the plantar aspect of the foot and an artery clip applied to prevent inadvertent removal of the guidewire during drilling.

The tube drill and MI Cannulated drill are then used to prepare the bone for screw insertion. Take care not to create a thermal injury to the portal when drilling as over zealous force can create significant heat when drilling.

The appropriate screw is then inserted with care to ensure adequate engagement of the head of the screw in cortical bone (Figure 9).

Fixation of Osteotomy

- The osteotomy should be internally fixed. Only if attempts to achieve stable internal fixation have failed should percutaneous k-wires be considered as a definitive fixation option. Fixation is achieved using cannulated compression screws in one of the two ways described below usually. The guidewire is inserted via a further stab incision either from;

  - Dorsal (proximal fragment) to plantar (head fragment) utilising the long tail / plantar limb of the chevron.

  Or,

  - Dorsomedial (proximal fragment) to plantar lateral (head fragment). More rigid fixation can be achieved with this technique if the guidewire is inserted through 2 cortices of the proximal fragment before entry into the metaphysis of the head fragment.
Second screw can be placed Dorsal to Plantar or more parallel to 1st screw.

- It is strongly advised to use 2 screws to fix the chevron osteotomy to improve stability and avoid subsequent loss of position. If using the bicortical screw fixation technique then the surgeon should site the entry point for this screw sufficiently proximal so as to allow room to insert the second screw distally in the same plane (unicortical).

- A tangential view is useful here to confirm that the screw heads have been countersunk sufficiently.

- It can be helpful to insert / position the guide wire for the first (bicortical) screw before completing the chevron osteotomy. Ensure that the guide wire is withdrawn slightly before completing the osteotomy to ensure the wire does not impede the path of the burr.
Indications
Hallux valgus interphalangeus deformity.

Surgical Approach

- The stab incision, created with a Beaver Blade, is placed over the medial aspect of the proximal phalanx of the Hallux (Figure 1). The placement of this incision is vital. Firstly the incision must avoid the dorsomedial cutaneous nerve to the hallux, if palpable, this nerve should be marked before placing the incision.

- The incision must also allow a sufficiently proximal osteotomy of the phalanx otherwise the osteotomy becomes very difficult to fix (Figure 2). Thus it is advisable to check positioning of the skin incision under image intensifier. Once the incision is made then the periosteal elevator is used to carefully create a working area for the burr.

Osteotomy with Burr
2 mm x 12 mm Shannon Burr

- The plane of the osteotomy is first defined by the entry cut of the burr into the phalanx (Figure 3). It is from this entry cut that the dorsal and plantar limbs of the Akin are then made. The burr is advanced into the phalanx until the lateral cortex is felt/abutted but not penetrated.

- The burr is then rotated about the skin incision to complete the dorsal and plantar extents of the osteotomy whilst preserving the lateral cortex. Please note that the cut will remove 2 mm of bone and this is usually sufficient to allow adequate correction of the interphalangeal deformity (Figure 4 - Page 10).
If further bone resection is required then this can be achieved by exchanging the Shannon burr for a wedge burr (3.1 mm) and repeating the cut, or by closing the osteotomy down onto a 12 mm Shannon burr.

If the osteotomy is difficult to close then it often because the plantar lateral ‘corner’ of cortex has been left intact and needs to be cut. Rotation of the burr driver pencil rather than translation movement is vital if thermal injury / maceration of the portal is to be avoided. In other words think of the skin incision / portal as the fulcrum about which the burr can rotate.

Care should be taken to avoid damaging the EHL / FHL tendons inadvertently, the FHL tendon is most at risk. The burr is not efficient at cutting soft tissue unless under tension and hence it is wise to flex the hallux whilst completing the plantar limb of the osteotomy.
Fixation of the Osteotomy

- The osteotomy should be internally fixed. Only if attempts fail to achieve stable internal fixation should percutaneous k-wire fixation be considered as definitive fixation.

- Fixation is achieved using a single cannulated compression screw. The guidewire is inserted via a further medial stab incision 5 mm proximal to the proximal edge of the proximal phalanx (Figure 5). This is made using the beaver blade, which once deep to the skin is directed to the base of the proximal phalanx with the Hallux held in varus. This closes off the articular surface from risk of damage by the blade creating a path for the guidewire to be inserted.

- The guidewire is then inserted crossing the osteotomy and the proximal phalanx obliquely. Once satisfactory position of the guidewire has been confirmed on the image intensifier the wire can be measured to determine screw length.

- The guidewire is then driven through the lateral aspect of the Hallux until it emerges through the skin and an artery clip applied to prevent inadvertent removal of the guidewire during drilling.

- The tube drill and MI Cannulated drill are then used to prepare the bone for screw insertion.

- The screw is inserted with care to avoid leaving the head prominent.
Closure & Post Operative Care
(Chevron / Akin osteotomies)

- At the end of the procedure, steri-strips can be applied to the wounds.

- Gauze soaked in chlorhexidine or saline is then applied followed by wool and crepe in order to splint the toe alignment and soft tissues.

- A heel wedge or rigid flat shoe is worn on the operated foot for 4 to 6 weeks following surgery and the patient informed of the need for diligent elevation of the foot for the first 2 weeks following surgery.

- At 2 weeks post surgery, the wounds are inspected and hallux motion encouraged.

- DVT prophylaxis is according to national guidance and local protocol.
Indications:
Severe hallux valgus deformity correction

Overview

- As with open surgical techniques for correction of hallux valgus, it is important to understand the limitations of any osteotomy in terms of deformity correction. Broadly speaking, once the M1: M2 intermetatarsal angle increases beyond 17 degrees, the likelihood of achieving adequate and durable correction of associated hallux valgus deformity with a distal metatarsal osteotomy is very much reduced, except when the M1 diameter is very broad and relatively short.

- One option in these more severe deformities is to undertake a basal lateral closing wedge osteotomy closing the intermetatarsal angle. Basal osteotomies are inherently powerful in terms of their capacity to correct the intermetatarsal angle but more demanding in terms of stability due to the moment arm of weight bearing forces in the forefoot increasing greatly the more proximal the site of the osteotomy.

- Beware of the unusual situation of broad intermetatarsal angle and severely lateral facing M1 distal articular surface; very large Distal Metatarsal Articular Angle. In this situation an additional distal de-rotation osteotomy will be required.

- The procedure begins with a distal soft tissue release and bunionectomy.
Distal Soft Tissue Release

- As for M1 chevron – see M1 chevron surgical technique text (see page 4).

Simple Bunionectomy

- A 5 mm skin incision is made 1.5cm proximal to the flare of the medial eminence / bunion and plantar to the mid axis of the metatarsal diaphysis, but not so plantar so as to endanger the medial plantar digital nerve. The straight periosteal elevator is inserted to contact bone and a subperiosteal tunnel created to and over the bunion. It is important to comprehensively elevate the thick capsular attachments from the bunion otherwise the burr will struggle to engage the bone.

- The 3.1mm wedge is inserted through the portal and the tunnel created to overlay the bunion. The bunion is then reamed with the burr under image intensifier guidance. Bone debris is periodically ‘milked’ from the portal and saline wash can help to remove debris combined with the rasp.

- Care should be taken when reaming the dorsal extent of the bunion in order to avoid injury to the dorsal medial cutaneous nerve. Once adequate bone resection is confirmed on the image intensifier then thorough irrigation and rasping must be undertaken to ensure complete removal of bony debris; clear soft tissue on image intensifier helps confirm this. If this clearance of debris is inadequate then there is a risk of encouraging subsequent new bone formation in the area or irritation due to residual bony fragments.
The first step is to fix the M1:M2 intermetatarsal angle to its broadest excursion i.e. fix the 1st tarsometatarsal joint in its maximum varus excursion. This is achieved by driving a 2 mm k-wire across the base of the 1st and 2nd metatarsals whilst squeezing the intermetatarsal space with the other hand to open this up. This effectively simulates the weight-bearing situation and will help avoid under correction during the operation.

Next create a dorsal skin portal over the proximal diaphyseal-metaphyseal junction. This should be just to the lateral side of the EHL tendon, which must be protected throughout the procedure.

The 20 mm Shannon burr is then driven into the metatarsal in a slightly dorsolateral to plantar medial direction, 10 degrees from vertical/sagittal, and through the plantar cortex. This axis is then extended in both distal and proximal directions. In the proximal direction care should be taken to avoid weakening the medial metaphyseal cortex otherwise this may fracture as the osteotomy is closed. In the distal direction the osteotomy is continued through the lateral cortex. Care must be taken to maintain the plane of the osteotomy during this step and also to avoid injury to the EHL and maceration of the skin portal.
The osteotomy channel is then widened with continued burring with the 20 mm Shannon or through the application of a 3.1 mm Wedge Burr. This is continued until the osteotomy can be closed with adequate correction of the intermetatarsal angle.

The osteotomy is then fixed with one or preferably 2 screws if there is adequate space. These are inserted through additional stab incisions in a slightly dorsomedial to plantar lateral direction, perpendicular to the plane of the osteotomy.

Finally the 2 mm k-wire is removed and the portals washed out with saline to remove any bone debris.

Saline / chlorhexidine soaked gauze dressings and wool / crepe bandaging are then applied.

It is important that the patient is instructed to elevate the leg for the first 2 weeks post-surgery to minimize soft tissue swelling and encourage soft tissue healing. The patient is provided with a heel wedge shoe and crutches and kept NON weight bearing for the first 6 weeks post-surgery as per surgeon preference. Early weight-bearing carries an increased risk of failure of fixation and the patient must be educated as to this risk.

A post-operative review at 2 weeks to check portals and apply a compressive strapping / bandage to the forefoot is carried out. This strapping can then be removed by the patient 4 weeks post-surgery. A further outpatient review at 6 weeks post-surgery is then carried out with radiographs. Usually the patient can be allowed to full weight – bear in ordinary footwear at this stage. Post-operative VTE prophylaxis can be applied as per local protocol.
Indications
Hallux Rigidus following failed non-operative treatment

Surgical Approach

• The stab skin incision is usually placed over the medial aspect of the 1st metatarsal, proximal to the medial eminence. The placement of this incision is vital. Firstly the incision must avoid the dorsomedial cutaneous nerve to the hallux; if palpable, this nerve should be marked before placing the incision. The incision must also allow sufficient access to the dorsal osteophyte. A separate incision will be required to access lateral osteophyte if present when employing this approach. The additional stab skin incision is placed over the dorsum of the 1st MTPJ just to the lateral side of the EHL tendon sheath. This additional portal will allow access to lateral osteophytes if present.

• Once the incision has been made then the periosteal elevators are used to carefully lift the capsule from the osteophytes and thereby create a working area for the burr.
Cheilectomy with Burr
3.1 mm Wedge Burr

- The osteophytes are shaved using a 3.1mm wedge burr with care to avoid thermal injury / maceration to the working portal. As the osteophyte is burred away, the removed bone emerges from the portal in a paste.

- The burring process is made easier if at regular intervals the bone paste is ‘milked’ out of the portal followed by irrigation with saline delivered through the portal under pressure from a syringe, e.g. via venous cannula, to wash away smaller fragments. The rasp instrument is then used to remove more debris. Introduce the rasp through portal and orientate the rasp surface away from bone and then withdraw with gentle digital pressure on overlying skin. Care must be taken to ensure that the rasp is not used to smooth the bone surface, merely to clear bony fragments from the soft tissues.

- This process is continued until sufficient bone has been removed as confirmed on image intensifier.

Closure & Post Op Care

- At the end of the procedure, steri-strips can be applied to the wounds.

- Chlorhexidine / saline soaked dressing gauze is then applied so as to splint the soft tissues. Wool and crepe bandaging are then applied.

- A flat post-operative shoe is worn on the operated foot for one week following surgery and the patient informed of the need for diligent elevation of the foot during this period. The patient can remove the bandages at 48hrs to leave the dressing only in place and can then mobilise the hallux more freely.

- After this initial week the wounds are inspected and joint motion encouraged in ordinary footwear and physiotherapy.

- DVT prophylaxis is according to national guidance and local protocol.
Indications may include:

- Plantar pain
- Intractable plantar keratosis
- MTPJ subluxation and dislocation (reducible)
- Hammer / claw toe correction
- Prophylactic at time of first ray surgery to address relative over length / prominence
- Post-operative transfer metatarsalgia

Surgical Approach

- Stand facing the foot from the end of the table. Fix the relevant lesser mtpj between the thumb, placed dorsally, and index finger of the non-dominant hand. A stab incision with the beaver blade is then made to the right side of the relevant lesser MTPJ; left side if surgeon left hand dominant.

- This incision need go no deeper than the skin. Avoid extensive stripping of periosteum especially on the plantar surface of the neck as this is both unnecessary and may potentially compromise the blood supply to the head of the metatarsal.

Creation of Osteotomy

2x12 mm Shannon Burr

- Select the 12mm Shannon burr for this osteotomy. The burr is inserted through the portal created and placed against the lateral wall of the neck of the metatarsal. The correct position is felt at the concavity of the diaphyseal – metaphyseal junction. It is helpful to fix the relevant lesser MTPJ between the thumb and index finger of the non-dominant hand and mildly plantar flex the toe within this grasp. With experience image intensifier confirmation of positioning of the burr is unnecessary but, to begin with, some may find it useful to confirm correct burr position with the c-arm.

- The osteotomy is then created by a rotation of the burr pencil driver so that the burr sweeps through the neck of the metatarsal from lateral to dorsal, not plantar to dorsal. The plane of the osteotomy should be at 45 degrees to the axis of the metatarsal.
**DMMO** (Distal Metatarsal Metaphyseal Osteotomy)

- When performed correctly, the osteotomy is extra-capsular with respect to the MTPJ. Completion of the osteotomy can be confirmed by mobility of the head of the respective metatarsal and also by observing movement on image intensifier views. Saline or Chlorhexidine soaked strips of dressing gauze are then used to splint the toes in a neutral / desired position followed by application of wool and crepe bandaging.

**Post Operative Care**

- The patient can, and should, be mobilized full weight-bearing in a flat postoperative shoe immediately post-surgery with instructions to elevate the operated foot / feet for the first 14 days. There is a dynamic element to DMMO’s and hence loading of the forefoot is desired in the early postoperative period to encourage even loading of the metatarsal cascade.

- The patient is usually reviewed in the outpatient department at 1-2 weeks post-surgery and the toes splinted with the use of a commercially available toe alignment splint or taping. It is important to educate the patient as to how to use the splint correctly, or how to apply the taping, to maintain desired toe position during the healing period.

- The splint / taping is continued for the first 4-6 weeks post-surgery according to surgeon preference and the patient also educated to encourage mobility of the operated toes in plantar flexion. Physiotherapy may also be helpful in this respect.
Surgical Approach

- The patient is positioned supine with a sandbag under the hip of the side to be operated. The recommended surgeon position and image intensifier position are shown in (Figure 1). The image intensifier is positioned under the foot so that the surgeon can work with the foot over the detector of the image intensifier and can easily obtain a lateral view of the calcaneum when required without moving the foot.

- The plane of the desired osteotomy is marked on the skin on the lateral surface of the heel using a surgical marker pen using a straight metal instrument under image intensification to plan this (Figure 2). The osteotomy path should be well away from the posterior facet of the subtalar joint.

- The portal is then positioned at the centre of the path of the desired osteotomy, osteotomy apex if planning a chevron. Only the skin is cut, portal approximately 6-8mm. The surgeon must remember the proximity of the sural nerve and due to anatomical variability, must assume this to be at risk. An artery clip is therefore used to create a clear path to the bone.
**Medialising Calcaneal Osteotomy**

3 mm x 20 mm Shannon Burr

- The burr is then introduced into the calcaneum through the portal. The surgeon should ensure that all of the cutting surface of the burr is inserted into the bone immediately and in this way can ensure that there is no possibility of cutting soft tissue during the procedure.

- The burr is not long enough to cut both cortices of the calcaneum in one sweep and this should not be attempted. Instead the surgeon should cut the near cortex first and then the far (medial) cortex.

- The skin mark acts as a useful guide to the surgeon during the creation of the osteotomy and the handle of the burr is maintained in the same plane as the skin mark (Figure 3). However, the surgeon should regularly check the position of the burr and the path of the osteotomy using the image intensifier and adjust the path of the burr if required.

- Once the near cortex has been cut then the surgeon can complete the osteotomy by cutting the far cortex in a similar fashion. This is achieved by following the path already created by cutting the near cortex. Care should be taken not to over insert the burr through the far (medial) cortex during this procedure as this may place the neurovascular bundle at risk of injury. Over insertion is avoided by employing a prodding action to cut the far (medial) cortex during which the surgeon receives good feedback through the burr handpiece as to the point at which the burr is through the cortex to be cut.
• The osteotomy becomes mobile once completed and can then be easily displaced as desired.

• A temporary 2 mm k-wire can be introduced through the portal to lever the osteotomy and assist with desired displacement and control of the osteotomy if desired.

• Fixation can then be undertaken as per surgeon preference.

• At the end of the procedure, steri-strips can be applied to the wound.

• Chlorhexidine / saline soaked dressing gauze is then applied.

• A plaster of paris backslab is then applied.

• The patient is kept non-weight-bearing for 6 weeks following surgery.

• The portal is inspected at 2 weeks post surgery in the outpatient department.

• DVT prophylaxis according to national guidance and local protocol.
ORDERING INFORMATION

HV Screw Range

HV010–2  HV Screw 10 mm
HV012–2  HV Screw 12 mm
HV014–2  HV Screw 14 mm
HV016–2  HV Screw 16 mm
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HV032–2  HV Screw 32 mm
HV034–2  HV Screw 34 mm

MICA Forefoot Implants (2x pack)

MI001–5  Shannon Recta Burr 2 mm x 20 mm
MI002–5  Shannon Recta Burr 2 mm x 12 mm
MI003–5  Shannon Corta Burr 2 mm x 8 mm
MI004–5  Wedge Burr 3.1 mm x 13 mm
MI005–5  Wedge Burr 4.1 mm x 13 mm
MI007–5  Shannon Burr 3 mm x 20 mm

MICA Forefoot Surgery Instruments

MI006  MI Instrument Set (Sterile Packed for Single Use)
HV0200–5  HV Instrument Set MI
HV039–6  K-wire 100 mm x 1 mm
HV040–6  K-wire 200 mm x 2 mm
HV035–6  Tube Drill 2 mm
MI008–6  MI Drill Bit 3 mm
MI0045–10  MI Depth Gauge
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Sterile Packed Implants and Instruments

The WG Healthcare Forefoot range of implants and instruments is supplied sterile packed. This ‘sterile packed for single use’ approach has advantages for both surgical and nursing staff as well as the patient.