

Five- and 10-Year Follow-Up of Nonvascularized Toe Phalanx Transfers

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Purpose The purpose of this study was to evaluate long-term outcomes of nonvascularized toe phalanx transfer.

Methods We retrospectively reviewed 54 nonvascularized toe phalanx transfers in 29 children with symbrachydactyly. Forty-seven transfers in 24 children were evaluated at 5-year follow-up and 27 transfers in 14 children were evaluated at 10-year follow-up. We recorded the incidence of the early physal closure and the length of the transferred toe phalanx on plain radiographs at 5- and 10-year follow-up. Growth rate in the first 5 years and the following 5 years were calculated. Function of the metacarpophalangeal joint (motion, stability, and alignment) was also evaluated.

Results The mean age at surgery was 1.5 years. Seven toe phalanges were trimmed because the skin pocket was tight. Five transfers required revision surgery for partial necrosis of the skin pocket. At 5-year follow-up, the physis was closed in 23%, and at 10 years, 78% of physes were closed. The phalanx length was 87% of expected at 5-year follow-up and 71% at 10-year follow-up. Growth rate was 0.83 mm/y in the first 5 years and 0.22 mm/y in the following 5 years. Active motion was rated as good in 24, fair in 7, and poor in 16. Stability and alignment were rated as good in 37 and 33, fair in 8 and 5, and poor in 2 and 9, respectively.

Conclusions Nonvascularized toe phalanx transfer offered a relatively simple method to lengthen short digits and to provide satisfactory function. The transferred toe phalanges grew at a near-normal rate in the first 5 years, but the growth rate decreased between 5 and 10 years. (*J Hand Surg Am.* 2017;■(■):1.e1-e5. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)

Type of study/level of evidence Therapeutic IV.

Key words Toe phalanx, symbrachydactyly, lengthening, reconstruction, long-term.



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SYMBRACHYDACTYLY IS A CONGENITAL hand abnormality characterized by a combination of short and webbed fingers and hypoplasia of the hand. It tends to occur unilaterally and may be associated with absence of the pectoralis major muscle. In 1971, Blauth and Gekeler¹ modified Pol's classification, dividing symbrachydactyly into 4 types based on morphological characteristics. This includes the short finger type, in which all fingers are present but are short and usually missing middle phalanges; these patients also commonly have a cutaneous syndactyly.

The second category is the oligodactylic type, typically missing the central 3 fingers. The third is the monodactylic type, in which the thumb is the only digit present. Finally, the adactylic type presents without any of the digits, including the thumb. In relatively mild forms of symbrachydactyly, surgery is focused on elongation of the fingers and release of the cutaneous syndactyly. These procedures include on-top plasty,² distraction lengthening,^{3–5} nonvascularized toe phalanx transfer,^{6,7} and free vascularized toe transfer.^{8,9} Entin in 1959¹⁰ first used the toe phalanx to reconstruct congenital abnormalities of the upper extremities. However, the following reports during the 1970s showed little or no growth in the transferred phalanges.^{11,12} In 1982, Goldberg and Watson⁷ reported maintenance of the physis and growth of the phalanx in toe phalanges transferred with intact periosteum, physal plate, and lateral collateral ligaments. Subsequent reports have confirmed the importance of the intact periosteum and physal plate.^{6,13} However, the long-term growth of the transferred phalanx is not fully known and the functional results of the reconstructed metacarpophalangeal joint are incompletely understood.

We have used nonvascularized toe phalanx transfers since 1993 for the oligodactylic and monodactylic type symbrachydactyly to improve length and motion of the fingers.

The purpose of this study was to evaluate our long-term experience with nonvascularized toe phalanx transfers in patients with symbrachydactyly, including assessments of bone growth and digit function.

MATERIALS AND METHODS

This study protocol was approved by the local ethics review board. We retrospectively reviewed 54 free, nonvascularized toe transfers in 29 children with symbrachydactyly, who were treated between 1993 and 2010. Five children (7 toe phalanges) were lost before the 5-year follow-up and excluded from this study. Ten children (20 toe phalanges) did not reach the 10-year follow-up and were excluded for the 10-year evaluation. Consequently, 47 transfers in 24 children were evaluated at 5-year follow-up and 27 transfers in 14 children were evaluated at 10-year follow-up. There was a remnant of the native proximal phalanx in the finger in 17 transfers, whereas no remnant was present in 30 transfers. We compared, on the plain posteroanterior radiographs, the percent length of the transferred phalanx with the nontransferred phalanx in the contralateral foot, at 5- and 10-year follow-up. The radiographs were

manipulated on a digital imaging workstation, the Picture Archiving and Communication System, to measure the lengths down to 0.1 mm. The transferred phalanx was always the proximal phalanx from the fourth toe. When we transferred both fourth toe proximal phalanges, an average length of the proximal phalanx of the third and fifth toes was used as an extrapolated value because a preliminary study showed that this was a good approximation for the normal fourth toe proximal phalanx. The incidence of early physal closure, defined as a bridge formation across the physis, was recorded. Growth rate in the first 5 years and the following 5 years was calculated.

At follow-up, we also evaluated the motion, stability, and alignment of the metacarpophalangeal joint and each category was graded as good, fair, or poor. If active extension exceeded 0° and active flexion exceeded 45°, motion was graded as good. If the extension lag was greater than 30° or active flexion was less than 30° or total active motion was less than 30°, motion was graded as poor. Otherwise, motion was graded as fair. Lateral instability and malalignment were graded as good if they were less than 10°, fair if between 10° and 30°, and poor if more than 30°.

For statistical analysis, the student *t* test was used. *P* values below .05 were considered significant.

Surgical technique

The recipient fingers were prepared according to the technique described previously by Tonkin et al.¹⁴ If a remnant of the proximal phalanx was present, its distal end was flattened for fixation to the toe phalanx. If not present, we divided the tendinous hood, which connects the flexor and extensor tendons, at the distal end of the metacarpal. The divided hood creates flexor and extensor tendon stumps and 2 collateral ligaments. We did not use intraoperative mechanical expansion with a balloon catheter, but preceding tissue expansion had been performed as a separate operation in 4 cases.

According to the description of Buck-Gramcko,⁶ the toe phalanx was harvested extraperiosteally together with the collateral ligaments and dorsal/plantar joint capsules at its base. The gap created by the excision of the proximal phalanx was reconstructed with an iliac bone graft with apophysis. The fourth toe was the first choice. For multiple transfers, bilateral fourth toes were used, followed by the third toes on either side.

The toe phalanx was inserted into the pouch and stabilized with nonabsorbable sutures to the remnant or sutures to the flexor and extensor tendons and

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