CHAPTER 50

# DESYNDACTYLY AND SYNDACTYLY

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## SYNDACTYLY AND ITS SURGICAL REPAIR

Syndactyly is an irregularity in which there is incomplete delineation of the normal anatomic boundary between digits, in essence "a local arrest of normal development".[1] It is the most common congenital anomaly of the hand, occurring at a rate of approximately 1:2250 births.[2] The incidence in the foot has been reported to be 1:1000 to 1:3000, with a predilection for males over females of 3:1.[1,3,4] Persistent webbing in the foot most often occurs in the second interspace.[5] The incidence of bilateral pedal involvement ranges between 35 and 50%.[6] A positive family history may be present in 10 to 40% of cases.[7]

Although syndactylism is a relatively common congenital or developmental defect, this condition can be iatrogenic or traumatically acquired. The deformity can be isolated with sporadic occurrence or associated with other congenital malformations such as in Apert's syndrome or Poland's anomaly (Apert's Syndrome consists of craniostosis, ocular hypertelorism, downslanting palpabral fissures, midface dificiencies, mental deficiency, and symmetrical syndactyly of the hands and feet involving digits two, three, and four. The Poland anomaly involves unilateral synbrachydactyly and ipsilateral aplasia of the sternal head of the pectoralis major muscle. Associated pedal anomalies are clubfoot, metatarsus adductus as well as syndactyly of the toes.)

It is important to determine the extent of syndactylization when considering surgical intervention, especially in the presence of osseous union. In 1932, Kanavel first classified syndactylism as it related to the hand into degrees based on the severity of the fusion.[8] In first degree syndactyly, only the skin and subcutaneous tissues are involved, and second degree indicates an element of osseous union. First and second degree syndactylization are amenable to surgical correction. The third and fourth degrees indicate severe alteration of anatomy which obviates surgical intervention on the premise that restoration of normal function cannot be expected. Temtamy and McKusick have described five types of isolated syndactyly, all of which are inherited in an autosomal dominant fashion and have variable expression.[9] Three of these can occur in the foot. Type 1 (zygodactyly) is the partial or complete webbing of the second and third toes. Type 2 (synpolydactyly or polysyndactyly) is the syndactylization of the 3rd and 4th toes with polydactyly of the 5th toe. Type 3 is associated with metatarsal fusion. Davis and German have classified syndactylism into four categories based on the extent of digital division. Type 1 is incomplete syndactyly, where webbing of the toes does not extend to the digital tuft; Type 2 is complete syndactyly with webbing extending to the distal tuft; Type 3 is simple soft tissue syndactyly without phalangeal involvement; Type 4 is syndactyly complicated by abnormal phalangeal bones.[1]

### Indications and Contraindications to Surgical Intervention

Type I syndactyly in the foot (as outlined in any of the above classification schemes), in contrast to the hand, most often does not lead to functional difficulty or further deformity. Consequently the indication for surgical separation of digits is usually related to cosmesis, although pain and digital contractures can compel a patient to seek treatment. Cosmetic concerns may range from the inability to wear certain types of shoegear to ridicule and psychosocial implications in the child. Syndactyly can affect normal foot function and become symptomatic if one or both of the conjoined digits becomes contracted.

Contraindications for desyndactylization are few. Non-compliance may be the only real contraindication, as improper postoperative care can compromise the success of the operation and lead to infection, wound dehiscence, hypertrophic scarring, slough of skin graft or recurrence of the deformity.

### Preoperative Considerations

The goals of surgical desyndactylization include release of the affected digits, adequate soft tissue coverage, acceptable cosmetic appearance, and prevention of contracture and recurrence of deformity. It is essential to identify any shared osseous or myotendinous structures between the digits as these will need to be addressed along with the cutaneous defect. Radiographic evaluation is helpful in

this regard. Flexion/extension functions of each toe should also be assessed, as this may indicate absence or weakened myotendinous input to the fused digit.

Careful consideration of the neurovascular supply and cutaneous mobility is also essential. As with any plastic surgical procedure, excessive local skin tension must be avoided as this may be cause for contracture or dehiscence. Options for coverage of the cutaneous defect include local rotational or advancement flaps or a full-thickness skin graft. Park et al described a method of using local advancement flaps from dorsal and plantar tissues to fill the defect.[10] Kanaval in 1932 described a "butterfly" flap for use in finger syndactyly in which a single, full-thickness skin graft is fashioned to fill the entire defect of the new web.[8] Weinstock et al described a similar procedure in the foot using a full thickness skin graft obtained from redundant skin on the dorsum of the foot.[11] Other plastic surgical techniques have been described including variations of skin plasty.[12,13]

Local flaps may provide adequate coverage, albeit at the expense of increased tension on the wound. Repair in this fashion also has a tendency toward more contracture than the use of a skin graft. Grafts to cover this defect are easily obtained from the redundant skin on the dorsum of the foot, take quite readily to the wound bed in this region, and can be bolstered to the wound without significant tension on the local tissues. This is of course at the expense of a separate surgical (donor) site. Because grafts ultimately afford less tension on local tissues than flaps, full thickness skin grafts are preferred for cutaneous coverage of the new webspace.

## ARTIFICIAL SYNDACTYLIZATION

One method for dealing with flail or unstable toes is through surgical syndactylization. The original description of this procedure is attributed to McFarland, and has also been described by Scrase and Kelikian.[14-16]

### Indications/Contraindications to Surgical Intervention

This procedure is commonly used in cases involving a flail or overriding fifth toe. This procedure may also be indicated as a treatment for a recurrent or intractable interdigital heloma molle.[16] Excision of an interdigital heloma may leave behind a painful scar, or perhaps there was never any resolution of the original symptomatology after interphalangeal joint arthroplasty or exostectomy. After exhausting conservative measures, such as splinting and manipulation, there may be an indication for excision of the sulcus and joining the adjacent toes. The floppy digit is tethered through skin plasty to a functional toe for stabilization.

Often a significant stabilizing portion of a digit is lost secondary to long term joint luxation, reconstructive procedures (i.e., resection arthroplasty), trauma, or infection. Loss of function of the flexor apparatus at the base of the proximal digital phalanx can result in severe digital contracture. Due to the loss of intrinsic stability, the toe may be flail and require further reconstruction, including osseous or soft tissue balancing procedures. In cases involving central digits a stable adjacent toe can be harnessed through syndactylization to provide function and stability to an otherwise unbalanced toe. Kelikian et al suggested utilization of this procedure as a preventive measure for the second digit in connection with Keller arthroplasty.[16]

Finally, artificial syndactylization has been utilized in cases of a congenital crossed fifth toe where there is no underlying osseous deformity.[17] In cases of crossed overlapping fifth toes additional skin may be removed from the plantar sulcus to further plantarflex the toe upon closure. When an adductovarus component is also present Z-plasty lengthening of the extensor tendon may be necessary.

Chronic interdigital maceration and associated lesions may also be eliminated with this procedure. Quite often this is seen with adductovarus rotation or other digital contracture. Advancement of the webspace and excision of the chronic lesion will afford relief from this condition and prevent recurrence.[18]

### Preoperative Considerations

Syndactylization of toes can be thought of as a "web advancement" procedure. The essentials of this procedure include removal of a skin wedge devoid of subcutaneous tissue, including the heloma if present, and suturing the skin edges on the adjacent digits together. Any other soft tissue contracture is also addressed. The same considerations given to desyndactylization should be given to syndactylization, namely attention to neurovascular structures and local soft tissue tension.

Many authors have published their experience with this procedure in large series of patients.[15-21] Various descriptions of the skin plasty have been described, including a V–Y plasty of the dorsal skin, a double U skin plasty of adjacent toes, and a T-shaped skin plasty in the sulcus midline. All incisions will produce the same effect; that is, exposure of the underlying subcutaneous tissue and advancement of the dermis.

All digital contractures should be released prior to syndactylization. Other compounding factors affecting

the fifth toe must be identified and addressed for a successful outcome of syndactylization with the fourth toe. An abducted or plantarflexed fifth metatarsal head, medially deviated fifth metatarsal head cartilage, dorsomedial contracture of the skin, metatarsalphalangeal joint capsule and extensor tendon, and plantar medial contractures of interphalangeal joints may be present.[19,22]

## OPERATIVE TECHNIQUES

### Surgical Desyndactylization With Full Thickness Sinus Tarsi Skin Graft

The procedure is carried out with the patient supine and under intravenous sedation with local anesthesia to the affected digits and graft donor site (if required). A tourniquet is not used. The foot is prepped and draped just above the ankle.

The syndactylized toes are addressed first to prepare the recipient site. The orientation of the adjacent sulci to the syndactylized webspace is appreciated both dorsally and plantarly, and an arc is formed from these boundaries to define the proximal extent of the incision (Figures 1, 2). The normal commissure between digits is beveled from dorso-proximal to plantar-distal and this relationship should be appreciated. A hypodermic needle may be used as a point of reference. A #15 blade is used to carry out a linear incision which extends along the convexity from dorsal to plantar and is carried down to the superficial fascial layer (Figure 3). Electrocautery is used for additional hemostasis. The wound is measured along the sagittal and transverse axes, and a moist sponge is then applied in the sulcus. The transverse axis effects two 'wings,' which are oriented on each side of the commissure.

Attention is then directed to the dorsolateral aspect of the foot in the region of the sinus tarsi. Two converging semi-elliptical incisions are arranged in oblique fashion along the axis of relaxed skin tension. The incision length is slightly greater than double one of the wing measurements, and slightly wider than the dorsal-plantar measurement. This will allow for apices that can be handled with tissue forceps, as these will later be trimmed and decrease the likelihood of tip necrosis. A #15 blade is then used to remove the full thickness skin graft in toto from the underlying subcutaneous tissues (Figure 4). Any adhering subcutaneous tissue is dissected from the graft as this will impede graft acceptance. The subcutaneous tissue at the donor site is undermined as needed to mobilize the skin for closure. The foot is also held in a slightly everted position to reduce tension on the skin margins during closure. Subcutaneous and intradermal closure is achieved with 4-0 and 5-0 absorbable suture respectively (Figure 5). One effective method for reducing the tension on the skin wound is to remove a portion of subcutaneous fat along with the skin graft and perform a subcutaneous fascial closure. Care should be taken to reflect the branches of the superficial peroneal nerve if these are encountered during dissection.

The graft can be meshed using a #15 or #11 blade. Suture is placed at the lateral and medial margins and the fit of the graft in the sulcus is assessed. Suture is then placed at the dorsal and plantar margins of the graft on each toe, dividing the graft into quadrants. If needed, a basting stitch is placed in the midsubstance of the graft to hold the graft in place and diminish the dead space between the graft and the subcutaneous fascia (Figure 6). Each quadrant is then sutured in place. We use a simple running-type stitch extending from each corner, with the

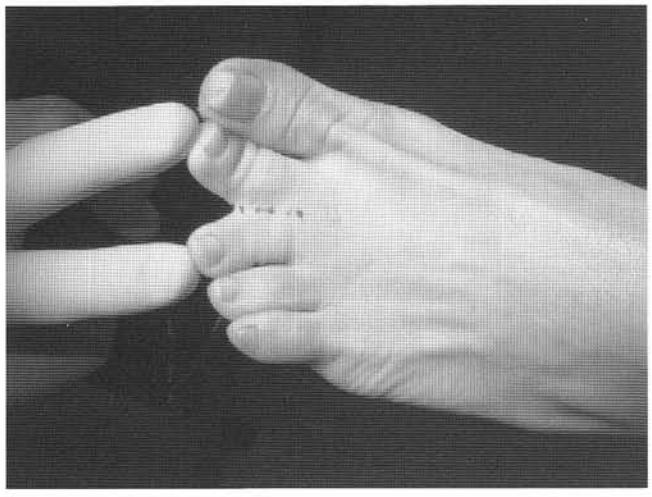


Figure 1.

Figure 2.

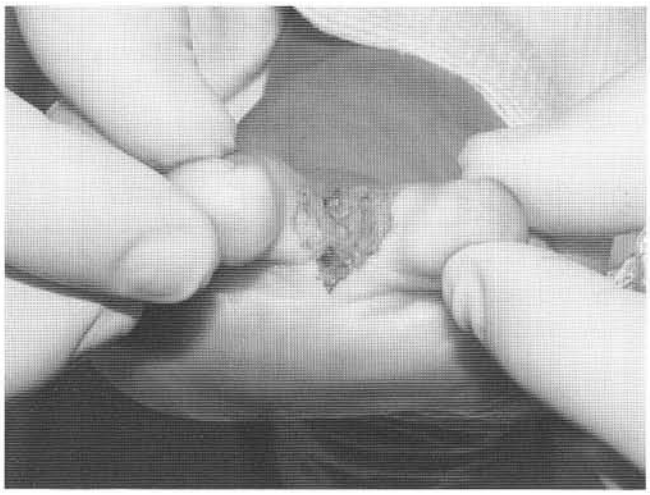
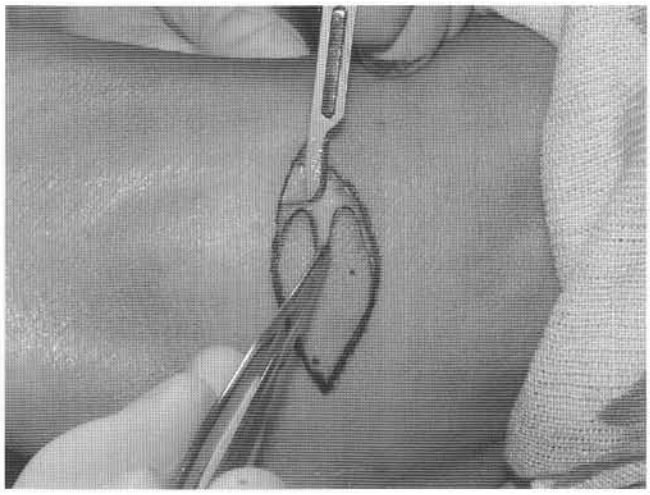


Figure 3.



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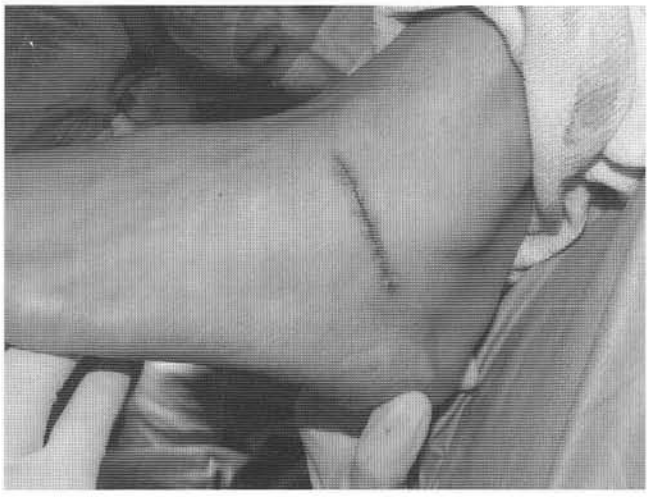

Figure 5.

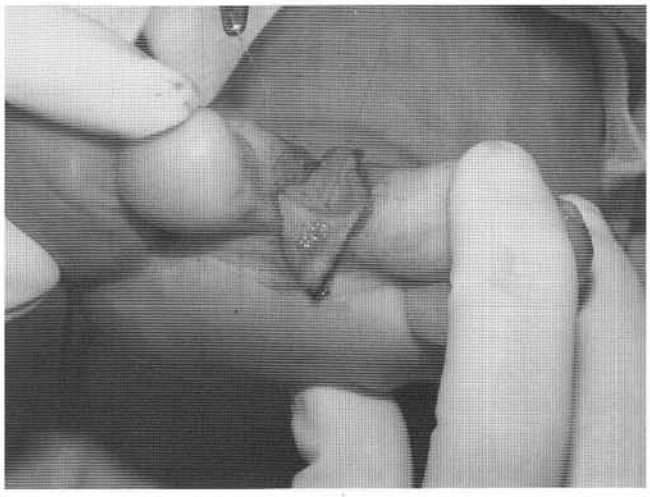

Figure 6.

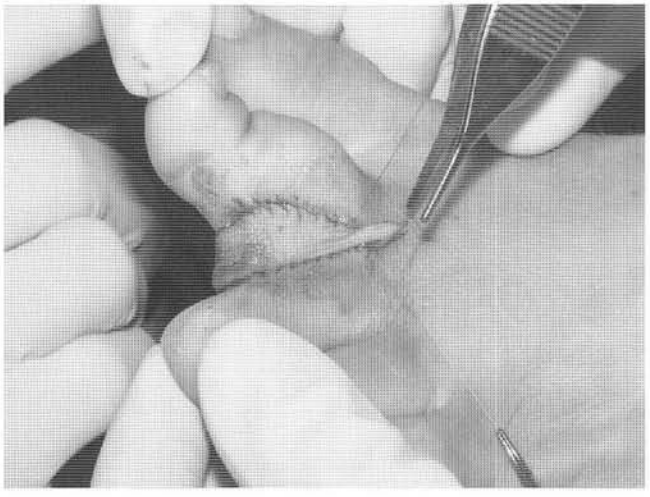

Figure 7.

Figure 8.

final throw exiting from the proximal skin at the adjacent corner. A tag is left in this stitch that is used to tie in to the adjacent running stitch (Figure 7). Any excess skin is removed at the apices. We recommend a small gauge (5-0 or 6-0) absorbable braided or monofilament suture for this procedure.

Attention is then directed to the donor site where bismuth-impregnated non-adherent gauze is placed against the graft site. The drying effect of this dressing is especially important during the plasmatic stage when significant serous weeping can become problematic resulting in maceration of the graft and surrounding skin. Both wounds are then covered with a dry sterile dressing. The dressing over the graft is placed with slight compression to maintain adherence of the skin graft to the recipient site.

### Digital Syndactylization With Lesion Excision

The digits to be joined are assessed for contracture, and arthroplasty is performed if necessary. The incision is closed and protected with an adhesive dressing prior to performing the syndactyly. The authors utilize a lesion-encircling approach for the deep seeded heloma molle.

The same procedure can be used for syndactylization of any two digits. The patient is placed in the normal supine position and the foot is prepped to the ankle. The digits are infiltrated with local anesthetic containing a dilute epinephrine solution. Any lesion within the web-space is circumscribed with the skin marker as this skin will be excised in toto (Figure 8). Often the case is opposing lesions on both digits, most commonly the fourth and fifth toes. In this case the incision is marked out on the fifth toe which is then pressed against the fourth to create the 'butterfly' shaped incision.

A #15 blade is used to excise the skin wedge in toto from the underlying subcutaneous tissue (Figure 9). The wedge can be handled with tissue forceps although a skin hook may help tense the local tissues while incising through them. The blade is held perpendicular to the skin while this procedure is carried out to prevent skiving the wound edges. The toes are then held together to assess the position of the digits as they will sit when syndactylized. Small guage (5-0) nonabsorbable suture is used in simple interrupted fashion to reapproximate the skin edges and close the sulcus (Figure 10).

The wound is then painted with betadine and dressings are applied. Sterile 4" gauze squares and gauze wrap should be sufficient to protect the wound and stabilize the toes. Postoperative splinting is carried out for several weeks to prevent disruption of the syndactyly.

## DISCUSSION

Plastic surgical techniques involving syndactylization and desyndactylization of the digits are an indispensable part of the foot and ankle surgeons' repertoire. For simple soft tissue syndactylization a full thickness skin graft is an excellent option for coverage of the defect and for prevention of deformity recurrence. Grafts in this region take readily to the wound bed, provide excellent coverage of the defect, and maintain minimal tension on the area from surrounding tissues. There is however additional morbidity associated with a separate surgical site and there is always potential for wound complications with either incision. In contrast, local skin flaps offer the benefit of only one surgical site although generally there is more tension on the wound after the cutaneous advancement. Because it is essential with most plastic

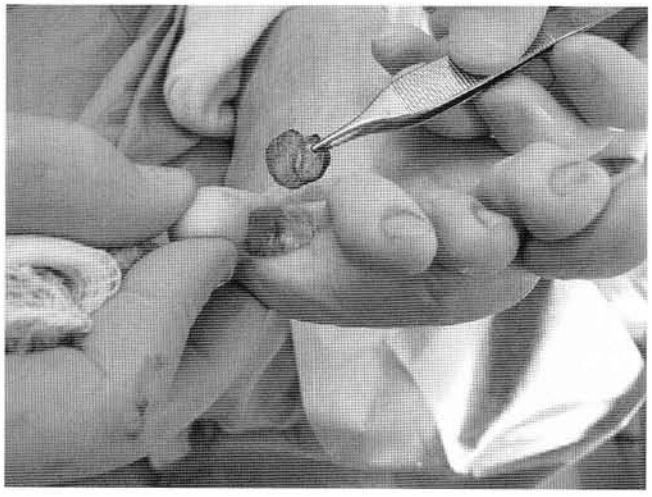

Figure 9.

Figure 10.

surgical procedures to protect the region from such forces the authors prefer the use of as full thickness skin graft for this procedure.

Postoperative bandaging should be as instrumental to the desyndactylization procedure as the suture itself, as this step will certainly contribute to a favorable post-operative outcome. The dressing applied at the time of surgery should be applied with sufficient pressure to hold the graft in place against the wound bed and prevent shear of the graft should the toes actively or passively move. The first dressing change is performed at 5 – 7 days post-op, at which time the graft is assessed for color, turgor, and any evidence of infection or dehiscence. Around one week post-operatively the wound will begin to produce a transudate which will necessitate daily dressing changes with fresh gauze placed with slight compression over the graft. Minimal to non-weight bearing is instituted until the first dressing change and is followed by a period of protected weight bearing until the graft is fully incorporated.

Excessive local skin tension or premature movement of the syndactylized digits away from each other post-operatively can lead to hypertrophic scar formation or wound dehiscence. Digital contracture is also a possibility due to scar formation or excessive sulcus tissue excision. Every measure should be taken to ensure atraumatic handling of the delicate digital tissue intra-operatively, and stability is added through proper post-operative bandaging. It is important to hold the skin edges everted while suturing the sulcus together, as invagination of the skin edges will recreate the lesion and compromise the success of the operation. When excessive tissue is removed from the dorsum of the interdigital space of central digits or the excised skin ellipse is asymmetrical, rotation of one or both of the toes may occur. This is due to a 'tear-drop' shaped defect that remains dorsally after the toes have been opposed and is then sutured under tension. Position assessment should be made intra-operatively and should be identified as related to skin wedge dimensions or to soft tissue contracture or osseous deformity of the digits. If not properly released prior to syndactylization residual joint or soft tissue contractures will result in two adjoined contracted digits. Active digital dorsiflexion and plantarflexion may be lost. This is especially true for cases involving subluxed or crossing over fifth toes where sacrifice of digital flexors may be required to reposition the toes.

Because web space maceration may be problematic for both syndactylization and desyndactylization procedures, the patient may need to paint the area daily with topical iodine solution for its drying as well as anti-microbial effects. Continued splinting with bandages, and ambulation in a rigid-soled surgical shoe is essential until the wounds are fully healed.

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