

Surgical/Technical Tips

Physiolysis for Metatarsal Bracketed Epiphysis

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Abstract

Metatarsal bracketed epiphysis is an uncommon deformity with abnormally located/continuous physeal tissue along the diaphysis leading to shortening and angular deformity of the medially convex bone. Treatment of this condition is primarily surgical and varies depending on the stage. Treatment with early physiolysis to remove the excess growth plate is a surgical technique that has been previously reported. This method gives the greatest potential for correction of longitudinal and angular deformity of the bone as the patient grows. To our knowledge, there are no visual demonstrations of surgical techniques. For ease of visual demonstration of this procedure, we document its use in an 8-year-old female with Stage 3 bracketed epiphysis. Demonstration includes central physiolysis, using polymethylmethacrylate (PMMA) to block the regrowth of the bar.

Key Concepts

- Treatment of stage 3 bracketed epiphysis by central physiolysis and use of PMMA to block regrowth of the bar gives the affected bone the greatest potential for angular and longitudinal correction.
- Outline the area to be excised using guide wires at each end of the bone and remove the bar (cartilage and epiphysis) found in between them, down to the trabecular bone in the diaphyseal area.
- Use a centrally located threaded pin to anchor bone cement (PMMA), if needed.

Introduction

Metatarsal bracketed epiphysis is an uncommon disorder of the tubular bones due to abnormally located/continuous physeal tissue along the diaphysis (Figure 1). This deformity results in an abnormal

secondary ossification center which interferes with growth by causing progressive shortening and an angular deformity of the affected bone (Figure 2).¹⁻³



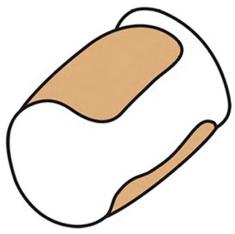


Figure 1. Abnormal physeal tissue bracketing medially along the diaphysis (Choo et al.).¹
^aFigure 1 from Longitudinal epiphyseal bracket by Choo AD, Mubarak SJ in Journal of Children's Orthopaedics. 2013;7(6):449-454. doi:10.1007/s11832-013-0544-1.¹

This disorder most commonly presents in the middle phalanx of the fifth digit of the hand or the great toe, seen as hallux varus. The etiology of this disorder is not completely understood but is thought to be the result of the incomplete development of primary ossification centers during fetal development.^{1,2} This

can be associated with tibia hemimelia and limb length discrepancy. An ormally developed metatarsal contains only a proximal epiphysis, but with a bracketed epiphysis, a proximal, medial, and distal epiphysis are present. These grow towards each other and coalesce causing deformity and potential future discomfort with footwear. The disorder progresses in stages: (Stage 1) a delta or wedge-shaped phalanx with radiolucent cartilaginous epiphysis, (Stage 2) formation of ossification centers at the proximal and distal end or the bone, (Stage 3) unification of the proximal and distal ossification centers that bracket the longitudinal diaphysis, (Stage 4) complete closure of the bracket (Figure 3).

The diagnosis can be made with plain radiographs due to the abnormal wedge-shaped bone, subsequently with the appearance of a secondary ossification center, and finally with closure of the bracket epiphysis resulting in the shortened growth and angular, wedge-shaped deformity of the affected bone. MRI or CT are generally not needed for early presentation but may be advantageous with duplicated digits or unusual presentations. CT imaging of the epiphyseal bracket is shown in Figure 4.

Historically, the bracketed epiphysis was treated with opening and closing wedge osteotomies. Because the

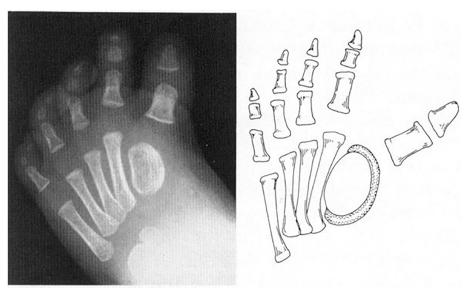


Figure 2. Foot deformity indicated bracketed epiphysis (Choo et al. image at right). ¹ ^b Figure 1 from Longitudinal epiphyseal bracket by Choo AD, Mubarak SJ in Journal of Children's Orthopaedics. 2013;7(6):449-454. doi:10.1007/s11832-013-0544-1. ¹



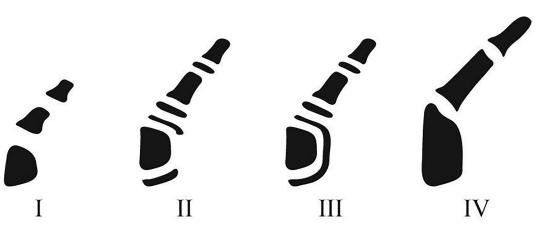


Figure 3. Stages of bracketed epiphysis throughout growth (Choo et al).¹ ^cFigure 3 from Longitudinal epiphyseal bracket by Choo AD, Mubarak SJ in Journal of Children's Orthopaedics. 2013;7(6):449-454. doi:10.1007/s11832-013-0544-1.¹

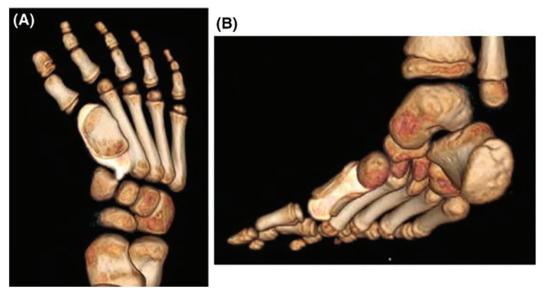


Figure 4. Three-dimensional reconstruction of a foot CT (Choo et al.). ¹
^dFigure 2 from Longitudinal epiphyseal bracket by Choo AD, Mubarak SJ in Journal of Children's Orthopaedics. 2013;7(6):449-454. doi:10.1007/s11832-013-0544-1. ¹

osteotomy does not remove the extra physeal tissue, there is an increased risk of recurrence. However, the wedge osteotomy does remain an important treatment option in Stage 4 when the bracket has closed. Subsequently, the epiphyseal bracket was treated with resection of the longitudinal diaphysis and placement of a fat graft. Polymethyl methacrylate (PMMA) later became the chosen graft material over fat because of its superior attachment to the physis in ossified longitudinal bracketed epiphysis. The procedure was first performed

in the fifth digit on the hand by Vickers in 1987 using a fat graft, then in the first metatarsal by Mubarak et al. in 1993 using PMMA (Figure 5).^{1,2}

Currently, Stage 1 and 2 can be treated with physiolysis of the bracketed epiphysis. Stage 3 is treated with physiolysis and insertion of polymethyl methacrylate (PMMA) to prevent bar formation. Treatment with surgical physiolysis is recommended as early as possible (around 6 months of age) to maximize the longitudinal



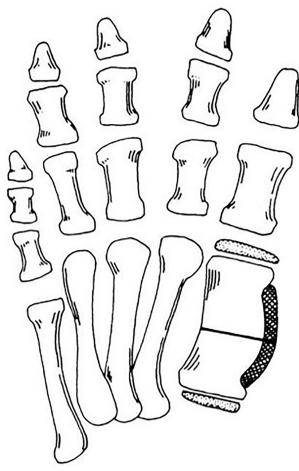


Figure 5. Diagram of 1st metatarsal ossified bracket treatment with PMMA (Choo et al). ¹ ^eFigure 6c from Longitudinal epiphyseal bracket by Choo AD, Mubarak SJ in Journal of Children's Orthopaedics. 2013;7(6):449-454. doi:10.1007/s11832-013-0544-1. ¹

and angular correction of the affected bone.³ After the growth plates are closed in Stage 4, a corrective wedge osteotomy can be performed with or without a bone graft.² External fixation has been used in combination with central physiolysis when extreme angulation is seen or when the extremity is fully grown. The main benefits of using an external fixation method arises from the increased control of the area in comparison to a noninvasive immobilization method; some disadvantages include risk of infection and additional responsibility for the patient in terms of maintenance.^{6,7}

The purpose of this manuscript is to demonstrate the method of central physiolysis with PMMA. This case

presentation will review the diagnosis and treatment of epiphyseal bracket in the foot of an 8-year-old skeletally immature female with Stage 3 metatarsal bracketed epiphysis. This patient was chosen for visual demonstration because it is easier to visualize the surgical technique on an older patient with larger bones and to demonstrate use of PMMA. More classically, excision of the bracketed epiphysis is performed in a younger child to allow for optimal correction of the deformity as the child grows. Depending on the stage of the bracketed epiphysis, PMMA may not be needed.

Description of the Method

The patient initially presented as a 4-month-old female who was born with a supernumerary great toe. The toe was removed at 8 months, but metatarsal deformity was still present at 1-year follow-up. The patient was lost to follow-up and returned at age 8. Radiography, CT, and MRI at this time confirmed that the patient had a bracketed epiphysis (Figures 6 and 7).

CT was more helpful than MRI with this deformity by showing the bracket more clearly (Figure 7).

Treatment for this Stage 3 bracketed epiphysis with central physiolysis was performed to address the metatarsal epiphyseal bracket. Other foot deformities, which included a short 1st metatarsal and curving of toes, were minor and not addressed during this procedure.

To begin the central physiolysis, a tourniquet was applied at the thigh, and an incision was made over the medial aspect of the first metatarsal. Next, soft tissue was dissected down to the bone (Figure 8).

Fluoroscopy was used to locate the epiphyseal bracket for excision (Figure 9). Two smooth guide wires were placed parallel to the growth plates proximally and distally to highlight the area to be removed (Figure 10).

The two guide wires could be removed after marking the area to be excised using an oscillating saw by making grooves near each pin (Figure 11). Then, a small osteotome, rongeur, and curette were used to remove the epiphysis and physis until trabecular bone





Figure 6. Preop x-rays showing deformity of the great toe caused by bracketed epiphysis.

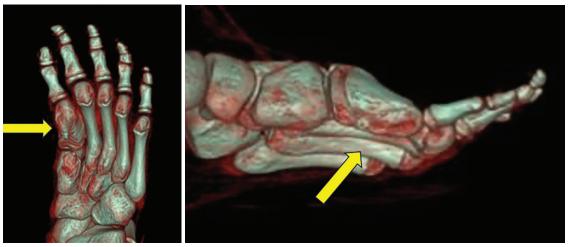


Figure 7. Preop CT confirming bracketed epiphysis (arrow).



Figure 8. Soft tissue was dissected down to the bone.

was encountered (Figure 12). Smooth guide wires were then removed. Next, PMMA was applied over the area of the resected tissue. A threaded guide wire was placed centrally on the surgical area of the bones (Figure 13) to serve as an anchor for the PMMA. The area was then filled with PMMA (Figure 14), taking care to remove any excess. Finally, the threaded guide wire was cut flush with the PMMA.

Postoperatively, the patient was non-weight-bearing in a bivalved fiberglass cast for 1 week. The cast was removed on postoperative day 8 and weight-bearing was resumed in a CAM boot. Her surgical wound was checked weekly for 3 weeks, during which she completed a course of prophylactic antibiotics. The boot





Figure 9. Locating the epiphyseal bracket.



Figure 10. Smooth guide wires placed parallel to growth plate.



Figure 11. Oscillating saw makes a groove near pins on either side of the wires.



Figure 12. Epiphysis and physis removed until trabecular bone was encountered.

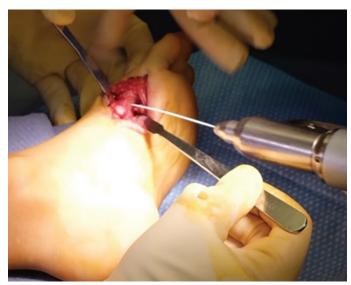


Figure 13. Threaded guide wire placed centrally.



Figure 14. Area filled with PMMA.



was discontinued 3 weeks after surgery. She returned to shoes, taking care not to rub the scar. She began resuming light activity 1 month after surgery and had no restrictions on activity at 6 months. This time period allowed for complete scar maturation.

Follow-up

The patient healed uneventfully, and the great toe deformity will be monitored over time to determine if additional surgery is required to further correct the deformity. Figure 15 are clinical photos prior to surgery and at 1-year postoperatively.

The short first metatarsal is expected to catch up in length to some degree with the rest of the toes since it has open growth plates proximally and distally. Some catch-up growth can be seen at the 1-year postoperative visit (Figure 16).

Summary

To the best of our knowledge, there are no other videos documenting the surgical technique of central physiolysis to treat metatarsal epiphyseal bracket. This submission aims to fill a gap in the literature as video resources become more prevalent, complimenting Choo and Mubarak's 2013 paper outlining this surgical technique. Central physiolysis is a reliable procedure for metatarsal epiphyseal bracket, allowing for optimal correction and functionality of the foot, especially when performed at an early age. Figure 17 demonstrates a 4-month-old child who underwent early central physiolysis at 4 months of age and at age 11 had almost symmetrical 1st metatarsals.

An advantage of central physiolysis is that it removes the pathological physeal tissue, therefore, decreasing the risk of recurrence. Care must be taken not to leave behind part of the longitudinal growth plate at the time of surgery to prevent bar reformation. PMMA sticks to the physis better than fat and is the preferred substance for Stage 3 cases with ossified longitudinal epiphyseal brackets. Disadvantages of this method include insertion of a foreign substance (PMMA) into the surgical site. If the physiolysis is done prior to the ossification of the longitudinal epiphysis, insertion of material is not needed in the younger patients. Overall, central physiolysis is





Figure 15. Preoperative clinical photo (left) and at 1 year follow up (right).





Figure 16. X-ray images postop 1 year.



Figure 17. Central physiolysis in a 4-month-old child with 11-year follow-up.

a relatively simple surgical technique, causes minimal difficulty for the child, and can have excellent cosmetic results.

Additional Links

 POSNAcademy: Metatarsal Epiphyseal Bracket: Treatment by Central Physiolysis

Disclaimer

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