

THE FOURTH METATARSOPHALANGEAL JOINT ARTHROPLASTY IN THE SURGICAL CORRECTION OF INTERDIGITAL LESIONS

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Interdigital keratoses are the result of transverse plane pressures between the toes and are among the most painful digital skin lesions that the podiatric physician encounters. They seem to be far more symptomatic and bothersome to patients than the more typical dorsal skin lesions associated with the classic sagittal plane hammer-toe deformity. Interdigital keratoses may or may not be associated with a hammertoe deformity. They can result from digital parabola or malalignment problems in any plane, bony spurring of the phalanges, or tight shoe wear among many other possibilities. The goal of surgical correction of this painful problem is to reduce the pathologic transverse plane pressures resulting in the keratosis accumulation, yet not disturb the associated anatomy to the point that other new deformities and complications could result. The purpose of this presentation is to review the etiology and pathologic possibilities associated with interdigital keratoses and discuss surgical approaches, specifically to the fourth metatarsophalangeal joint, that would not only surgically correct the problem, but respect the anatomy and function of the digits to prevent further deformity and complications.

PATHOLOGIC POSSIBILITIES

Interdigital keratoses are the result of transverse plane pressures between adjacent toes. Generally, pedal digital joints are not linearly opposed in the transverse plane in a normal digital parabola. The interphalangeal joint condyles miss one another in the presence of normal shoe pressures. The presence of pathologic pressures to create a painful keratosis occurs when two adjacent interphalangeal joints or a metatarsophalangeal joint and an interphalangeal joint approximate one another. When the digital joints oppose one another, point areas of pressure can develop between the digits. Arthritic digital joint spurring can exaggerate the pain and reduce the amount of pressure required to create a painful interdigital keratosis. The thin and poorly padded interdigital skin thickens with callous as a protective mechanism. The thickened skin can overcompensate and a painful interdigital lesion develops. The

moist environment between the toes tends to macerate the lesion or callous resulting in a "soft corn" or *helloma molle*. Ulceration and infection can occur even in the healthy individual especially with home debridement efforts and the use of topical acid plasters. The presence of neurovascular compromise can often exaggerate the pace of ulceration and infection complications with interdigital keratoses.

Interdigital keratoses should not be confused with interdigital dermatological problems. The absence of typical etiologies for interdigital keratoses such as bony prominences or opposed joint condyles aids in the differential diagnosis. Non-pressure type interdigital skin problems tend to respond with appropriate treatment. Interdigital pressure keratoses are aided by local care, but tend to recur in time. The differential diagnosis of interdigital non-pressure type lesions includes tinea, psoriasis, and other exfoliative skin conditions. Long standing interdigital pressure keratoses can damage the interdigital skin to such an extent that even with surgical reduction of interdigital pressures, the lesions can recur. Combination type presentations are possible as well.

The apposition of adjacent digital joints in the transverse plane is the basic etiology of pressure interdigital keratoses. Understanding the reasons two digital joints oppose one another aids in selecting options for both operative and nonoperative care. The three cardinal body planes provide an easily-understood method of categorizing these lesions. The digit may be hammered or clawed in the classic sagittal plane deformity. These sagittal plane presentations result in relative shortening of the toe that may bring adjacent digital joint condyles into apposition. Hammertoes can cause adjacent joint apposition either distally or proximally in the interdigital area. Transverse plane digital deformities of adductus or abductus can likewise bring adjacent digital joint prominences into apposition. Cross-over toe deformities will exaggerate transverse plane digital deformities. Narrow-fitting shoes can exaggerate transverse plane digital pressures and create malalignments and interdigital pressures not apparent in the unshod evaluation. Finally, frontal plane digital rotations can result in interdigital

malalignments. This plane of deformity presents in combination with other planes of digital malalignment, and is very commonly found in the fifth toe.

SURGICAL TECHNIQUE

The surgical approach to the fourth metatarsophalangeal joint involves a dorsal linear incision centered over the extensor tendons and the joint. The incision needs to have sufficient length to respect not only the proximal and distal linear needs for visualization but respect the depth of exposure needs about the lateral aspect of the joint to avoid undue retraction forces on the margins of the wound. A hypertrophic scar is a possibility following this procedure due to the anti-tension orientation of the incision that can be aggravated by undue heavy-handed retraction on an unnecessarily short incision. Heavy scarring can result in pain and restricted metatarsophalangeal joint motion postoperatively. The incision typically extends from the distal shaft and neck junction area of the metatarsal proximally to just distal to the base and shaft junction area of the proximal phalanx distally. Care must be taken to respect the angular possibilities of the metatarsals and forefoot in the transverse plane. This orientation helps to maintain a dorsal midline approach to the metatarsal and phalanx and avoid the possibility of deviating more over the intermetatarsal space soft tissues.

The incision is deepened vertically through the subcutaneous tissues to the deep fascia. More transverse plane dissection is carried out to expose the deeper tissues over the deep fascia which in this area includes the extensor hood apparatus about the metatarsophalangeal joint. Dissection over the deep fascia is emphasized about the lateral joint area with minimal medial dissection performed only to facilitate closure. A short bladed retractor is used more medially, while a longer-bladed retractor is inserted to expose the lateral aspect of the joint to the deep transverse intermetatarsal ligament, which is retained intact. At this point centrally and dorsally located over the metatarsophalangeal joint, the laterally positioned long extensor and the medially positioned most lateral branch of the short extensor tendons should be visible through the deep fascia.

A deep incision may be placed lateral to the short extensor tendon or split the short and long extensor tendons. The incision is maintained several millimeters lateral to the margin of the short extensor or, if the extensor tendons are split, the long extensor. This margin of tissue is important as an anchor point for suture closure of the layer outside and away from the tendon. The incision can be made directly through both the deep

fascia and capsular-periosteal layers or each layer can be incised individually. Little dissection or freeing of the extensor tendons is performed. The extensor tendons can then be retracted medially with a skin hook. The incision into the joint capsule is carefully completed to expose the articular cartilage of the joint. Further deep dissection follows the bony contours of the phalanx and metatarsal directly over the bones themselves. This level of dissection again is emphasized more laterally than medially. The goal of this deep osseous exposure is to create visualization of the dorsal-lateral corner of the joint prominence. Dissection need not be carried out to compromise the attachments of the lateral collateral ligament. This ligament should be maintained, if possible, to preserve the lateral integrity of the joint against potential adduction deviation of the proximal phalanx postoperatively. The tissue margins at the capsular-periosteal tissue level should be respected and maintained. If this layer is torn or the proximal or distal attachments compromised or inadvertently "T"-ed-out closure of the layer and coverage of the joint becomes very difficult.

The exposure distally includes the dorsal-lateral corner of the proximal phalanx base to the proximal shaft area to a depth not violating the lateral collateral ligament insertion. The exposure proximally includes the dorsal-lateral corner of the metatarsal head to the distal shaft area not violating the origin of the lateral collateral ligament at the lateral epicondyle. The lateral incisional line is developed for several millimeters over the joint itself to permit a tissue anchor for suture closure. Once soft tissue exposure is completed, osseous resection can begin.

Osseous resection involves removing bone from the dorsal-lateral joint corner. Once the cortex of the bone is resected, rasping and contouring is generally sufficient to reduce any prominence. Typically, a rongeur can be used effectively to resect the cortex of the metatarsal and phalanx. Power equipment can be used, but can be cumbersome and difficult to control in the smaller, lesser metatarsophalangeal joints. Following cortex resection, an angled hand rasp will effectively contour the margins and softer medullary bone consistent with the shaft of the phalanx distally and shaft of the metatarsal proximally. Osseous resection is restricted to the dorsal-lateral corner of the joint avoiding significant lateral bone resection that could include the lateral epicondyle of the metatarsal and the collateral ligament attachment or the base of the proximal phalanx and the attachment of the plantar fascia. Careful clinical palpation over the skin of the interdigital space is used to assess the adequacy of the osseous resection. Prior to closure, the metatarsophalangeal joint should be relocated to a congruous alignment. This

maneuver helps assure that equivocal osseous resection has been performed and relative prominence of either the head of the metatarsal or the base of the phalanx has inadvertently occurred.

Closure involves a layered approach. The periosteal-capsular layer can be closed individually or include the deep fascia. Careful closure of this deep layer aids coverage and protection of the joint. The deep fascia layer closure is important to re-establish the position of the extensor apparatus over the joint and avoid postoperative digital malalignment, especially in metatarsus adductus,

transverse plane forefoot malalignment foot types. The joint should be held in anatomic position while suturing to prevent malalignment. The strength and integrity of the joint supporting strictures is hopefully re-established. The subcutaneous tissue and skin layers are surgically repaired in layers to aid padding of the joint in a prior area of pressure and aid in reducing forces on the skin that could result in hypertrophy of the scar. The surgical dressing should not only provide compression but, maintain the alignment of the fourth metatarsophalangeal joint in all planes.

CLINICALLY ILLUSTRATED TECHNIQUE

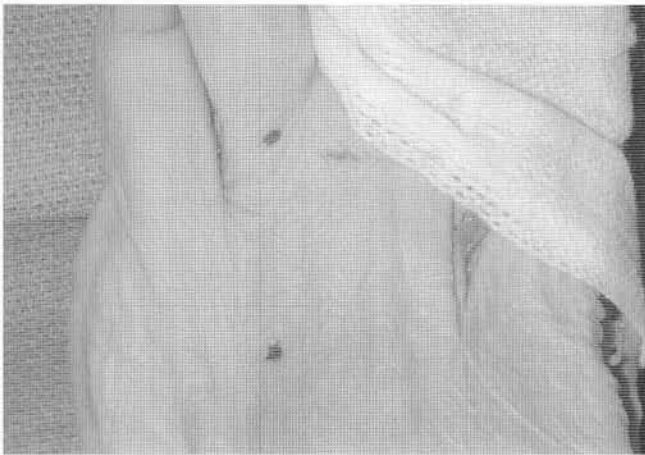


Figure 1. Skin incision from distal base of the phalanx to proximal neck of the metatarsal.

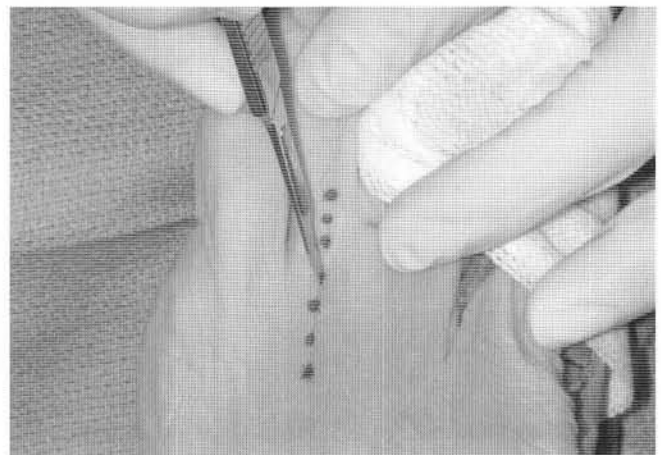


Figure 2. The incision is centered over the metatarsophalangeal joint dorsally.



Figure 3. Lateral deep dissection to the transverse deep intermetatarsal ligament.

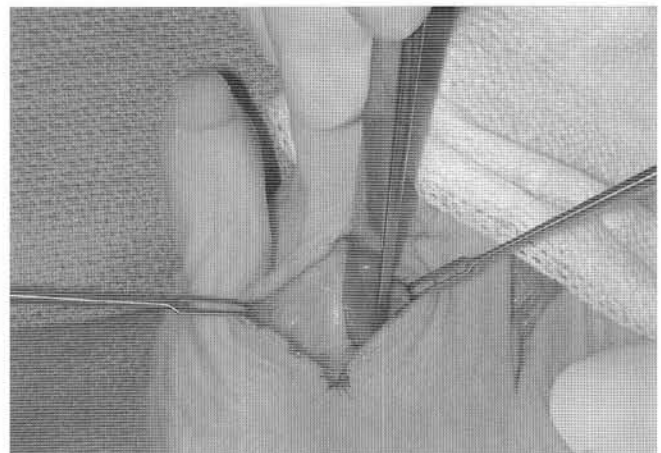


Figure 4. Medial superficial dissection only over the dorsal aspect of the joint.

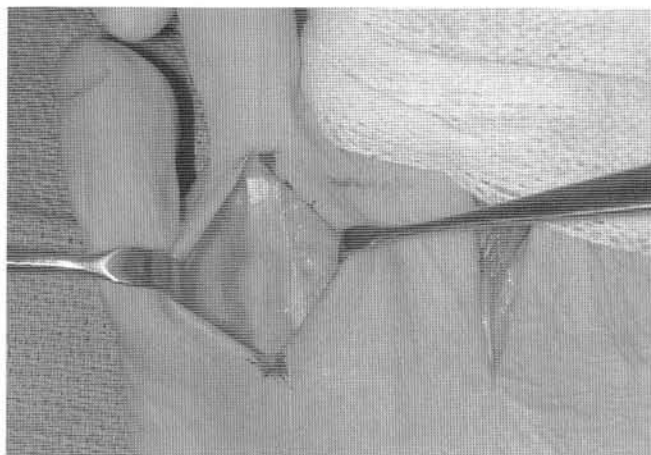


Figure 5. Deep lateral retraction and more superficial medial retraction.

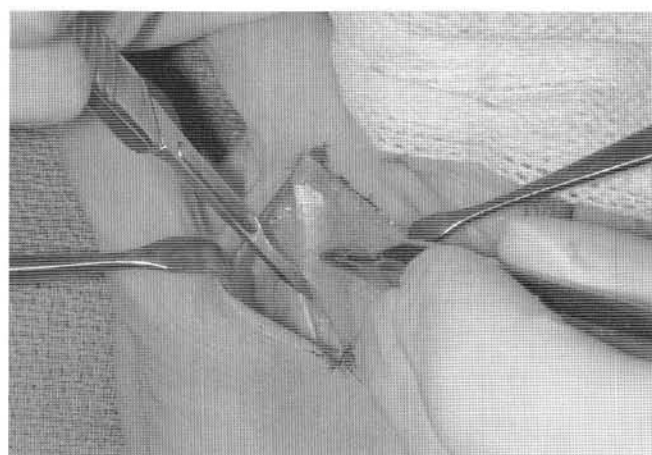


Figure 6. Deep fascial and capsular-periosteal incision.



Figure 7. Completed deep incision from phalanx to metatarsal.

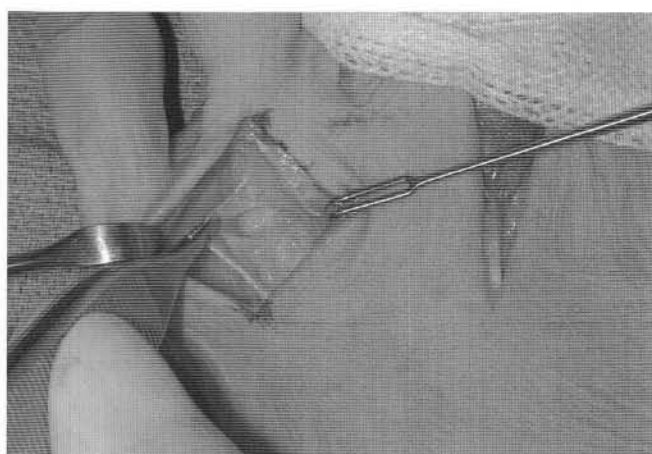


Figure 8. Extensor in skin hook medially, capsule in pick-up laterally developing joint exposure.

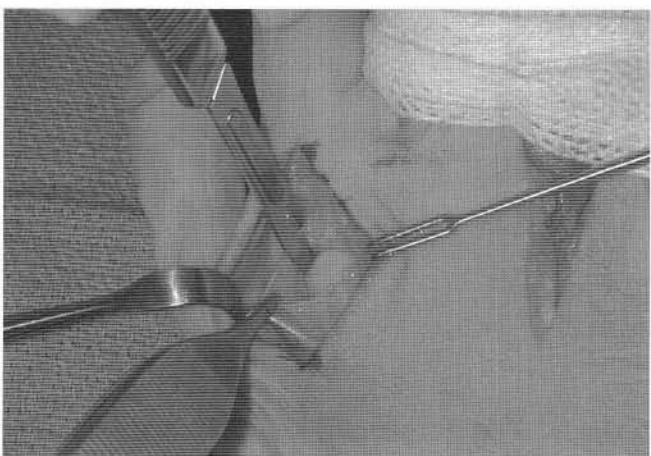


Figure 9. Completing the lateral joint exposure.

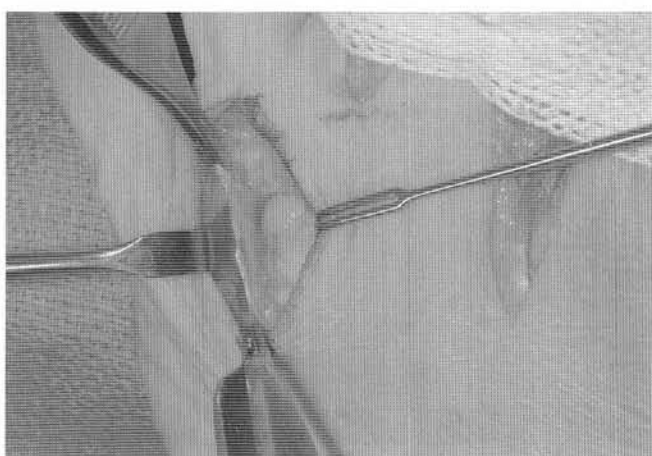


Figure 10. The persevered lateral capsular layer to the epicondyle of the metatarsal.

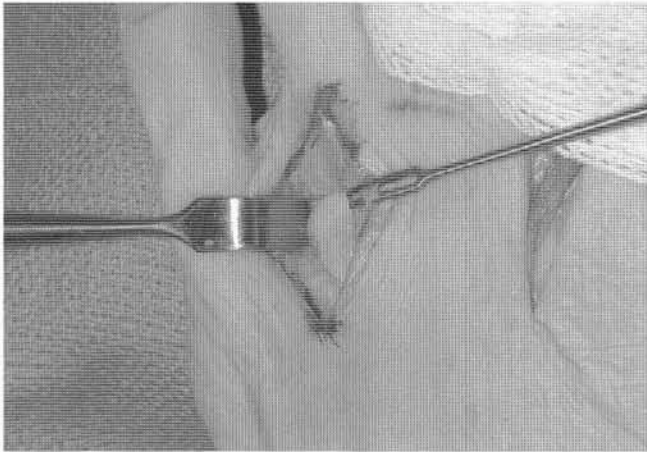


Figure 11. Visualization of the dorsal-lateral fourth metatarsophalangeal joint.



Figure 12. Combined resection of the phalanx and metatarsal with sagittal saw.

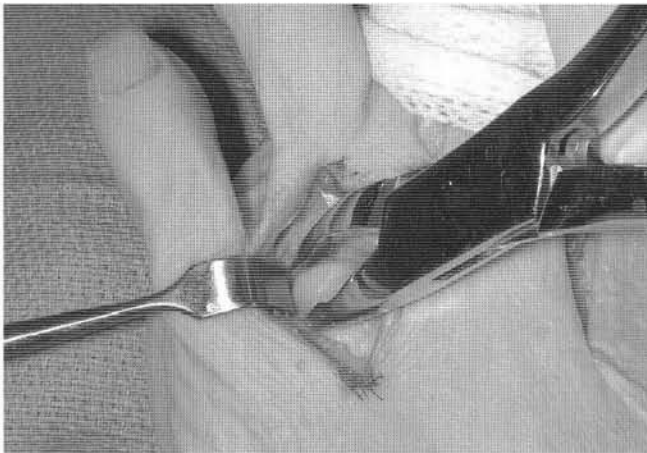


Figure 13. Individual metatarsal and phalanx cortex resection with rongeur.

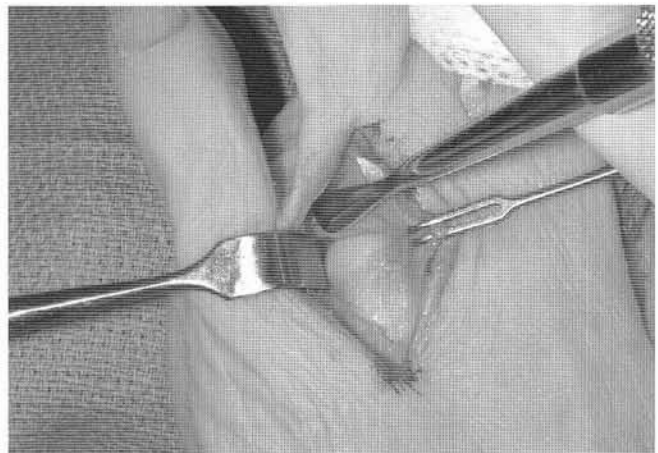


Figure 14. Hand contouring of the metatarsal and phalanx with angled bone rasp.



Figure 15. Initial cortex resection of the metatarsal.



Figure 16. Final appearance of the metatarsal head following rasping and contouring.

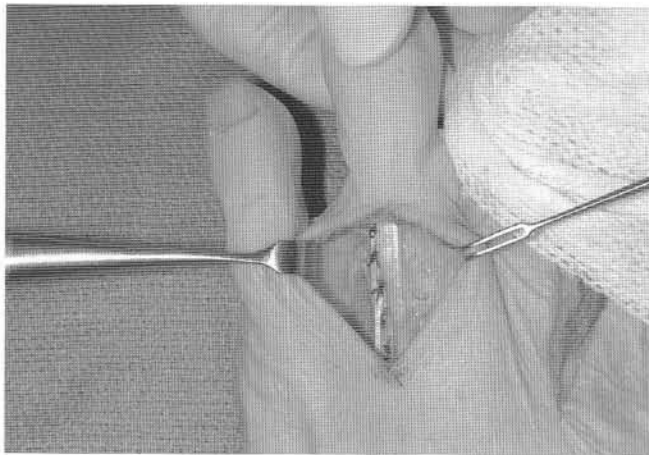


Figure 17. Deep fascial and capsular closure held in anatomic position.

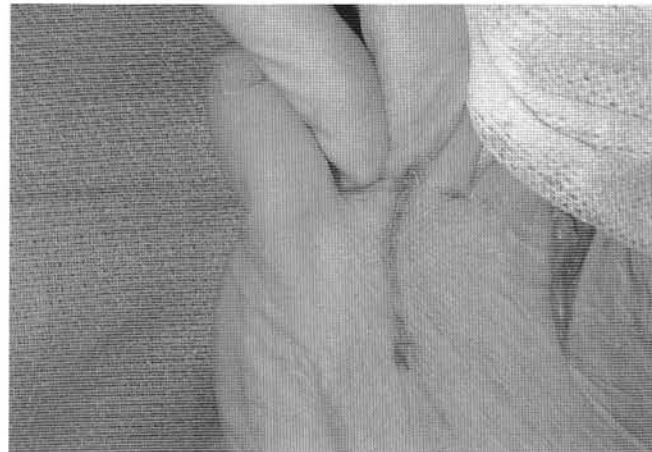


Figure 18. Final inspection of the adequacy of bone resection after skin closure.

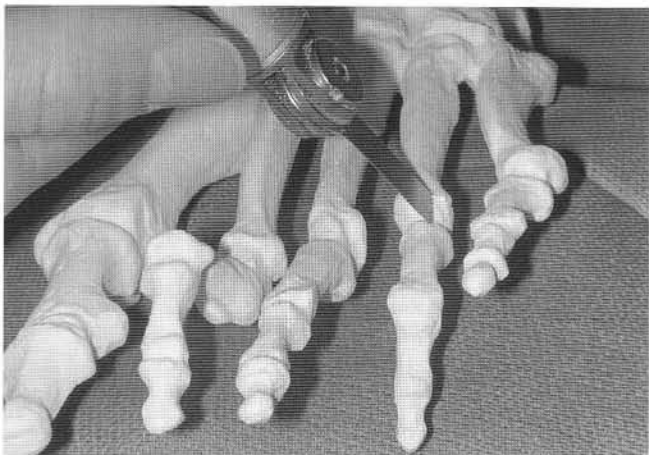


Figure 19. Bone model representation of the joint resection angle.

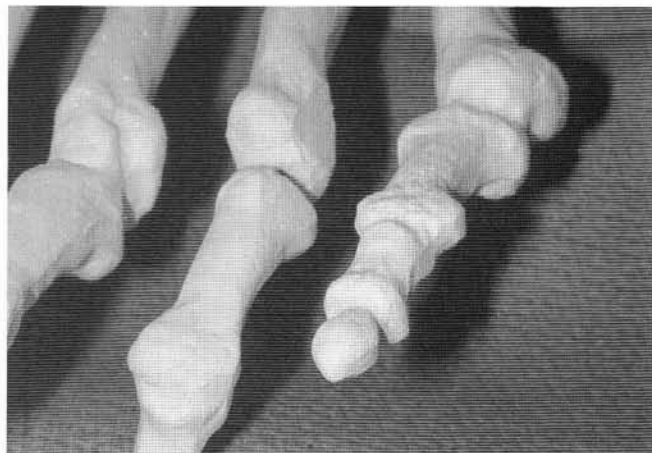


Figure 20. Bone model representation of the angle following joint resection.

CONCLUSION

Interdigital keratoses of the fourth and fifth digits are among the most painful skin lesions of the forefoot and interdigital keratoses are the result of transverse plane pressures across the lesser digits. The lesion can be distal or proximal in the interdigital space. The more proximal interdigital keratoses are the result of the lateral fourth metatarsophalangeal joint contacting the medial fifth proximal interphalangeal joint. Surgical options for more proximal fourth interdigital keratoses include osseous resections of the fourth metatarsophalangeal joint and the proximal interphalangeal joint of the fifth toe to reduce the transverse plane pressures. Syndactyly may be considered as a primary option for surgical repair

especially where interdigital skin scarring or skin sensitivity is noted as contributing to the presenting pain complex. The osseous resections involved about the metatarsophalangeal joint must respect the insertions of the key soft tissues that stabilize the joint. The bone resection is focused to the dorsal-lateral corner of the joint. This helps avoid the lateral epicondyle of the fourth metatarsal and the lateral collateral ligament origin as well as the base of the proximal phalanx and the plantar fascial insertion. By respecting the lateral and plantar soft tissues of the fourth metatarsophalangeal joint, postoperative digital malalignment complications can be avoided, yet permit adequate osseous resection to reduce the pathologic pressures and the painful pressure lesion.