Physeal Resection in Polydactyly Reconstruction of the Fifth Metatarsal

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Abstract

Foot polydactyly is a common foot deformity that is usually corrected surgically early in life to facilitate shoewear. When the polydactyly involves a widened metatarsal head with a single metatarsal epiphysis that articulates with 2 toes, surgical correction involves removal of part of the ring apophysis of the metatarsal. Traumatic injury to the ring apophysis, such as a Salter VI lawn mower injury to the foot, frequently results in angular deformity and/or metatarsal shortening. The purpose of this study was to evaluate whether careful surgical resection of the ring apophysis causes growth deformity.

Radiographs and operative reports were reviewed in children with postaxial polydactyly. Those who had a widened metatarsal head that were surgically corrected with partial physeal resection including the ring apophysis were further examined. The fifth and second metatarsal lengths were measured in triplicate and their ratios were compared using a Wilcoxon rank sum test.

There were 131 children with postaxial polydactyly identified, of whom 7 (5 bilateral) had preoperative and postoperative radiographs suitable for measurement. The median age at surgery was 13 months with mean follow up time of 17.25 months. Of the 12 toes surgically corrected, only 1 showed a significant difference in metatarsal length ratios compared preoperative to postoperatively. There was no significant difference in metatarsal length ratios after surgical correction overall.

No statistically significant length deformity was demonstrated following surgical removal of the ring apophysis. While this study is small, out of the 54 cases that were reviewed, only 2 had complications requiring reoperation. The remainder had no recorded complaints of pain or angular deformity. Despite the absence of documented follow up, it is likely that patients would have returned had they had experienced pain, deformity of the foot, or difficulty in shoewear.

Introduction

Foot polydactyly is a common deformity, found in approximately 1.7 of every 1000 live births, with a degree of variance among different ethnicities.[1] Among the black population, foot polydactyly is found in up to 13.9 of 1000 live births.[1, 2] Polydactyly is commonly associated with many syndromes, but it is thought to be an autosomal dominant trait with variable penetrance when it is an isolated manifestation.[1-4] It is bilateral in 40% to 50% of cases; however, the anatomical configuration is not necessarily identical on both feet.

Foot polydactyly comprises a continuum of extra toes and/or metatarsals, which may be located in several positions. Temptamy and McKusic classified polydactyly as being preaxial, central ray, or postaxial.[1,2, 4] Preaxial refers to the duplication of the hallux; central refers to duplications of the second, third, or fourth toes; and postaxial refers to a duplication of the most lateral digit. Post axial polydactyly is most common, and was the focus of this study.[1-5]

Duplication or deformity of the metatarsal can accompany any of the forms of polydactyly. A classification based on anatomic configuration of the metatarsal was described by Venn and Watson.[2] This classification describes 6 types of polydactyly: (1) normal metatarsal with distal digit duplication, (2) block metatarsal, (3) Y-shaped metatarsal, (4) T-shaped metatarsal, (5) normal metatarsal shaft with a wide head (usually articulates with the extra digit), and (6) complete ray duplication.

The consequences of having foot polydactyly are variable and case dependent. Minor complications are shoe discomfort or difficulty fitting shoes. Other problems include discomfort or pain upon walking, exertional intolerance, and cosmetic and psychological concerns. Typically these problems are improved with surgery.[1,2,6-8]

Surgery is generally performed around 1 year of age: the anesthetic risk is reasonable, the foot is a reasonable size, and the child not yet learned to walk. There is, however, no consensus regarding surgical technique.[5-7] The most controversial issue is whether to remove the digit that is least developed or to remove the digit that restores the foot to the most normal contour, if these are not the same digit.

In instances of a duplicated or widened metatarsal, the metatarsal must be narrowed. This typically involves removing part of the width of the physis, which also removes the ring apophysis on the lateral side of the metatarsal.

Traumatic avulsion of the ring apophysis has been demonstrated to cause growth disturbances,[7] as seen in a Salter-Harris fracture type VI injury to the metatarsal.[9] Bone grows across the physis, closing that side of the physis,[9] which can lead to significant angular and length deformities.

The risk of a similar growth disturbance is unknown when patients have a surgical resection of the physis and ring apophysis rather than a traumatic one. This study sought to examine whether surgical ablation of the ring apophysis of a metatarsal, when done as part of polydactyly reconstruction, resulted in growth deformity or inhibition.

Materials and Methods

A retrospective chart review from 2000 to 2010 was conducted, searching for children who had surgical reconstruction of foot polydactyly, toe excision, or toe amputation. Medical records and radiographs were reviewed for these patients to determine the type of polydactyly. Patients who exhibited a widened metatarsal head, in addition to the extra toe, were included.

The charts and radiographs were evaluated either electronically using the program ISite PACS[10] or using the hard copies of the radiographs. Patients who did not have radiographs done at least 6 months postoperatively were excluded. For those with both preoperative and postoperative radiographs, the lengths of the second and fifth metatarsals of the affected foot were measured in triplicate using the program ISite PACS.[10] The triplicate measurements of the metatarsals were averaged, and the ratio of fifth to second metatarsals was calculated from the averages. Preoperative and postoperative ratios were compared for change in metatarsal length ratios. The Wilcoxon rank sum test was used to evaluate statistical significance. A p-value of 0.05 was considered to be significant, and two tailed tests were used throughout. Standard summary statistics were calculated for demographic and other variables.

Results

Records and radiographs with surgical codes corresponding to polydactyly or toe amputation were reviewed, totaling 131 patients with 189 toes. Sixty-nine of the patients were males and 62 were females. None of these patients had more than 6 toes per foot. There were 58 bilateral cases (35 male and 23 female). Of the total 189 toes, 62 toes in 47 children required surgical excision of a portion of the metatarsal head, including part of the physis and the ring apophysis: 54 of these 62 were the fifth metatarsal and the remainder involved the first metatarsal. All 54 cases of postaxial polydactyly had at least 1 follow up with cast removal, but only 20 of these 54 cases had follow up that included x-rays; 12 of these 20 had documented exams and radiographs 6 months or more following the index surgery, likely adequate time

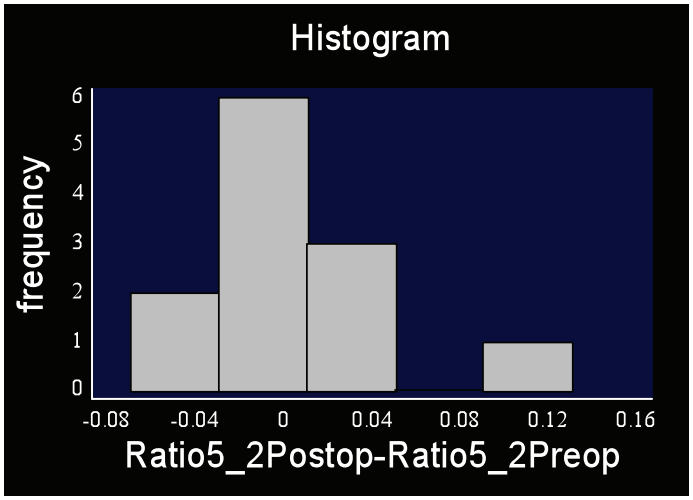

Figure 1. The preoperative ratios were subtracted from the postoperative ratios and the differences were plotted above by frequency.

to see growth changes. Of the 54 cases (42 patients), 31 patients with 42 toes were asked to return as needed following a clinic visit that ranged from 3 weeks to 4 years postoperatively. There were 11 patients with 12 toes who were given a return clinic appointment but did not keep the appointment. All patients who were lost to follow up had at least 1 postoperative evaluation by the surgeon.

In total, 7 patients with 12 toes were included in the final analysis. There were 3 male and 4 female: 5 of the cases exhibited bilateral polydactyly. Average age at surgery was 22.5 months, with median age of 13 months and a range of 5 to 76 months. Mean post-operative follow up interval was 17.25 months (6 months to 48 months). The mean length ratios of the fifth to second metatarsal were 0.85 preoperatively and 0.85 postoperatively. The length ratio of the second metatarsal compared to the fifth was the same postoperatively as it had been preoperatively. The ratio differences are depicted in Figure 1. This was not significantly different from 0 ($p=0.4561$) when using the signed rank test. None of these 12 patients required further surgeries, and there were no complications noted in the medical record.

One patient included in the study exhibited an increase in second to fifth metatarsal ratio post-operatively: the fifth metatarsal was longer in proportion to the second metatarsal 5 months after the operation. The initial ratio was calculated to be 0.79 preoperatively and was found to be 0.90 postoperatively. In further follow up visits, the patient has not had complaints regarding pain or shoe wear.

Discussion

The Salter Harris type VI fracture, involving traumatic damage to or avulsion of the ring apophysis,[11]

has been shown to cause angular and length deformities in growing children.[9] Bone growth spans the physis in the injured area, causing the closure of the physis on the injured side. Growth of the remaining physis can produce the growth inhibition or angular deformity. In the foot, these fractures are often associated with lawn mower or other crushing injury.[12]

A similar, albeit less traumatic, event occurs during the surgical reconstruction of foot polydactyly when the supernumerary digit shares a widened metatarsal head with the normal digit such that the 2 toes share a common metatarsal head. In order to narrow the residual metatarsal to correspond to the residual toe, part of the metatarsal head including part of the physis and the ring apophysis, is resected along with the extra toe. Although this surgical correction is strikingly similar to the Salter-Harris type VI fracture, in this small group of patients with polydactyly correction, excision of part of the physis and ring apophysis did not cause appreciable growth inhibition or angular deformity.

The primary limitation of this retrospective study is the small number of children who had follow up radiographs for inclusion at 6 months or more postoperatively. Accordingly, definitive conclusions about the incidence of growth deformity involved with surgical removal of the ring apophysis in polydactyly cannot be made.

Polydactyly reconstruction is a frequent surgical procedure in young children, and the fact that patients rarely present with growth-related issues support speculation that this procedure rarely results in symptomatic growth complications. None of the 12 patients included in analysis had cosmetic complaints or shoewear difficulty.

There were a total of 42 patients with 54 toes (including the ones whose data was included in this study) who underwent the same procedure. Thirty-one patients with 42 toes continued to be followed until they were told that they no longer required follow up. That 24 of these patients did not have radiographs at the follow up visit suggests that no complaint was expressed and the treating physician evidenced no need for radiographs.

Pediatric orthopaedic care in this state is limited to one facility, making it likely that significant postoperative complications, even after years of growth, would be referred back to this center rather than being treated at an outside facility. The lack of follow up complaints, coupled with the favorable outcome of the children in this small group, suggests that surgical correction of polydactyly with a widened metatarsal head is unlikely to cause the growth deformity sometimes seen in traumatic injury.

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