



Free nonvascularized toe phalangeal transfer (FNVTPT)

Trasferimento libero non vascolarizzato di falangi delle dita del piede

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Summary

Free nonvascularized toe phalangeal transfer is one of the treatment options for congenital digital hypoplasia. Specific anatomical and surgical technique aspects must be taken into account in order to achieve a favourable outcome, and donor site morbidity must also be considered.

Key words: free phalanx transfer, symbrachydactyly, digital hypoplasia

Riassunto

Il trasferimento libero non vascolarizzato di falangi delle dita del piede rappresenta una delle opzioni di trattamento per l'ipoplasia digitale congenita. Al fine di ottenere un risultato favorevole, devono essere presi in considerazione specifici aspetti anatomici e di tecnica chirurgica, e deve essere considerata anche la morbidità del sito donatore.

Parole chiave: trasferimento libero di falange, simbrachidattilia, ipoplasia digitale

Introduction

Free nonvascularized toe phalangeal transfer (FNVTPT) is an established surgical technique for the treatment of digital hypoplasia. It was first described by Wolff ¹ then also reported by other authors ^{2,3,4}. Goldberg and Watson ⁵ and Buck-Gramcko and Pereira ⁶ popularised the technique. Free phalangeal transfer still represents a viable alternative to microvascular toe-to-hand transfer in cases where the latter cannot be performed or is not indicated. Radocha et al in 1993 published a series of 73 transfers suggesting that the transfers are more likely to survive and subsequently the epiphyses to remain open if the nonvascularized phalangeal transfer procedure is performed at an early age ⁷. This finding was further confirmed by a more recent study published in 2021 ⁸.

Indication

Hypoplastic hand digits where a functional improvement may be achieved with the insertion of a phalanx. The procedure should ideally be performed at an early age and the pre-operative assessment should ascertain the presence of a sufficiently

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Conflitto di interessi

L'Autore dichiara di non avere alcun conflitto di interesse con l'argomento trattato nell'articolo.

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broad skin and soft tissue envelope to accommodate a toe phalanx without tension, the presence of a functional flexor and extensor tendinous mechanism and of an adequately developed metacarpal, and the presence of a viable toe phalanx of appropriate size and shape for the transfer ⁷.

Advantages

The main advantages of FNVPT are the following:

- this procedure can be performed at an early age;
- it does not involve sacrificing whole toes;
- it is technically less demanding than a microvascular toe-to-hand transfer;
- it does not appear to affect the gait;
- it has been historically perceived as a low morbidity procedure by families and surgeons alike.

Surgical technique

It has been demonstrated that the viability and growth of the transferred toe phalanx in the hand depend also on the preservation of an intact periosteum therefore the phalanx should be transferred intact ^{5,9}. Subsequently, the size of the skin and soft tissue envelope at the recipient site is the limiting factor for the phalangeal size as the hypoplastic digit must accommodate the intact transferred phalanx without an excessive tissue tension in order to reduce the risk of post-operative tissue necrosis, phalangeal loss and other complications ¹⁰. The traditional technique for toe phalangeal harvest involves a dorsal incision on the recipient site where a bursa or a fibrous-cartilaginous remnant distal to the metacarpal head may be present. The aforementioned structures distal to the metacarpal head should be incised preserving their proximal attachment and exposing the metacarpal head in order to create a metacarpophalangeal joint with proximal soft tissue attachments for the base of the transferred phalanx. A space is then created in the hypoplastic digit preserving the neurovascular bundles. A dorsal, extensor tendon splitting approach is typically used in the donor toe. The chosen phalanx is harvested as a whole, preserving the flexor and extensor tendons in the donor toe. The proximal toe phalanx has been traditionally more commonly used for the transfer, however the middle phalanx can be chosen when a smaller bone transfer is required ¹¹. The toe phalanx is harvested extraperiosteally. A proximal cuff of capsule including collateral ligaments and plantar plate should be harvested with the phalanx in order to obtain a more stable attachment to the recipient site. A double ended Kirschner wire is inserted longitudinally into the phalanx, ensuring that it does not protrude from the phalangeal base. The free end of the Kirschner wire is then used to pierce

the fingertip skin and the phalangeal graft is guided into the recipient soft tissue pocket down the Kirschner wire. Once the donor phalanx is appropriately positioned in the soft tissue envelope, the Kirschner wire is driven into the metacarpal. The capsule and collateral ligamentous structures at the phalangeal base are then sutured to the previously prepared tissues around the metacarpal head, ensuring that the flexor and extensor tendons are also attached to the dorsal capsule and plantar plate respectively. The skin is sutured avoiding excessive tension and the tourniquet is released to verify that an adequate soft tissue perfusion is present. Traditionally, either pre-operative soft tissue expansion, intra-operative z-plasty or local flaps have been adopted to reduce the risk of excessive soft tissue tension and subsequent ischaemia. The author prefers a palmar V-Y approach to the recipient site that increases the palmar length of the soft tissue envelope allowing to accommodate an intact phalangeal graft with a reduced tissue tension whilst correcting any flexion contracture of the hypoplastic digit ¹⁰, followed by skin suture with absorbable suture material. The donor site management will be discussed in a separate section.

Post-operative care

A soft dressing, a cast and a bandage are applied, protecting the surgical wound and the K-wire. The cast and K-wire are usually removed at 4 weeks post-operatively.

Donor site management and morbidity

A number of techniques for toe phalanx harvest and donor site management have been described by various authors since the procedure's inception. Wolff ¹ reconstructed the donor site using a rib cartilage graft, while Buck-Gramcko and Pereira ⁶ preferred to suture the flexor to the extensor tendons. Smith and Gault ¹² did not suture the flexor to the extensor tendons. Radocha et al ⁷ maintained the toe length in the post-operative period with a Kirschner wire and a suture through the nail for toe distraction. Until recently, only a few studies acknowledged some long-term consequences on the donor site ^{2, 6, 11, 13, 14, 15}. Bourke and Kay in 2002 proposed iliac crest bone grafting to the donor toes ¹⁵, however the long term outcomes of this technique are not currently available. In 2012, the first study exclusively focused on donor site morbidity with a long-term follow-up demonstrated universal deformities of the donor toes and commonly associated deformities of adjacent toes at the long-term follow-up ¹⁶. The worsening of the donor site morbidity over time highlighted the fact that a short-term follow-up of the donor site in the foot is inadequate. It also remains unclear and a matter of debate whether any of the proposed donor

toe reconstructive options or post-operative protocols is superior to the others concerning the long-term donor site outcome.

Pearls and pitfalls

- Risk of soft tissue necrosis and phalangeal exposure or extrusion in case of excessive skin and soft tissue envelope tightness/tension at the recipient site;
- Early physeal closure and lack of phalangeal growth in case of periosteal damage, physeal damage, partial phalangeal harvest or procedure performed too late in childhood⁸;
- Risk of phalangeal resorption especially when the periosteum is damaged, like following phalangeal trimming or harvest of partial phalanges¹⁶;
- Risk of metacarpophalangeal instability and subluxation if the recipient soft tissue envelope is too tight and/or in the absence of metacarpophalangeal capsuloligamentous reconstruction and tendon attachments to the transferred phalanx;
- No phalanges should be harvested from the second toe in case of potential requirement or consideration of a future microvascular toe transfer, making the third and fourth toes the preferential donor sites for FNVTPPT;
- It is paramount to discuss openly and thoroughly all aspects relating to this procedure, including those relating to the donor site morbidity, with the patient's family, ensuring that all other viable treatment alternatives are also explored and considered.

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