Keratotic Disorders of the Plantar Skin

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This chapter discusses the etiology and treatment of keratotic lesions of the plantar skin as a result of friction or pressure or both over a bony prominence. These must be distinguished from the intrinsic disorders of the skin such as verruca and dermatosis, especially tinea infestations (see Chapter 32).

Movement of the center of pressure along the plantar aspect of the foot illustrates the long period that the center of pressure dwells beneath the metatarsal heads during normal walking (see Chapter 1). After heel strike, the center of pressure moves very rapidly to the metatarsal head area, where it dwells for more than 50% of the stance phase, after which it moves toward the toes (Fig. 8–1). Because of this extended period of weight bearing in the metatarsal area, abnormal alignment of the forefoot, either localized or generalized, can result in a problem with a keratotic lesion.
Examining the various causes of plantar keratoses (Box 8–1), one realizes that when the patient presents with a plantar callus, a significant differential diagnosis must be considered in the patient evaluation. As a rule the diagnosis is not difficult to make, but at times the diagnosis may not be clear-cut, and one needs to consider these various causes.

**Anatomy**

The usual pattern of the metatarsals demonstrates that the first metatarsal is shorter than the second approximately 60% of the time. The mobility of the first metatarsocuneiform (MTC) joint or the first metatarsophalangeal (MTP) joint determines the degree of weight bearing of the first ray. The plantar aponeurosis mechanism that brings about plantar flexion of the first metatarsal during the last half of stance phase becomes less functional as a hallux valgus deformity develops. As a result, plantar flexion of the first ray might not occur, which could result in a transfer of pressure to the second metatarsal head and subsequently a diffuse callus secondary to increased weight bearing. If the first MTC joint is hypermobile, which probably is pathologic in no more than 5% of patients, again the first metatarsal does not bear its share of the weight, and pressure is transferred to the lesser metatarsals, where a diffuse callus can develop beneath the second and possibly third metatarsal (Fig. 8–2). The second and third metatarsals are quite stable because of the rigidity of their tarsometatarsal articulations; therefore, if the first metatarsal is hyper-

**BOX 8–1 Causes of Plantar Keratoses**

**BONE CAUSES**
- Prominent fibular condyle metatarsal head
- Long metatarsal
- Morton's foot
- Hypermobile first ray
- Post-trauma effects
- Abnormal foot posture (varus or valgus)

**SYSTEMIC DISEASES**
- Rheumatoid arthritis
- Psoriatic arthritis

**Dermatologic Lesions**
- Wart
- Seed corn
- Hyperkeratotic skin

**Soft Tissue Causes**
- Atrophy of plantar fat pad
- Crush injury sequelae
- Plantar scar secondary to trauma

**Mechanical Causes**
- Subluxed or dislocated metatarsophalangeal joint
- Hallux valgus deformity resulting in transfer lesion

**Iatrogenic Causes**
- Secondary to metatarsal surgery (e.g., plantar flexion)
- Transfer lesion
- Hallux valgus surgery (e.g., shortening or dorsiflexion of metatarsal)

**Figure 8–1** Movement of the center of pressure along the plantar aspect of the foot during walking. Note the way the center of pressure rapidly moves from the heel and dwells in the metatarsal region before moving distally to the great toe. (From Hutton WC, Stott JRR, Stokes JAF: In Klenerman L [ed]: The Foot and Its Disorders. Oxford, Blackwell Scientific, 1982, p 42.)
mobile or elevated from any cause, callus can form beneath these metatarsal heads. The fourth and fifth metatarsals are more mobile and therefore calluses rarely develop beneath them unless there is a problem with abnormal foot posture. A moderate degree of mobility also exists between the lateral two rays and medial three rays between the cuboid and lateral cuneiform.

The posture of the foot must always be considered in evaluating the patient with an intractable plantar keratosis (IPK). The IPK may be caused by the abnormal posture of the foot, and unless the posture is corrected by conservative or surgical treatment, the IPK will persist. Postures of the foot that can cause abnormal callus formation include an equinus deformity of the ankle joint, a cavus foot, a flatfoot, a varus forefoot deformity, a valgus flatfoot deformity, and an abnormal alignment of the MTP joints.

An equinus deformity of the ankle joint that results in localized weight bearing on the metatarsal head area usually results in a diffuse callus beneath the first, second, and third metatarsal heads. This can result in a painful condition, particularly in the older patient, who often develops atrophy of the fat pad. In the patient with an insensate foot, such as the patient with diabetes or a peripheral neuropathy, ulceration of the plantar aspect of the foot can occur.

The cavus foot is a rigid foot with a decreased area of weight bearing. In the cavus foot the calcaneus is usually in a dorsiflexed position and the forefoot in equinus, so the weight-bearing area is diminished, with a resultant diffuse callus beneath the metatarsal head area. Often this condition becomes more symptomatic as the patient ages and the fat pad atrophies more.

The flatfoot does not usually develop significant callus formation beneath the metatarsal heads. If it is associated with a hallux valgus deformity, however, the

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**Figure 8–2** Harris mat print of a patient with hypermobility of the first metatarsal. Because the first metatarsal does not carry much weight, pressure is transferred to the second and third metatarsals as well as to the tip of the hallux.

**Figure 8–3** Harris mat print of patient with varus forefoot deformity. Note that pressure is borne on the lateral aspect of the foot with significantly decreased weight bearing beneath the medial aspect of the foot.

**Figure 8–4** Harris mat print of patient with valgus forefoot deformity in which increased weight is borne along the medial side of the foot and, in particular, beneath the first metatarsal head.
and longitudinal arch, and position and posture of the hindfoot. Then the range of motion of the ankle, subtalar, transverse tarsal, and MTP joints should be noted. The posture of the forefoot in relation to the hindfoot needs to be quantified. The neurovascular status of the foot is likewise evaluated.

The plantar aspect of the foot is carefully evaluated. The location of the lesion and its characteristics are observed. A plantar wart is usually localized but occasionally demonstrates a mosaic pattern. A wart is usually not specifically located beneath a metatarsal head, although it is usually present on the plantar aspect of the foot.

A keratotic lesion needs to be carefully evaluated to establish, first, which metatarsal head it is beneath and then its characteristics. The callus may consist of a localized seed corn, a discrete plantar keratosis beneath the fibular condyle of a metatarsal head, a diffuse callus beneath a metatarsal head, a diffuse callus beneath several metatarsal heads, or a localized callus beneath the tibial sesamoid.

To facilitate identification of the lesion and to be sure it is not a wart, the lesion is often trimmed with a no. 17 blade. Trimming enables the clinician to identify the margins of the callus, because in a well-localized plantar keratosis the callus itself has definite circumscribed edges, as opposed to a diffuse callus, which is a generalized thickening of the plantar skin without a defined margin. A wart, on the other hand, may have a small amount of hyperkeratotic skin overlying it, but very quickly one enters the warty material, which consists of multiple end arteries that bleed vigorously, as opposed to a true plantar keratosis, which has no blood supply (Fig. 8–6).

Weight-bearing radiographs should be obtained along with sesamoid views, if indicated. Occasionally

**Figure 8–5** A, Foot in a patient with rheumatoid arthritis with large diffuse plantar calluses beneath the metatarsal heads and nonfunctional toes. B, Harris mat print demonstrating concentration of pressure beneath metatarsal heads and lack of weight bearing by lesser toes.

Abnormal alignment of the metatarsophalangeal joints secondary to either subluxation or dorsal dislocation results in a plantarward force on the metatarsal head that often develops into a diffuse callus beneath the involved metatarsal head. An extreme example is a patient with advanced rheumatoid arthritis (Fig. 8–5).

**Diagnosis**

The evaluation of a patient with a plantar keratotic lesion begins with a careful history of the condition and should include what type of footwear aggravates and relieves the pain as well as what type of treatment has been attempted in the past.

The physical examination begins with the patient standing. Careful observation should be made of the posture of the toes, characteristics of the MTP joints and then its characteristics. The callus may consist to establish, first, which metatarsal head it is beneath and then its characteristics. The callus may consist of a localized seed corn, a discrete plantar keratosis beneath the fibular condyle of a metatarsal head, a diffuse callus beneath a metatarsal head, a diffuse callus beneath several metatarsal heads, or a localized callus beneath the tibial sesamoid.

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**Figure 8–6** A, Wart on the plantar aspect of the foot does not usually occur on a weight-bearing area. B, Histologic features of the wart demonstrate considerable vascularity within the lesion. C, Mosaic wart has similar histology but is more widespread.
a small marker placed over the lesion helps to identify the offending structure.

**Treatment**

**Conservative Treatment**

The plantar callus is trimmed with a sharp knife. When trimming a callus, one should attempt to reduce the hyperkeratotic tissue, and if it is invaginated, this too should be trimmed. With a deep-seated lesion, however, it is not possible to remove all the keratotic lesion at the first trimming, and sometimes several trimmings are necessary to permit the deep-seated portion of the callus to surface. Occasionally a seed corn, which is a well-localized keratotic lesion usually 2 to 3 mm in diameter, can be removed at the first sitting, although it might require a second trimming (Fig. 8–7).

After debridement of the callus, a soft metatarsal support is used to relieve the pressure on the involved area (Fig. 8–8). The soft support can be used initially, provided that the patient’s shoe is of adequate size. If the patient is wearing stylish women’s dress shoes, there may not be sufficient volume for the foot and the metatarsal support. The patient with a significant keratotic lesion needs to be encouraged to wear a broad, soft, preferably low-heeled shoe to provide more cushioning for the plantar aspect of the foot. The metatarsal support is placed into the shoe just proximal to the area of the lesion (Fig. 8–9). When doing this, it is important to instruct the patient that initially this support may feel uncomfortable and may take a period of breaking in of a week to 10 days.

The patient is then seen periodically in the office for trimming of the lesion, adjustment of the metatarsal support, and possibly even placement of a larger one, as necessary. If the patient has a postural abnormality of the foot such as a forefoot varus or valgus, or possibly a cavus foot, a well-molded soft orthotic device may be of benefit. The orthotic device, however, should not be used until one has experimented with the removable soft supports first to see whether the patient will respond to an orthosis.

If the callus persists and is symptomatic, surgical intervention can be considered.

**Surgical Treatment**

**TYPES OF PLANTAR CALLOSITIES**

Surgical management of a plantar keratosis is based on the characteristics of the callus.

A *discrete callus* with a central keratotic core is observed beneath the fibular condyle of the metatarsal head and beneath the tibial sesamoid (Fig. 8–10). When the patient with a localized lesion walks over a Harris mat, the imprint created is well localized beneath the prominence that has brought about the
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Forefoot

Histologically this lesion is a dense, keratinized lesion with a central core (Fig. 8–12). A diffuse callus is observed beneath a metatarsal head that does not have a prominent fibular condyle and is noted most often beneath the second metatarsal head. Occasionally a diffuse callus is noted beneath multiple metatarsal heads (Fig. 8–13). When this type of callus is present and is trimmed, although the material consists of hyperkeratotic skin, there is no central core as one observes in a discrete callus. When this patient walks over a Harris mat, the print that is observed is diffuse beneath the entire metatarsal head or beneath multiple metatarsal heads (Fig. 8–14). This

Figure 8–9 Placement of a soft metatarsal support in the shoe. A, Support is placed just proximal to the “smudge” on the insole. This is usually around the base of the tongue. B and C, The support can be moved medially or laterally, depending on the location of the plantar lesion.

Figure 8–10 Examples of discrete intractable plantar keratoses (IPKs). A, Lesion beneath the second metatarsal head. B, Discrete keratosis beneath the third metatarsal head. C, Discrete keratosis beneath the fourth metatarsal head. (B from Mann RA: Instr Course Lect 33:289, 1984.)

Figure 8–11 Harris mat print demonstrating well-localized area of pressure—a discrete plantar keratosis.
type of diffuse lesion is occasionally observed beneath the first metatarsal head if it is plantar flexed. It is observed beneath the second metatarsal head when the first metatarsal is short or hypermobile or is functioning insufficiently because of instability brought about by an advanced hallux valgus deformity or possibly insufficiency after bunion surgery, if the joint has been destabilized. A diffuse callosity beneath the second, third, and fourth metatarsal heads is usually observed in a patient with an extremely short first metatarsal, which results in increased weight bearing beneath the three middle metatarsals (Fig. 8–15). Occasionally a diffuse callosity is present beneath the fifth metatarsal head in patients with a varus configuration of the forefoot, or it can be attributable to plantar flexion of the fifth metatarsal associated with a tailor’s bunion.

A diffuse type of callus can result after trauma involving a metatarsal fracture that results in a metatarsal’s becoming prominent if it is plantar flexed or, beneath an adjacent metatarsal, if it is dorsiflexed, with the normal metatarsal left to bear increased weight.

The importance of differentiating the type of the callus is that the nature of the callus determines the type of surgical procedure that will give the best result.

**Localised Intractable Plantar Keratosis**

A localized IPK, which is usually caused by the prominence of the fibular condyle, is treated by a DuVries metatarsal condylectomy. DuVries initially described the procedure in which he carried out an arthroplasty of the MTP joint by removing a portion of the distal articular surface and the plantar condyle. Coughlin and Mann modified the procedure and removed only the plantar condyle, and both these procedures seem to result in satisfactory resolution of the problem.
Figure 8–15  Typical findings with Morton’s foot (toe). A, Plantar aspect demonstrates diffuse callus beneath second and third metatarsal heads. B, Harris mat print demonstrates increased weight bearing beneath the second and third metatarsals, with little or no weight bearing beneath the first metatarsal head. C, Radiograph demonstrates typical Morton’s foot with short first metatarsal and relatively long second and third metatarsals.

Figure 8–14  Harris mat print demonstrates diffuse keratotic lesion beneath second metatarsal head. Compare with Figure 8–13. (From Mann RA: Instr Course Lect 33:293, 1984.)
DuVries metatarsal condylectomy.

1. A hockey stick–shaped incision begins in the second web space and is carried across the metatarsal head proximally to about the distal third of the metatarsal shaft (Fig. 8–16A).
2. Passing medially and laterally to the extensor hood, the transverse metatarsal ligament is identified and released.
3. The interval between the two extensor tendons is opened and continued through the joint capsule to expose the MTP joint.
4. The collateral ligaments are transected, and the MTP joint is sharply plantar flexed while pressure is applied to the plantar aspect of the foot with the index finger of the same hand (Fig. 8–16B and C).
5. The distal 2 mm of articular cartilage is removed from the metatarsal head in a plane perpendicular to the metatarsal shaft. As this cut is made, the osteotome needs to be angled slightly proximally; otherwise it will skid off the cartilage and make an oblique cut (Fig. 8–16D).
6. The MTP joint is now sharply plantar flexed to bring into view the plantar condyle. The plantar 20% to 30% of the metatarsal head is incised longitudinally.

About 2 mm of articular cartilage is removed. Note angulation to facilitate removal of more of the fibular aspect. Edges of the metatarsal are smoothed, then the capsule and skin are closed.
is removed with a 10- to 12-mm thin osteotome. The osteotome must be angled slightly plantarward to avoid inadvertent splitting of the metatarsal shaft (Fig. 8–16E).

7. On completion of the osteotomy in the metatarsal head, the plantar condyle is delivered by use of a Freer elevator or thin rongeur in the adjacent interspace, and the condyle is removed. It is difficult to pull this fragment of bone out directly over the proximal phalanx, so it is pushed into the interspace and removed (Fig. 8–17).

8. The edges are carefully rongeured, and the joint is reduced (Fig. 8–16F). The skin is closed in a routine manner.

9. A compression dressing is applied for 12 to 18 hours, and the patient is permitted to ambulate in a postoperative shoe.

Postoperative Care

The bulky surgical dressing is changed after 18 to 24 hours, and the patient is placed into a snug compression dressing consisting of 2-inch conforming gauze (Kling) and adhesive tape. The patient is permitted to ambulate in the postoperative shoe, which is worn for 3 weeks. The shoe is removed and the patient encouraged to work on range-of-motion exercises.

Results

In a review of 100 patients surgically treated by Mann and DuVries, there was 93% patient satisfaction. It was observed that 42% of the lesions were beneath the second metatarsal head, 31% beneath the third, 19% beneath the fourth, and 8% beneath the fifth. A transfer lesion occurred in 13% of the patients, and the original lesion failed to resolve in 5%.

The 5% complication rate included fracture of a metatarsal head, avascular necrosis of the metatarsal head, and clawing of the toe. There were no cases of dislocation of the MTP joint after this procedure. Postoperative range of motion of the MTP joint rarely demonstrates more than 25% loss of motion. It has always been somewhat surprising that so little motion is lost after this type of arthroplasty, whereas when a similar procedure is carried out for a dislocated MTP joint, significantly more motion is lost.

COUGHLIN’S MODIFIED METATARSAL CONDYLECTOMY

The modification of the condylectomy by Coughlin is carried out in the same way as the DuVries metatarsal condylectomy except that the distal portion of the metatarsal is not removed (Fig. 8–18 and video clip 36). This makes removing the plantar condyle a little more difficult. Up to now there has been no published report regarding the results of this modification of the DuVries procedure, although preliminary data indicate about a 5% incidence of transfer lesions.

Figure 8–17 Excised plantar condyle. A, Note marked prominence of the fibular portion of the condyle in this specimen. B, Plantar view of the same specimen illustrating the large condyle. (A from Mann RA: Instruct Course Lect 33:292, 1984.)

Figure 8–18 Coughlin’s modification of plantar condylectomy. Plantar 20% to 30% of the condyle is removed, and the distal portion of the metatarsal head is left intact.
A vertical chevron osteotomy of the metatarsal head has been described by Dreeben et al for treatment of a painful callus beneath the metatarsal head. The article did not classify the callus into localized or diffuse categories. A vertical chevron osteotomy was performed in the metaphysis, and the metatarsal head was elevated approximately 3 mm.

**Surgical Technique**

1. A 2-cm dorsal incision is made over the metatarsal head and neck region. The incision is carried down, the extensor tendon moved aside, the metatarsal neck exposed subperiosteally, and the plantar periosteum left intact. The MTP joint is not entered.

2. A chevron-type cut with the apex based distally is produced with a power saw just proximal to the edge of the dorsal joint capsule. An attempt should be made to leave the plantar periosteum intact (Fig. 8–19 and video clip 39).

3. The metatarsal head is displaced dorsally by plantar pressure but not more than 3 to 4 mm.

4. The osteotomy site is stabilized with a 0.045-inch Kirschner wire introduced through a separate stab wound. The skin is closed in a routine manner.

**Postoperative Care**

The patient walks in a postoperative shoe with weight bearing as tolerated. The Kirschner wire is removed after 3 weeks, and gentle range of motion is begun at that time. The postoperative shoe is continued for a total of 6 weeks.

**Results**

The series reported by Dreeben et al contained 45 patients. Complete relief of the symptoms was noted in 67%; 24% had residual pain, 9% demonstrated a transfer lesion, and in 4% the callus was unchanged. The authors pointed out that the metatarsal head should be elevated at least 3 mm but not more than 4.5 mm. Kitaoka and Patzer used the same procedure on 21 feet—16 women and 3 men with a mean age of 59 years (32 to 85). They reported good results in 16, fair in two, and poor in three. In four patients (20%) the callosity persisted, and in three (14%) a transfer lesion developed.

**Discrete Callus Beneath Tibial Sesamoid**

A discrete callus beneath the first metatarsal head lies under the tibial sesamoid. A localized lesion does not occur beneath the fibular sesamoid. A diffuse callus can be observed beneath the entire first metatarsal and is usually associated with a plantar-flexed metatarsal, often observed in the patient with a cavus foot or Charcot–Marie–Tooth disease.

The lesion beneath the tibial sesamoid can often be managed conservatively, although when it occurs after bunion surgery and the sesamoid is localized beneath the crista of the metatarsal head, surgical intervention is usually required (Fig. 8–20).
Even if there is only a moderate amount of callus over the lesion, once it is trimmed, a discrete keratotic lesion is usually identified.

TIBIAL SESAMOID SHAVING

The surgical procedure we prefer is tibial sesamoid shaving, in which the plantar half of the sesamoid is removed (video clip 34). In the past we advocated excision of the sesamoid for this problem, but after a review of our cases, we believe that tibial sesamoid shaving is a superior procedure with significantly less morbidity.14

Surgical Technique

1. The skin incision is made slightly plantar to the midline and centered over the medial aspect of the MTP joint. The incision is carried down to the capsular structures without undermining the skin (Fig. 8–21A).

2. Along the capsular plane the incision is developed in a plantar direction over the medial aspect of the tibial sesamoid. Great care is taken to identify the medial plantar cutaneous nerve, which often passes with a small vessel along the plantar aspect of the abductor hallucis tendon.

3. With the nerve identified and retracted plantarward, the periosteum over the tibial sesamoid is stripped to expose the plantar two thirds of the sesamoid. The plantar half of the tibial sesamoid is removed with a small oscillating saw, and the edges are smoothed (Fig. 8–21C and D).

4. The wound is closed in a routine manner and a compression dressing is applied (Fig. 8–21E and F).

Figure 8–20 Keratotic lesion beneath the tibial sesamoid. A, Even if there is only a moderate amount of callus over the lesion, once it is trimmed, a discrete keratotic lesion is usually identified. B, Radiograph demonstrates a tibial sesamoid centered beneath the metatarsal head. C, Axial view demonstrates a sesamoid sitting beneath the crista.
Figure 8–21 Tibial sesamoid shaving. A, Skin incision is made just below the midline and carried down to expose the joint capsule. The plantar medial cutaneous nerve is identified and retracted. B, After the tibial sesamoid is exposed, the plantar half is removed (s, sesamoid; f, flexor hallucis longus tendon). C, Appearance after excision of the plantar aspect of the tibial sesamoid. D, Excised piece of the tibial sesamoid. E and F, Axial and lateral radiographs demonstrate tibial sesamoid after removal of the plantar half. (C and D from Mann RA: Instr Course Lect 33:289, 1984.)
Postoperative Care

The patient is kept in a postoperative shoe with the foot in a firm dressing for 3 weeks and then is permitted to ambulate as tolerated.

Results

A follow-up study of 12 of our patients demonstrated that 58% had excellent results with no recurrent callus, 33% had good results with slight recurrence of the callus, and one patient (9%) had a fair result and required periodic trimming of the plantar callus. All patients maintained full range of motion of the first MTP joint, and none had a painful scar.

Complications

The most significant complication after this procedure is injury to the medial plantar cutaneous nerve. If this occurs and is noted at surgery, one must consider freeing up the nerve more proximally and moving it away from the plantar aspect of the foot. If the damage to the nerve appears to be too severe, one must consider whether the nerve should be sectioned and buried beneath the abductor hallucis muscle to prevent a neuroma from forming on the plantar medial aspect of the foot.

Further discussion of tibial sesamoid shaving is presented in Chapter 10.

Diffuse Intractable Plantar Keratosis

At times the second metatarsal is long because of the anatomic pattern of the foot. Whether a true plantarflexed metatarsal exists except after trauma has not been adequately demonstrated. A diffuse IPK beneath any lesser metatarsal head may be caused by a transfer lesion as a result of adjacent metatarsal osteotomy or trauma. A diffuse IPK beneath several metatarsal heads is mainly attributable to the lack of weight bearing by the first metatarsal and does not represent a surgical problem.

In attempting to be as precise as possible in the treatment of a diffuse IPK, if the offending metatarsal is long, it should be shortened to the level produced by a line connecting the two adjacent metatarsals (Fig. 8–22). This would mean that if the second metatarsal is long relative to the first and third, it should be shortened back to a line produced by connecting the first and third metatarsals. If a diffuse callus results because of a transfer lesion and the metatarsal is not long, we prefer to carry out a basal osteotomy to bring the metatarsal head to the same level as the adjacent metatarsals.

When a metatarsal osteotomy of any type is considered, it is imperative that a contracture of the MTP joint is not present. An MTP joint fixed in a dorsiflexed position can cause a painful plantar callosity that should be managed by correction of the MTP joint and not the metatarsal. In general, metatarsal osteotomies are contraindicated in the patient with a fixed deformity of the MTP joint, unless one is treating an MTPS deformity.

OBLIQUE METATARSAL OSTEOTOMY

The concept of the oblique metatarsal osteotomy was described by Giannestras, who produced a proximal step-cut osteotomy to shorten the symptomatic metatarsal. In his series of 40 patients, 10% developed a transfer lesion. Finding this surgical procedure technically difficult, we modified it to an oblique longitudinal osteotomy (Fig. 8–23). This is technically simpler and gives uniformly satisfactory results.

Surgical Technique

1. The skin incision is a long dorsal incision centered over the involved metatarsal. It is developed through subcutaneous tissue and fat, with great caution taken to identify and retract the cutaneous nerves. The involved metatarsal is identified, an incision is made over its dorsal aspect down to the bone, and the metatarsal is exposed subperiosteally (Fig. 8–24A).
2. If more than 5 to 6 mm of shortening is required, the transverse metatarsal ligament needs to be sectioned, particularly when dealing with the third and fourth metatarsals. This is usually not necessary for the second metatarsal.
3. Before the osteotomy is performed, a transverse mark is etched in the metatarsal at the midportion of the osteotomy so that as the osteotomy site is displaced, the surgeon can measure precisely how much shortening is occurring. With a thin saw blade, an oblique osteotomy as long as possible is produced in the metatarsal shaft. When an osteotomy is performed in the second metatarsal, the...
Figure 8–22  Metatarsal shortening. **A**, Line is drawn from first to third metatarsal head. This indicates the amount that the second metatarsal head needs to be shortened. **B**, Line is drawn between first and fourth metatarsal head to indicate the amount of shortening required to create a smooth metatarsal pattern.

Figure 8–23  Diagram of oblique metatarsal osteotomy of a lesser metatarsal to correct the weight-bearing pattern. (From Mann RA, Coughlin MJ: Video Textbook of Foot and Ankle Surgery. St Louis, Medical Video Productions, 1991.)
Short oblique osteotomy has been made. When carrying this out on the second metatarsal and 10 had an osteotomy of the second and third metatarsals. Pain was relieved in 31 of 32 patients, and there were no transfer lesions. The median time to radiographic union was 10 weeks. The authors pointed out that they carefully adjusted the metatarsal length radiographically, as well as carefully palpating the plantar aspect of the foot to judge whether or not the correct amount of shortening had been achieved. The mean radiographic shortening was 3.4 mm (range, 1 to 5 mm).

Results

Although we have not specifically reviewed our series of cases, we have noted that the main complication is a transfer lesion, which occurs in about 10% of cases. This is usually not because the metatarsal was shortened too much but because the distal fragment dorsiflexes several millimeters. Better internal fixation using two oblique screws can alleviate this problem.

A recent study by Kennedy and Deland used this procedure in 32 consecutive patients. Twenty-two patients had a single osteotomy of the second metatarsal and 10 had an osteotomy of the second and third metatarsals. Pain was relieved in 31 of 32 patients, and there were no transfer lesions. The median time to radiographic union was 10 weeks. The authors pointed out that they carefully adjusted the metatarsal length radiographically, as well as carefully palpating the plantar aspect of the foot to judge whether or not the correct amount of shortening had been achieved. The mean radiographic shortening was 3.4 mm (range, 1 to 5 mm).
Figure 8–25 Preoperative (A) and postoperative (B) radiographs demonstrate shortening of the second metatarsal to create a smooth metatarsal arch. Preoperative (C) and postoperative (D) radiographs demonstrate shortening of the third metatarsal after resection of the second metatarsal head to create a smooth metatarsal pattern. Preoperative (E) and postoperative (F) radiographs demonstrate shortening of the second metatarsal by means of screw fixation.
PART II

cussing this procedure do not say whether or not a keratosis. Furthermore, the articles discussed MTP joint, which, although producing shortening. This condition usually occurs after previous metatarsal surgery or a fracture.

BASAL METATARSAL OSTEOTOMY

The basal metatarsal osteotomy is used when a diffuse IPK is present and there is no metatarsal shortening. This condition usually occurs after previous metatarsal surgery or a fracture.

Surgical Technique

1. The skin incision is made over the dorsal aspect of the proximal half of the metatarsal and carried down through subcutaneous tissue and fat, with great caution taken to avoid the cutaneous nerves.
2. The dorsal aspect of the involved metatarsal is identified and an incision is made along the dorsal aspect of the metatarsal from about the midshaft area to the base. The periosteum is then stripped.

3. The site of the osteotomy should be just at the flare of the base of the metatarsal. If it is carried out much more proximal to this, the saw blade bounces off the adjacent metatarsals, and it is difficult to produce an accurate cut.
4. The size of the dorsally based wedge that is removed depends on the degree of depression of the metatarsal head. The involved metatarsal head usually needs to be elevated 2 to 4 mm, and thus the size of the base of the wedge should usually not exceed 2 to 3 cm. As the osteotomy is cut, an attempt is made to leave a plantar hinge intact.
5. We prefer to fix the osteotomy site by placing a 2.7-mm screw into the proximal portion of the base of the metatarsal, drilling a transverse hole distal to the osteotomy site, and then fixing these two points with a piece of 22-gauge wire. In this way the osteotomy site can be completely closed, with the metatarsal held in its precise position. There are other ways to fix the osteotomy site with a screw or pin, but we have found this technique to be the most reliable (Fig. 8–26).
6. The periosteum is closed, if possible, as is the skin. A compression dressing is applied.

Postoperative Care

The patient ambulates in a postoperative shoe until healing occurs in approximately 4 to 6 weeks. With the compression obtained by this method of fixation, we have had rapid healing of the osteotomy site and no nonunions. We have not tabulated our cases, but the postoperative incidence of transfer lesions is probably less than 5%, probably because in these cases, one can accurately produce the degree of dorsiflexion necessary to correct the problem. The only other potential problem with this procedure is entrapment of a dorsal cutaneous nerve, which can usually be avoided.

DORSIFLEXION OSTEOTOMY OF FIRST METATARSAL FOR PLANTAR-FLEXED FIRST METATARSAL

This procedure is described in Chapter 20.
Pedowitz, using a distal oblique osteotomy and early ambulation for a single plantar callus of unspecified type, reported good results in 83% of patients. He did note a 25% incidence of either residual keratosis or transfer lesions. Treatment of a single IPK by resection of a metatarsal head should be avoided except when an infection or chronic ulcer has occurred. Resection of a metatarsal head only leads to significant problems, including development of a transfer lesion beneath an adjacent metatarsal head, shortening and contracture of the involved toe, and, in general, significantly more problems than are solved (Fig. 8–27).

When two adjacent metatarsals are significantly longer than the others, as is occasionally noted after significant shortening of the first metatarsal with a bunion procedure, shortening of the two metatarsals may be considered. As mentioned previously, if the three middle metatarsals are long because of a short first metatarsal, the problem should not be approached surgically. Osteotomies that allow the metatarsal heads to float or to level the tread should be discouraged (Fig. 8–28). Internal fixation to accurately elevate or shorten a metatarsal is important.

**SUBHALLUX SESAMOID**

At times a midline callus is present beneath the great toe at the level of the interphalangeal joint. This callus can become quite large and can occasionally even ulcerate. The callus is caused by a subhallux sesamoid, which is a sesamoid bone lying just dorsal to the flexor
Surgical Treatment usually results in satisfactory resolution of the callus. If this fails, surgical intervention is required. A pad just proximal to the lesion to keep the pressure off the callus area. If this fails, surgical intervention is required.

Nonsurgical treatment involves placing a small felt pad just proximal to the lesion to keep the pressure off the callus area. If this fails, surgical intervention is required.

**Conservative Treatment**

Nonsurgical treatment involves placing a small felt pad just proximal to the lesion to keep the pressure off the callus area. If this fails, surgical intervention usually results in satisfactory resolution of the callus.

**Surgical Treatment**

**REMOVAL OF SUBHALLUX SESAMOID**

**Surgical Technique**

1. A longitudinal incision is made along the medial side of the hallux starting a little plantar to the midline. The incision starts at about the level of the MTP joint and is carried distally beyond the interphalangeal joint.
2. The skin flap is reflected plantarward, to the flexor tendon sheath, with some caution used because the plantar medial cutaneous nerve is in the plantar flap. The flexor hallucis longus sheath is identified and opened to expose the flexor tendon up to its insertion into the base of the distal phalanx.
3. The flexor tendon is retracted plantarward, and the sesamoid is noted on the dorsal aspect of the tendon just before its insertion into the phalanx. The sesamoid is carefully shelled out, with care taken not to detach the tendon from its insertion.
4. The wound is closed in a single layer and a compression dressing is applied.

**Postoperative Care**

The patient ambulates in a postoperative shoe for approximately 3 weeks until the soft tissue has healed, after which activities are permitted as tolerated.

**Results**

The results after excision of a subhallux sesamoid are uniformly satisfactory. The callus rarely, if ever, reforms. The only possible significant complication would result from inadvertently detaching the flexor hallucis longus tendon when the sesamoid is excised. This can be avoided by careful surgical technique.

![Figure 8–28](image-url) Complications after use of a high-speed bur to produce metatarsal osteotomies. A, Nonunions of six metatarsal necks. B, Radiograph of the left foot demonstrates abundance of new bone formation after the second metatarsal osteotomy. Radiograph of the right foot demonstrates nonunion through the second metatarsal head as well as joint involvement with osteotomy.
present with little or no subcutaneous fat left to provide a cushion between the skin and metatarsal head (Fig. 8–30A).

**Surgical Treatment**

Despite frequent trimmings, these lesions present a significant disability for the patient. When such a problem occurs, an elliptical incision of the area, undermining of the surrounding tissue, and meticulous closure have been used to produce a satisfactory result.

**SCAR EXCISION**

**Surgical Technique**

1. The area to be excised is carefully mapped out. The criteria for the size of the lesion to be excised are based on attempting to reenter soft fatty tissue, which will provide an adequate cushion for the metatarsal region (Fig. 8–30B). A full-thickness ellipse of tissue is removed and all the scar tissue is excised (Fig. 8–30C).
2. The skin margins are undermined, and the skin is closed in layers.
3. The initial closure is carried out with 2-0 chromic suture placed in the subdermal layers to bring the skin edges together. Then a near-far/far-near stitch is used to support the skin edge by relieving tension on either side of it. After this, a fine running stitch is used to keep the skin edges in perfect apposition and minimize scar formation. A compression dressing is then applied (Fig. 8–30D).

**Postoperative Care**

The patient is kept non-weight bearing for approximately 4 weeks to allow the soft tissues to heal with minimal stress. Usually the sutures are left in place 2 to 3 weeks.

**Results**

Although this technique is used infrequently, the results have been satisfactory. Occasionally the patient develops a minor callosity along the area of the scar tissue, but the procedure usually significantly relieves the pain created by the previous scar tissue.
SCARS ON THE PLANTAR ASPECT OF THE FOOT

Although plantar incisions for excision of an interdigital neuroma, procedures on the metatarsal head, and excision of the fibular sesamoid have been advocated in the literature, if an alternative incision is possible, it is preferable. Most plantar incisions heal benignly, but if a hypertrophic scar forms or the surrounding soft tissue atrophies, it can lead to an unsolvable problem. Most foot surgery can be carried out through a dorsal approach, and we strongly advise this, if possible. The fibular sesamoid can be removed through a dorsal incision in the first web space, which is preferable to the plantar incision. Interdigital neuromas and even recurrent neuromas can be removed through dorsal incisions rather than the plantar approach. At times the skin incision heals benignly, but the underlying fatty tissue unfortunately atrophies over a short period and leaves the patient with inadequate cushioning on the plantar aspect of the foot (Fig. 8–31).

If a plantar incision is used, the incision must be placed between the metatarsal heads to avoid a scar directly under a metatarsal.

HYPERTROPHIC PLANTAR SKIN

Some patients have hyperkeratotic skin, and these patients might not respond to removal of a bony prominence. This is not because the procedure was done incorrectly but because the patient has some type of a congenital skin disorder. Although the pressure has been relieved on the skin, the hyperkeratotic lesion might remain. The clinician should carefully examine the feet of the patient with a keratotic lesion to be sure this condition is not present (Fig. 8–32).
problems make it difficult for the patient to ambulate comfortably. Scars often become quite painful, sometimes from keratoses along the scar and at other times from atrophy of the fat pad. These scars often become quite painful, sometimes from keratoses along the scar and at other times from atrophy of the fat pad. These scars often become quite painful, sometimes from keratoses along the scar and at other times from atrophy of the fat pad. These scars often become quite painful, sometimes from keratoses along the scar and at other times from atrophy of the fat pad. These scars often become quite painful, sometimes from keratoses along the scar and at other times from atrophy of the fat pad.

**OSTEOCHONDROSIS OF A METATARSAL HEAD**

Osteochondrosis of a metatarsal head (Freiberg’s infraction) most often occurs in the second metatarsal head in adolescents and is most likely the result of an ischemic necrosis of the epiphysis. It is seen more often in girls.

The clinical complaint is usually pain and limitation of motion of the affected joint. The symptom complex is aggravated by activities and often relieved by rest. Physical examination demonstrates generalized thickening about the second MTP joint secondary to the synovitis. There is often some increased warmth. The joint demonstrates restricted motion secondary to pain.

**Diagnosis**

The diagnosis is confirmed by radiographs demonstrating osteosclerosis in the early stages and osteolysis with collapse in the later stages. At times in the early stages a central collapse is noted, and as the condition burns out, significant collapse often occurs with new bone formation (Fig. 8–33).

**Treatment**

Treatment is directed initially toward protection and the alleviation of discomfort. Early in the course of the disease, particularly if no significant distortion of the head has occurred, a short-leg walking cast or a stiff postoperative shoe to decrease the stress across the involved joint is indicated. As the disease process progresses or if the patient is seen after the acute phase has passed and the main problem is that of increased bone formation and restricted motion, surgical intervention may be of benefit. Surgery consists of debridement of the joint and excision of the proliferative bone (video clip 38).

**Figure 8–31** Painful plantar scars. A and B, Incisions that have been used to excise an interdigital neuroma. Unfortunately these scars often become quite painful, sometimes from keratoses along the scar and at other times from atrophy of the fat pad. These problems make it difficult for the patient to ambulate comfortably. C, Hypertrophic scar after plantar incision to remove a fibular sesamoid. There is no good remedy for this situation.

**Figure 8–32** Examples of feet with hyperkeratotic skin.
**EXCISION OF PROLIFERATIVE BONE**

**Surgical Technique**

1. The joint is approached through a hockey stick–shaped incision starting in the second web space. The incision is carried obliquely across the metatarsal head and over the dorsal aspect of the metatarsal shaft (Fig. 8–34A).

2. The incision is deepened to expose the extensor tendons, which are split to enable one to dissect the extensor hood off the underlying synovial tissue. By sharp dissection, the synovial tissue is removed and the joint is inspected (Fig. 8–34B).

3. If proliferative bone is present around the metatarsal head, it is generally removed, similar to the procedure for cheilectomy to treat hallux rigidus. The mediolateral bone is removed in line with the sides of the metatarsal, and the dorsal 20% to 30% of the metatarsal head is resected (Fig. 8–34C and D). If necessary, new bone that has formed around the base of the proximal phalanx is excised, although this occurs infrequently.

4. At this time approximately 75 to 80 degrees of dorsiflexion should be possible at the MTP joint. If this has not been achieved, more bone probably needs to be resected.

5. The extensor mechanism is closed, the skin is closed in a single layer, and a compression dressing is applied.

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**Figure 8–33** Radiographs of Freiberg’s infraction. A, Early stages demonstrate osteolysis and central collapse. B, Later stages of Freiberg’s infraction demonstrate central collapse and osteolysis.
Figure 8–34  Surgical technique for debridement of Freiberg’s infraction. Clinical photo (A) and radiograph (B) showing huge osteophyte formation (arrow) at the third metatarsophalangeal joint. C, Operative exposure. D, Removal of distal free fragment.
Postoperative Care

The patient is maintained in a firm dressing and postoperative shoe for approximately 10 days, until the wound has healed. The patient is then started on active and passive range-of-motion exercises to gain as much motion as possible.

Results

With this technique, satisfactory symptomatic relief can usually be achieved. In general, the patient will not regain as much active motion, but passively the MTP joint has sufficient flexibility that satisfactory function of the foot can be restored.

Although some have advocated excision of the metatarsal head or replacement with a prosthesis, we do not believe this procedure is indicated for this condition.

At times the only problem is a loose fragment, and this can be debrided without the necessity of excising any other bone.

REFERENCES