The Modified Boyd Fusion: An Uncommon Limb Salvage Procedure

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Statement of Purpose

The purpose of this case series is to share our surgical technique of a Modified Boyd fusion, consisting of a Chopart amputation combined with a tibiotalocalcaneal arthrodesis using an intramedullary nail. We hypothesize that the Boyd Modification affords the patient a stable weight-bearing platform while maintaining maximum limb length. Our configuration allows for functional ambulation and braces the limb, preventing the devastating biomechanical complications, which commonly plague solo Chopart amputations. Presented here are several cases where utilizing this technique provided successful results.

Literature Review

- It is well-proven in literature that more distal amputation sites provide better outcomes for the patient. The primary benefit of a distal amputation level is the decreased metabolic demand for postoperative ambulation and ability to ambulate without needing a prosthesis. These salvage techniques provide a better prognosis for the patient, increasing the patient's life span and quality of life [1,4].
- A modified Boyd fusion is a functional limb salvage technique that consists of a Chopart disarticulation at the midtarsal joint in conjunction with a subtalar and ankle arthrodesis. The Chopart amputation first described in 1792 has been regarded as a tenuous procedure, largely due to the equinovarus deformity that results from the unopposed flexor advantage [3,7]. This occurrence is especially concerning for neuropathic patients due to the increased plantar pressures which undoubtedly result in ulcerations and the need for additional procedures which lead to increase in morbidly and mortality. [6]
- We present that the Boyd Modification affords the patient a stable and functional platform that maintains a maximal limb length weight-bearing surface for ambulation and prevents the uneven pressures resulted in a Chopart ampuation alone. [2,5]

Case Reports

CASE #1: CZ is a 57-year-old female with a past medical history of Diabetes Mellitus Type II with peripheral neuropathy and hypertension. The patient stepped on a piece of glass and was doing home wound care for several weeks when she ultimately got worse and presented to the ED. She was admitted on Dec 28, 2013 with a WBC 26.5, sed rate 140, CRP 29, HbA1c 6.3 and negative blood cultures. Radiographs revealed edema and subcutaneous gas to dorsum of the foot across all metatarsal heads (Figure 1). A bedside I&D was done to decompress the abscess. The patient was taken to OR the next day, and a full thickness incision at the Lisfranc was done which revealed deep liquefied necrotic tissue along the flexor sheath in the plantar midfoot. The procedure was converted to modified Chopart amputation at the CC and TN level. The wound was packed and left open. The patient went on to receive two more incision and drainage procedures along with a STSG. Patient was again seen on 5/13/16 and was evaluated. She was diagnosed with ossesous equinus deformity with a wound measuring 4 x 4 cm (Figure 2). The patient underwent Tibial bone marrow aspirate, Achilles tenotomy and a subtalar and ankle joint arthrodesis with a intramedullary nail (Figure 3). An excision of the wound with bilobed rotational skin flap, an application of an external fixator, and naviculectomy were performed. The patient continued to follow up in the wound care center and eventually healed and was fitted for a carbon fiber prosthetic device (Figure 4) for added stability. The patient followed up for approximately 1 year without wounds and ability to ambulate without pain or reoccurrence of wounds.

CASE #2: RB is a 64-year-old female with past medical history of hypertension. On 6/7/16, she underwent bilateral iliac aortogram, right SFA, popliteal angioplasty with stenting. She presented with acute onset of ischemic gangrene to left distal plantar forefoot from emboli. On 8/31/16, she underwent an amputation of 4th and 5th digits left foot with partial amputation of digits 1st, 2nd and 3rd with extensive debridement of plantar shin due to gangrene. A bilayer application and wound VAC to plantar foot was performed. On 9/28/16, she underwent a Chopart amputation with flap closure and a tibiotalocalcaneal arthrodesis with intramedullary nail.

CASE #3: TR is a 48-year-old male with history of necrotizing fasciitis to right lower extremity in August 2014, and he underwent a Chopart amputation at an outside hospital. Patient continued to have a chronic non-healing ulcer to the plantar aspect of the right foot. On 5/20/15, he underwent excisional debridement of right foot ulcer, a tibiotalocalcaneal arthrodesis with an intramedullary nail, complex wound closure with a rotational skin flap, and an application of external fixation device with 2 rings and footplate.

CASE #4: WL is a 62-year-old female who presented to ER with pain in left lower extremity on 1/22/16. She had not seen a physician in over 20 years. Labs showed blood glucose of 391, CRP 43.8, HbA1c 12.8. Radiographs revealed an abscess in left foot and gas gangrene. She was taken to OR on 1/23/16 where a Chopart amputation of the left foot was performed. She had extensive necrotizing fasciitis to rays 2 thru 5 with liquefactive necrosis to dorsal and plantar muscles. On 2/3/16, she had a I&D of localized abscess of the plantar flap with excisional debridement of 4 x 5cm wound with washout of larger 10 x 10cm wound. On 2/15/16, she underwent a tibiotalocalcaneal hind foot fusion with a intramedullary nail, a reverse peroneal brevis muscle flap with excisional wound debridement with excision of navicular and cuboid bones. Application of bilayer, wound vac, and external fixator were performed. On 3/25/16, we performed a harvest and application of STSG.

Figure 1. Showing extent of soft tissue gas

Figure 2. Lateral view showing plantar wound and equinus deformity

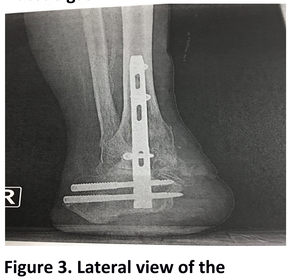

Figure 3. Lateral view of the intramedullary nail

Figure 4. Custom fitted carbon fiber prosthesis

Discussion

- The inherent muscle imbalance of the Achilles tendon on the rearfoot following a Chopart amputation eventually causes an equinovarus deformity. This deformity will eventually lead to uneven pressures on the residual stump that ultimately causes breakdown and development of wounds, which proves especially disastrous in a neuropathic patient. The combination of a Chopart amputation and a subtalar and ankle joint arthrodesis eliminated the unopposed pull of the Achilles tendon, and thus eliminates the development of the equinovarus deformity and the subsequent wounds. The major advantage of this procedure is that it maintains a maximal limb length and affords a stable platform for the patient.
- All 4 of the patients had the subtalar and ankle joint arthrodesis done with an intramedullary nail with internal dynamic joint compression. It is important to note that the subtalar and ankle joints were not denuded of their cartilage surfaces prior to intramedullary nail placement. The act of compressing the cartilage with the nail eliminates any movement in these respective joints. This has two advantages in that it decreases the overall anesthesia and operation time and unnecessary soft tissue dissection and wounds. All patients were monitored post-operatively with serial radiographs, which showed a stable subtalar and ankle joint. All 4 patients also had an external fixation device placed for added stability, while the subtalar and ankle joint fused and allowed time for soft tissue to heal. The external fixation device also allowed for earlier ambulation.
- Two of the patients had the Modified Boyd fusion planned with the Chopart amputation at or around the same time as the subtalar and ankle joint arthrodesis. The other two patients had a previous Chopart amputation with the development of chronic non-healing wounds where the subtalar and ankle joint arthrodesis was done to alleviate the equinovarus deformity that was contributing to the wound development. All the patients had a external fixation frame placed at the time of the subtalar and ankle joint arthrodesis with an intramedullary nail for stabilization. All the patients eventually healed any residual wounds.
- All 4 patients' AOFAS scores improved an average of 30 points postoperatively (30-61%); which is significant when considering the score decrease inherent with arthrodesis procedures (no sagittal or hindfoot motion).

Conclusion

The Modified Boyd fusion is a good limb salvage procedure to have in you repertoire for a specific subset of the population. It affords the patient a functional and stable platform and helps maintain a maximal limb length and weight-bearing surface for ambulation. This construct eliminates the equinovarus deformity normally seen in the Chopart amputation alone and has the potential to increasing the patient's quality of life by reducing the energy expenditure required for ambulation. Future studies with long term follow-up, larger populations, energy expenditure data and morbidity/mortality-specific to this procedure would be an invaluable tool to help determine the benefit of this procedure.

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