Tumors of the foot and ankle are rare.1-7,10,12,15,16 In the senior author’s experience, 153 cases were treated. 

■ **BACKGROUND**

- **Anatomy**
  - The Lisfranc joint is the tarsometatarsal joint. An amputation at this level will preserve the dorsiflexors and plantarflexors.

- **Background**
  - Tumors of the foot and ankle are rare. In the senior author’s experience, 153 cases were treated.
  - **Figure 1A** shows all anatomic sites, **Figure 1B** shows the distribution of malignant and benign cases, and **Figure 1C** shows the distribution of all types of surgical procedures.
  - Patients with tumors of the metatarsals complain of pain with an associated mass. The mass may be small and chronic. It may be first noticed after a minor injury. The patient may have difficulty with weight-bearing activities, including walking and standing. Shoe wear, particularly fashionable shoes, may be limited.
  - Physical examination often shows a tender mass localized to the metatarsal with some swelling. If a sensory nerve overlies the mass, there may be paresthesias. If the mass is large, there may be loss of motion, or discomfort with active range of motion of the foot and ankle.
  - For extensive disease of the forefoot involving the first and second interspace in adjacent metatarsals or multiple metatarsals, a Lisfranc amputation or a transmetatarsal amputation is indicated (**Figure 2A–C**). These amputation levels are highly functional with minor shoe-wear modifications and forefoot fillers. If the metatarsal bases can be preserved using a transmetatarsal amputation, the functional outcome is improved.
  - Careful preoperative evaluation is necessary, and MRI is especially important to assess the extent of marrow change in the metatarsals to ascertain the appropriate level of amputation.
  - For tumors extending to the tarsometatarsal joint with soft tissue extension, a Chopart amputation is a consideration. The Chopart amputation is a transarticular amputation that preserves the talus and calcaneus. The disadvantage of the Chopart amputation is the loss of the dorsiflexors of the foot, which allows unopposed action of the Achilles tendon, resulting in an equinus contracture.
  - To circumvent this problem, the tibialis anterior is used. It is detached from the tarsal navicular with a cuff of soft tissue, preferably periosteum. A drill hole is made through the neck and head of the talus in an oblique fashion from dorsolateral to plantar-medial. The tendon is then routed through this bone tunnel and sewn to itself or soft tissue as it exits through the tunnel. This repair may be augmented with bone anchors placed near the dorsal opening of the tunnel. The residual foot is maintained in maximal dorsiflexion (**Figure 2D, E**).
  - The advantage of a Chopart amputation over a Syme amputation is the maintenance of hindfoot height. This is an end-bearing residual limb and the patient can negotiate short distances without modified shoe wear or prosthetic fitting.

- **Indications**
  - **Lisfranc**
    - Extensive tumor involving the first and second interspace in adjacent metatarsals or multiple metatarsals
  - **Chopart**
    - Tumors extending to the tarsometatarsal joint with soft tissue extension. **Figure 3** shows the pathology specimen after wide resection of a chondrosarcoma involving multiple small bones of the foot.

**Imaging and Other Staging Studies**

- Preoperative studies include plain radiographs of the foot, including anteroposterior, lateral, and oblique views. If there is involvement of the ankle joint, then anteroposterior and mortise views are obtained as well. MRI is important to evaluate the amount of involvement of the metatarsals to determine the level of amputation. It also shows the extent of soft tissue tumors and may be helpful in distinguishing benign from malignant tumors.1,17
- MRI is helpful for assessing soft tissue involvement. **Figure 4A, B** shows a chondrosarcoma of the calcaneus, and the MRI shows extension into the soft tissue. It was treated with cryosurgery but recurred, and a below-the-knee amputation was performed.
- **Figure 4C, D** shows an example of a unilateral calcaneal brace (UCB). The radiograph shows the typical expansile appearance of the UCB. The CT scan shows greater bony detail. The lesion was treated with curettage, graft, and polymethylmethacrylate (PMMA).

**Surgical Management**

- The goal of the surgical procedure is remove the tumor with adequate margins. **Figure 5** illustrates a case of osteosarcoma of the calcaneus. Osteosarcoma is usually treated with wide resection, but in this case the tumor was confined to the calcaneus. The patient had a good response to adjuvant chemotherapy, with 100% tumor necrosis, and was treated with the only calcaneal prosthesis reported in the world.
- A long plantar flap is important for a sturdy end-bearing stump.
- The quality of the tissue is more important than the quantity.1
- The bony edges should be smooth and beveled if possible. An example is the Lisfranc amputation, in which the cuneiforms
FIG 1 • A. All anatomic sites of tumors of the foot and ankle (n = 153). B. Distribution of malignant and benign tumors of the foot and ankle (n = 153). C. Distribution of surgical procedures for tumors of the foot and ankle (n = 153).

FIG 2 • Chopart amputation has a poor reputation because many patients develop an equinus contracture. With transfer of the tibialis anterior to the neck of the talus, this problem can be avoided. This case is an example of synovial sarcoma involving the forefoot. A. This patient’s radiographs showed radiodensity surrounding the second metatarsal, a typical radiographic appearance of a synovial sarcoma. B, C. MRI shows extensive soft tissue mass. The patient was treated with a Chopart amputation. (continued)
D. Postoperative photograph shows good dorsiflexion function. E. Chopart amputation can be successful with the transfer of the tibialis anterior into the talar neck. This patient also had a Marcaine catheter placed for postoperative pain control (A).

FIG 3 • Chondrosarcoma can spread to involve multiple sites. This photograph shows the pathology specimen after a below knee amputation of a chondrosarcoma involving multiple small bones of the foot.

FIG 4 • Chondrosarcoma of the calcaneus. A,B. MRI shows extension into the soft tissue. It was treated with cryosurgery but recurred, and a below-knee amputation was performed. C,D. UCB of the calcaneus. The radiograph shows the typical expansile appearance of the UCB. The CT scan shows greater bony detail. The lesion was treated with curettage, graft, and polymethylmethacrylate.
should be contoured to a rounded end. In a Chopart amputation, the talus and calcaneus should be cut and contoured to fit a prosthesis.

- Myodesis is helpful to pad the end of the stump.
- Reconstruction of the anterior tibialis tendon insertion into the neck of the talus in the Chopart amputation will help prevent an equinus contracture.

Preoperative Planning
- Preoperative planning is crucial for a good outcome. The preoperative radiographs and CT and MRI studies are important to determine the amount of tumor involvement. The results of the biopsy will determine the level of amputation.

Positioning
- The patient is placed supine on the operating table. A thigh tourniquet is placed over adequate padding, such as Webril. A bump may be placed proximal to the sciatic notch on the ipsilateral hip to limit external rotation of the extremity during the procedure.

Approach
- Lisfranc and transmetatarsal amputations are performed through a midfoot incision, with a long plantar flap. This is the same approach with the Chopart amputation. The plantar skin is thicker and has specialized columns of plantar fat to provide for a weight-bearing stump.
LISFRANC AMPUTATION

- A transverse incision is made either at the middle or proximal third of the metatarsals, extending through skin into the subcutaneous tissue (TECH FIG 1C,D).
- The cutaneous branches of the terminal portions of the peroneal nerve are identified. Traction is applied, pulling the nerve distally. The nerve is transected sharply to allow it to retract proximally.
- The terminal branch of the dorsalis pedis artery is ligated and divided as it enters the first dorsal interspace and courses in the plantar fascia.
- The extensor tendons are placed on a stretch; this is best accomplished by flexing the forefoot and sharply dividing the tendons at the level of the skin incision, allowing the tendons to retract proximally.

FOOT AND ANKLE AMPUTATIONS: LISFRANC/CHOPART TECHNIQUES

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TECHNIQUES

- The Lisfranc joint is disarticulated sharply. A plantar flap is fashioned by extending the incision through the skin approximately 45 degrees from the transverse dorsal incision obliquely across the medial and lateral foot to the level of the distal metatarsals.
- The sensory nerve to the first ray is identified, traction is placed, and the nerve is transected sharply. The terminal branches in the medial plantar nerve are identified, placed on stretch, and sharply divided.
- The terminal branches of the medial plantar artery are identified, ligated, and divided. The superficial and deep flexor tendons are placed on stretch by dorsiflexing the forefoot through the Lisfranc joint and sharply dividing them, allowing them to retract proximally. No attempt is made to suture the extensor tendons to the flexor tendons.
- If there is a significant plantar extension of the tumor, a long plantar flap cannot be used. In this case, a fish-mouth configuration is preferable. To achieve this, equal dorsal and plantar flaps are constructed and the same operation is carried out as indicated above.
- The tourniquet is deflated and meticulous hemostasis is obtained. Excessive use of cautery to obtain hemostasis is discouraged to limit dysvascularity of the plantar flap.
- The plantar flap is brought up and myodesed to the tarsal bones. Alternatively, the plantar fascia can be sewn into the periosteum overlying the capsular structures in and around the tarsal bones. The skin is closed with 4-0 nylon sutures, and a small drain is placed deep to the flap and brought out either medially or laterally through the incision.

CHOPART AMPUTATION

- The Chopart amputation is performed through a transverse incision that is dorsally based at or just distal to the talonavicular joint (TECH FIG 1E,F).
- The dorsalis pedis artery and accompanying nerve are identified. The dorsalis pedis artery is ligated and divided, and the sensory nerve is placed on stretch and transected sharply, allowing it to retract proximally.
- The capsule of the talonavicular joint is circumferentially divided, along with release of the posterior tibial tendon. This tendon is tagged for later use as it is brought...
A corticotomy is made using a drill to open the lateral wall of the calcaneus. The tumor is opened, which allows for the curettage. Large curettes are used to remove the obvious tumor material. This is followed by inspecting and burring the edges of the remaining calcaneal wall. Once the resection is completed, the cavity is irrigated to again inspect the cavity for remaining tumor.

The posterior tibial tendon and the flexor hallucis longus and brevis tendons are divided; the tendons are allowed to retract proximally unless the posterior tibial tendon is used to augment the dorsiflexion repair.

The plantar branch of the posterior tibial artery is located, ligated, and divided. The flaps are maintained with sufficient soft tissue to keep them as thick as possible to prevent devitalization of the skin.

If the head of the talus is prominent, a portion of this bone can be removed in a beveled fashion by using an oscillating saw and angling the blade 30 degrees from distal proximal to plantar distal. The calcaneocuboid articulation is generally divided, but if part of the cuboid can be maintained, this is preferable. Contouring the distal talus and calcaneus will help to decrease the size of the stump, and this will help with prosthetic fitting.

The repair of the plantar soft tissue to the dorsal soft tissue is tenuous as there is no stout tissue dorsally to anchor the plantar flap. For this reason, a myodesis is preferred; it is performed by drilling holes in the distal talus and residual cuboid and anchoring the plantar fascia to the dorsal residual bone with 0 nonabsorbable suture. The subcutaneous tissue is approximated with 3-0 absorbable sutures and the skin repaired with 4-0 nylon suture.

The residual foot must be maintained in as much dorsiflexion as possible. To help achieve this, a rigid dressing is applied by binding the residual foot from a proximal-distal-dorsal direction and applying gentle but firm compression on the residual foot. This rigid dressing is applied and extended up to the proximal leg, maintaining the residual foot and ankle in a maximally dorsiflexed position to protect the repair.

CURETTAGE AND CRYOSURGERY OF THE CALCANEUS

A sciatric nerve catheter is used for intraoperative and postoperative pain control. General anesthesia is used for the procedure. The patient is placed into the lateral decubitus position with the affected side up. A tourniquet is placed on the upper thigh. After sterile surgical preparation and draping, an L-shaped incision is made from the tip of the fibula posteriorly and anterior to the Achilles tendon. The incision is parallel to the fibula, extending distally and making a curve at the border between the dorsal and plantar skin of the calcaneus laterally.

The initial skin is incised using the scalpel and dissection is carried down through the subcutaneous tissue. The incision and approach are inferior to the peroneal tendons, which remain safely superior to the dorsal fasciocutaneous flap. The sural nerve is also more superior and away from the operative field. The lateral wall of the calcaneus is exposed.

A corticotomy is made using a drill to open the lateral wall of the calcaneus. The tumor is opened, which allows for the curettage. Large curettes are used to remove the obvious tumor material. This is followed by inspecting and burring the edges of the remaining calcaneal wall. Once the resection is completed, the cavity is irrigated to again inspect the cavity for remaining tumor.

To do the cryosurgery, the tourniquet is inflated to 350 mm Hg. Gelfoam is used to line the skin edges and subcutaneous tissue around the wound site. The retractors are placed over the Gelfoam, and laparoscopic tape sponges are placed around the skin to cover the skin. The foot is placed into a basin of warm water to try to keep the foot warm to prevent any problems that the decreased temperature from the cryosurgery may cause in the uninjured portions of the foot. Normal saline is poured into the tumor cavity. Endocare cryosurgery probes are prepared on the back table. Ice balls are formed and noted at the tip of each of the probes. Three- and 5-mm probes are used for the cryosurgery. The cryoprobes are placed into the tumor cavity and left in to complete a 10-minute cycle. The skin is monitored for necrosis, and warm saline is used to keep the skin warm and supple. The cavity is allowed to thaw and the tourniquet is deflated.

The reconstruction portion of the procedure consists of an allograft cancellous bone block from the bone tissue bank that is cut and contoured and placed against the subchondral surface adjacent to the subtalar joint. Two small Rush rods are cut, contoured, and placed within the calcaneus to extend from the subtalar joint, abutting and holding the allograft in place. PMMA is mixed
with 1 g vancomycin on the back table and prepared by hand mixing. This is placed into the tumor cavity to fill the cavity, completing the reconstruction. The midfoot and forefoot are taken through gentle range of motion to ensure normal movement of these joints and to make sure that there was no iatrogenic extrusion of cement, which could compromise the motion of these joints. Also, the calcaneus is gently axially loaded with hand pressure to ensure that the reconstructed calcaneus moves as a single unit. A drain is placed, and the wound is closed in layers. A plaster splint is used.

**SYMES AMPUTATION**

- The incision extends from the anterior aspect of the lateral malleolus to the anterior aspect of the medial malleolus, continuing to the plantar skin. The incision at the plantar flap is made to the level of the calcaneocuboid joint. The soft tissues, including tendons, are incised and allowed to retract; the neurovascular bundle is identified and ligated. The talus and calcaneus are dissected sharply and removed.

- The surgeon must be cautious at the point of the Achilles tendon insertion site: the skin is thin and adherent and must be protected.

- The flares of the malleoli are removed with a sagittal saw. The plantar fat pad is fixed to the end of the stump with nonabsorbable sutures into drill holes of the distal tibia and fibula.

- A drain is placed and the wound closed in layers; 3-0 nylon suture is used to repair the skin. A well-padded soft dressing is applied.

**PEARLS AND PITFAILS**

<table>
<thead>
<tr>
<th>Indications</th>
<th>■ A careful and complete history and physical examination are essential. Preoperative studies are necessary to plan the resection and reconstruction.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical incision</td>
<td>■ A long plantar flap results in a better end-bearing stump. The natural cascade of metatarsal lengths should be maintained.</td>
</tr>
<tr>
<td>Wound healing complications</td>
<td>■ Local wound care with dressings and oral antibiotics are usually sufficient to allow for healing.</td>
</tr>
<tr>
<td>Deep infection</td>
<td>■ Parenteral antibiotics and surgical débridement may be necessary to treat deep infections. Early diagnosis and treatment can affect outcome.</td>
</tr>
<tr>
<td>Contractures</td>
<td>■ Postoperative splinting can help prevent contractures. Once a contracture occurs, it is treated with stretching if mild. Serial casting may be needed.</td>
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</table>

**POSTOPERATIVE CARE**

- Postoperative pain control will allow early mobilization of the patient. Wound healing without complications and prevention of contractures, particularly equinus contractures, are vital.¹

- For the Lisfranc and transmetatarsal amputations, a rigid postoperative dressing is used. The wound is dressed with nonadherent dressing gauze. A gauze roll is used to bind the residual foot. Cotton padding is then placed in strips from the hindfoot to the forefoot from plantar to dorsal in an attempt to reduce the tension on the suture line. The heel is well padded with cotton padding, and then a plaster cast is applied. The cotton padding may have elastic in it for built-in stretch. The plaster is also applied from proximal and plantar to dorsal and dorsal to reduce the tension on the suture line. The plaster application should be firm but not tight. It should be placed in closed-toe fashion and should extend up to the proximal leg, maintaining the residual foot in the neutral position to a slightly dorsiflexed position.

- This initial dressing is changed after 3 to 5 days and the Penrose drain is removed with the first dressing change. A similar plaster is applied for an additional 2 weeks. At the time of plaster removal, the sutures are removed. The patient is given a prescription for a shoe filler.

- After 2.5 weeks, the patient’s foot is placed in a buckle-wedge shoe for an additional 3 to 4 weeks. After that, shoe wear and progressive ambulation are encouraged.

- After a Chopart amputation, the cast is removed after 5 days and the drain is removed. A second dressing and cast are applied for about 3 weeks. The second cast is removed and the sutures are removed at the end of the 3 weeks. A third cast is applied and maintained for 6 to 8 weeks. After the final cast is removed, the patient begins physical therapy to begin range of motion, in particular dorsiflexion and plantarflexion excursion of the residual foot. A prosthetic measurement is taken.

**OUTCOMES**

- Patients with a Lisfranc, transmetatarsal, or Chopart amputation have good overall function compared with patients with a Syme amputation.⁵,¹¹,¹⁴ However, patients with an equinus contracture after a Chopart amputation have inferior results.⁵,⁸

- A Chopart amputation in a young patient is inferior in function to a Syme amputation due to the lack of ability to replace forefoot function when the space between the floor
and the plantar surface is reduced significantly in a Chopart amputation.

- The Chopart procedure provides an excellent level of amputation for a patient with limited activities and goals. The main advantage to this level is that little is lost between the distal end of the residual limb and the floor. This allows ease of ambulation without the need for a prosthetic device.

- For persons requiring short trips to the bathroom in the middle of the night or stability for transfers, the Chopart level is perfect. Unfortunately, the lack of anatomic structure and minimal distance from the plantar surface to the floor makes the Chopart amputation a poor choice for the active amputee.

- Ambulation is achieved with a foot spacer. For the Chopart stump, a clamshell type of prosthesis allows good weight-bearing function and restores the effective foot length.

- Generally, patients are able to ambulate 3 months after amputation using a simple shoe prosthesis.

- Gait analysis shows that abnormality and asymmetry of ground-reaction forces were less with a greater preserved stump length.

**COMPLICATIONS**

- Wound healing complications are treated with local wound care, elevation, and non-weight bearing. Oral antibiotics may be indicated. If there is skin flap necrosis, débridement with a skin graft may be necessary.

- Superficial infection is often resolved with a short course of oral antibiotics.

- Deep infection may require immediate operative débridement of devitalized tissue. Parenteral antibiotics are important to treat this limb-threatening problem. At the time of the débridement, a bone culture should be ordered to help determine the appropriate antibiotic.

- Equinus contracture is most easily treated by prevention. However, stretching with a therapist may be helpful. Serial casting may be required to correct the deformity.

**REFERENCES**


