Clinics in Surgery

Research Article
Published: 18 Jul, 2019

Chopart Amputation for Ewing's Sarcoma of the Metatarsal in a Pediatric Patient: Technique and Pearls

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Abstract

A 9-year-old female presented with non-metastatic Ewing's sarcoma of the third metatarsal isolated to the forefoot. After neoadjuvant chemotherapy, she underwent a Chopart amputation - a partial amputation of the foot at the level of the transtarsal joint. The Chopart amputation has been shown to have equivalent if not slightly better outcomes than the more common Syme amputation in pediatric patients. However, the Chopart amputation has sometimes been considered less favorable due to the development of equinus deformity. There are specific technical aspects of the procedure that help to minimize development of equinus, including performing tendon transfers of the ankle dorsiflexors to the talar neck through transosseous tunnels in addition to performing a tenotomy of the Achilles tendon. In this article, we discuss the case of a pediatric patient who underwent a Chopart amputation, we compare alternative partial-foot amputation options, and we detail technical pearls to optimize outcomes.

Introduction

A 9 year old female presented with five weeks of foot pain. A plain radiograph revealed a sizeable destructive lesion in the third metatarsal (Figure 1) that was soon diagnosed by biopsy to be Ewing's sarcoma. Staging was negative for distant metastasis and MRI demonstrated local spread to the adjacent metatarsals and tarsal-metatarsal joint (Figure 2). The transtarsal level was determined to be the most distal site for an amputation that would confidently produce tumor-free margins. Syme and the Chopart amputations were presented to the patient and her family as the most reliable procedures to address the malignancy while optimizing functional outcome. After extended discussion of the relative benefits and drawbacks of each procedure, the patient's family chose to proceed with a Chopart amputation in order to preserve as much of the native foot as possible. Cases of Ewing's Sarcoma (ES) involving the metatarsals are exceedingly rare and there is limited evidence in the literature to guide management for this specific location [1]. ES has an estimated prevalence of three cases per million, with less than 0.5% involving the metatarsals [2,3]. ES of the mid foot and forefoot in the absence of metastasis have a generally good prognosis with combined chemotherapy and wide-excision [1,4-9]. Greene et al., [10] reported that pediatric patients undergoing foot amputations at the Chopart level had marginally better outcomes than those following a Syme amputation, or ankle disarticulation. Both groups in their study did quite well with preserved ability to perform activities of daily living and minimal gait adjustments necessary when ambulating using prosthesis. The Chopart group was noted to have better outcomes when walking without prosthesis due to the preserved leg length and plantar heel structures. However, the Chopart-level amputation carries a risk of developing equinus contracture due to an imbalance of muscle tension that results from removing the navicular bone and forefoot where the primary ankle dorsiflexors insert while the calcaneal and the insertion of the gastroc-soleus complex remain intact. Patients who develop equinus deformity after Chopart amputation were shown to have inferior outcomes compared to a Syme amputation with a tendency to develop recurrent knee hyperextension leading to genus recurvatum and disruption of gait mechanics that decrease physical endurance and overall activity level [11]. While the Chopart amputation provides a more favorable plantar foot surface for ambulation without prosthesis, the shortened lever arm of the residual foot is less energy efficient than ambulating with prosthesis. This is one area where the Syme level amputation is advantageous compared to the Chopart as the space between the end of the residual limb and the floor where the hind foot structures were removed provides room for prosthesis. The maintained leg length of the Chopart amputation then becomes a hindrance as fitting the prosthesis adds length to the limb and may necessitate a contralateral shoe lift. The authors have obtained the patient's informed consent

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Received Date: *05 Jun 2019*
Accepted Date*: 11 Jul 2019*
Published Date*: 18 Jul 2019*

Citation:
Honstad C, Fox E, Hennrikus W. Chopart Amputation for Ewing's Sarcoma of the Metatarsal in a Pediatric Patient: Technique and Pearls. Clin Surg. 2019; 4: 2514.

Figure 1: Plain radiograph of the right foot demonstrating an expansive lytic lesion of the third metatarsal with periosteal reaction.

Figure 2: Axial proton density FRFSE sequence of the right foot showing large soft tissue component of the third metatarsal mass with expansion beyond the cortical margins and proximal extension to the tarsal-metatarsal junction.

for publication of the case report.

Surgical Technique

The patient was positioned supine on a radiolucent table, a tourniquet was applied to the operative leg, and the foot was prepped and draped in standard fashion. The transtarsal joint was identified fluoroscopically using a c-arm. A skin incision was made transversely across the dorsum of the foot overlying the navicular and extended to the medial and lateral glabrous skin junctions. Dorsal neurovascular structures were identified. The dorsal is pedis artery was ligated at the level of the incision. Branches of the deep and superficial peroneal nerves were tensioned, ligated, and allowed to retract. An incision across the plantar surface of the foot was made approximately 2/3 of the distance to the distal fore foot in order to create a plantar flap with enough length to wrap over the anticipated stump to meet the dorsal incision. Care was taken during creation of the plantar flap to preserve the structural integrity of the plantar fat pad superficial to the facial layer while avoiding disruption of the underlying musculature of the distal, amputated margin in order to maintain the tumor boundary. Next, the anterior compartment tendons were identified, including Tibialis Anterior (TA), Extensor Hallucis Longus (EHL) and Extensor Digitorum Longus (EDL). These were each dissected and resected out as far distally as possible without compromising tumor margins and

Figure 3: Intra-operative photograph demonstrating EHL and EDL tendons passed through the talar neck transosseous tunnels, tensioned with the foot in maximal dorsiflexion. Note the long plantar flap with preserved heel pad structures.

Figure 4: Intra-operative photograph after disarticulation of the talonavicular and calcaneocuboid joints and tensioning of the anterior tendons through the talar neck.

were each tagged with suture. Laterally, the sural nerve was identified, tensioned, transected, and allowed to retract. The peroneal tendons were also transected and allowed to retract. Medially, the Posterior Tibialis (PT) tendon was identified and followed distally to identify the talonavicular joint. The joint was opened using electrocautery and dissected from medial to lateral, extending into the calcaneocuboid joint. This was continued until disarticulation of both joints was achieved. Long and short toe flexors were transected and allowed to retract. The PT tendon was then transected and allowed to retract. The tibial nerve was tensioned, transected, and allowed to retract. All sites of nerve transection were injected with bupivacaine. The posterior tibial artery was then ligated and cut. Dissection was continued inferiorly to the fascial layer and then distally along the subfascial plane to the initial transverse plantar incision to create the plantar flap, which now consisted of fascia, subcutaneous tissue, and plantar skin. Once this was completed, the forefoot specimen was free from all attachments and was sent to pathology for permanent sections. Frozen section specimens were also sent at this time taken from multiple locations of the proximal and distal aspects of the surgical wound. After negative margins were confirmed, we turned our attention to reconstruction. The inferior distal edges of the calcaneal and talus were trimmed back using a sagittal saw to provide a more even, rounded surface. Two transosseous tunnels were made horizontally through the neck of the talus using sequentially larger drill bits and curettes. Tunnels were approximately 2 cm in length. The previously tagged TA tendon was passed through one of the drill holes from medial to lateral, folded back onto itself, tensioned to provide maximal dorsiflexion, and sutured in place with ethibond suture. The EHL and EDL tendons were then each passed through the second drill hole in opposing directions. The distal EHL tendon was folded back onto the more proximal EDL tendon, tensioned, and

Figure 5: Intra-operative photograph after plantar flap approximated to the dorsal skin edge.

Figure 6: Two-year follow-up photographs of healed foot stump and corresponding lateral radiograph. Note the neutral position of the residual hind foot.

sutured into place and *vice versa* with the distal EDL tendon sutured to the proximal EHL segment. Additional sutures were placed in the soft tissue surrounding the drill holes and attached securely to the tendons close to the site of their emergence from the drill holes for reinforcement of the repair. The wound was irrigated and a deep surgical drain was placed. The plantar flap was folded superiorly and approximated with the dorsal incision with ample soft tissue coverage over the anterior bony prominences. Soft tissues were approximated with vicryl sutures. The skin was closed with nylon interrupted sutures. An Achilles tenotomy was then performed. A 2 cm posterolateral incision was made overlying the tendon. The tendon was isolated through the incision using a Kelly clamp and sharply divided with a scalpel. All incisions were closed and all wounds were covered with bacitracin ointment and sterile dressings. The remnant foot was noted to be well balanced and a plaster splint was applied to maintain a neutral position. Post-operatively, that patient was non-weight bearing on the affected extremity and ambulated with crutches to allow adequate soft tissue healing. Adjuvant chemotherapy was delayed and skin sutures were retained for five weeks to allow wound healing. The patient has been followed for three years post-operatively without evidence of disease recurrence or post-operative complication. She continues to have a plant grade foot without development of equinus contracture. She ambulates in her prosthesis without a limp.

Discussion

François Chopart (1743 to 1795) was a French surgeon credited with first describing the transtarsal disarticulation that we know today as the Chopart amputation. He was a professor of anatomy and surgery, best known during his time for his work on a renowned, widespread surgical textbook. In 1791, he successfully treated a forefoot tumor in a young man by utilizing his advanced knowledge of anatomy in performing a transtarsal amputation. He is believed to have only performed the procedure once, and while he never personally described the technique formally, one of his pupils would go on to credit him with the procedure in a later publication. This eventually led to the eponym for the transtarsal joint and the procedure that bear his name today [12]. The Chopart-level amputation has been shown to have similar functional outcomes as the Syme amputation in pediatric patients, although it carries the risk of developing equinus contracture [11]. In order to prevent equinus, the tendons of the TA, EHL, and EDL can be preserved and transferred to the talar neck through transosseous tunnels (as demonstrated in Figures 3 and 4) to maintain anterior tension on the residual stump. In addition, tenotomy of the Achilles tendon helps to balance the ankle by weakening the deforming plantar flexion force of the gastroc-soleus complex. The Chopart amputation also has the advantage of preserving the native plantar foot pad better than the Syme with fewer skin complications with weight-bearing. Despite this, Chopart still carries the possibility of posterior heel pad migration and development of anterior bony prominence, both of which can lead to skin breakdown [13]. In our patient, these risks were minimized by maximal preservation of the native plantar surface and trimming of the distal inferior edge of the talus and calcaneal. There are several prosthetic options available after Chopart amputation. Simple shoe inserts are usually ineffective as there is little structural support to hold a normal shoe on to the residual limb. A rigid tibial-tubercle-height prosthesis or an Ankle-Foot Orthosis (AFO) that uses the more proximal leg for stability and distributes weight throughout the leg is typically better options. A semi-rigid foot plate can be added to lengthen the lever arm of the foot and improve force transmission during gait. Compared to a Syme-level amputation, the residual hind foot after Chopart amputation provides a superior weight bearing surface for ambulation during low-demand activities when prosthesis is not being used. However, the additional length added to the limb by the residual hind foot does not allow space between the limb and the floor as would be the case with a Syme amputation. This can make prosthetic fitting more challenging and may necessitate a shoe-riser on the contralateral leg in order to compensate for the added height of prosthesis [14]. After 3.5 years of follow-up, our patient has not required any intervention to address this issue; however, atibial epiphysiodesis can be considered as the patient approaches skeletal maturity to shorten the leg and allow space for prosthesis. The Chopart amputation has a maximal functional outcome very similar to the Syme but carries the risk of equinus deformity. In our patient, the Chopart was chosen because it offered clear margins for the removal of the Ewing's sarcoma of the metatarsal with maximal preservation of foot length, which was cosmetically important to the patient's family. To obtain a good functional outcome after Chopart amputation, it is crucial to balance the foot and avoid equinus deformity while maintaining the heel pad to avoid skin breakdown. If the patient does develop deformity after a Chopart amputation despite these efforts, ankle fusion or surgical revision, including amputation at the Syme level, may be considered.

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