Chapter 13
Plastic Surgery Procedures for Hammertoe Correction

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Case #1 Bilobed Flap Presentation

A 52-year-old female presents with the concern of an occasionally painful lesion on the dorsal lateral aspect of her left second digit (Fig. 13.1). She notes that it has drained clear gelatinous material and reduces in size but often returns within a month or two. Shoe modification and intralesional injection, with cortisone or 4% alcohol sclerosing solution, are often attempted for conservative therapy.

Diagnosis

Digital mucoid cysts present as a solitary, round or oval, clear to flesh-colored nodular lesions on the dorsal aspect of the fingers and toes. They are uncommon in the younger population and occur in a greater frequency in females (3:1 ratio) [1]. The pathophysiology is poorly understood, but they are often located at the level of the distal interphalangeal joint and are attributed to osteoarthritic changes caused most commonly by a mallet toe deformity. The patient's symptoms result from increased pressure and shoe gear irritation. Conservative therapy often fails, requiring surgical excision [2].

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E. A. Cook, J. J. Cook (eds.), *Hammertoes*,
https://doi.org/10.1007/978-3-319-16552-3_13

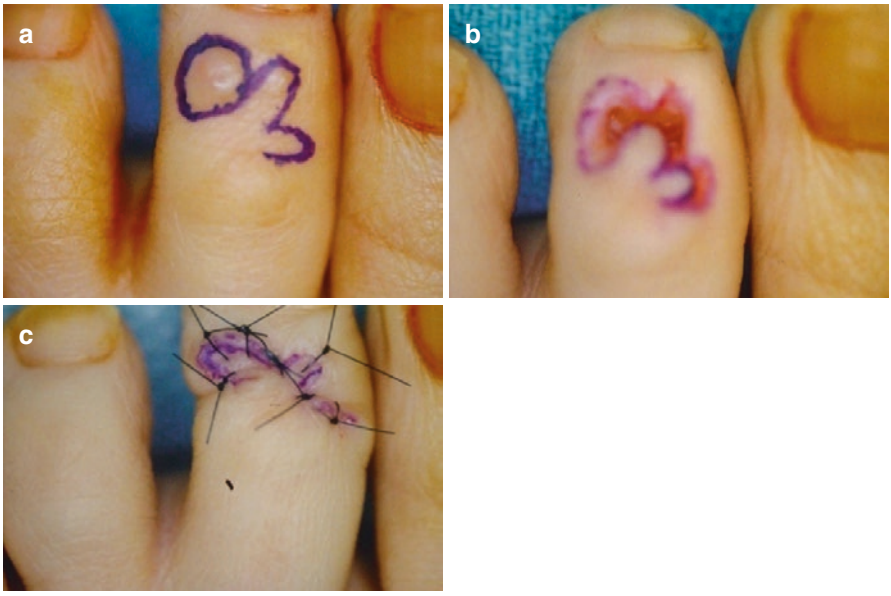

Fig. 13.1 (**a**) Small lesion noted to lateral second DIPJ. (**b**) Resection of lesion with planning of double-lobe flap outlined with skin marker. (**c**) Flap following transposition and closure with simple interrupted suturing technique

Surgical Technique and Pearls

The bilobed flap was designed to move additional skin over a larger distance than what is available with a single-lobe flap. This flap does not typically require additional skin grafting and allows for primary closure [3]. The bilobed transpositional flap extends beyond the excised lesion and utilizes adjacent donor sites for closure of the defect. This allows for redistribution and redirection of skin tension, allowing for primary closure of the soft tissue defect [4].

The two flaps that are separated by an angle share a common pedicle and encompass the epidermis, dermis, and subcutaneous tissue. The vascular supply is composed of a source artery and its associated vein from the local subdermal plexus that perforates the subcutaneous tissue.

Careful dissection, delicate soft tissue handling, and hemostasis are imperative for preservation of blood supply and tissue integrity.

The technique for creating a bilobed flap includes an initial full-thickness excision through the subcutaneous tissue of the lesion. Following excision of the lesion, assess the lines of maximal extensibility and RSTL. The pinch test can help determine how supple the adjacent tissue is and determine the axis of rotation for flap planning. Variations of the bilobed flap design exist, but the most common configuration is a 90-degree angle [5]. The rotation of this flap consists of a 360-degree circle for rotation on an axis point [6]. A design is constructed with the adjacent lobe

with 75% of the size of the original defect and the secondary lobe approximately 50% of the original defect [7]. Outlining the plan with a fine tip surgical marker works best when working on small digital areas. Full-thickness incisions perpendicular to the skin, avoiding skiving, and atraumatic technique with single-prong skin hooks can help prevent complications such as scar formation, wound edge, and flap necrosis. The flap can be elevated from deeper connective tissue, with care to include subcutaneous adipose tissue to remain within the flap. The local tissue surrounding the donor site should be carefully undermined with dissection scissors. Undermining, however, should be limited with only enough to produce laxity, thus increasing the extensibility of local skin and decreasing tension on the flap during closure. The larger adjacent flap can be rotated into the primary defect and then the second lobe into the primary flap donor site. Careful closure avoiding strangulating the soft tissue and avoiding suturing the acute angles of the flap can prevent necrosis and dehiscence at the surgical site. Closure should be performed with simple interrupted technique and with suture no larger than 4-0 nylon to avoid suture-induced ischemia. Subcutaneous sutures are rarely necessary and should be avoided to prevent tissue reactivity. Any dog ears created from excess skin should not be removed, as they will resolve spontaneously over 2–3 weeks.

Outcomes

Excision of a lesion with the adjunctive bilobed flap closure has been demonstrated to be highly curative with successful results and low complication rates as adjunctive treatment of digital mucoid cysts [8]. A retrospective review completed by this author found that there were zero recurrences, flap failures, or significant complications in a cohort of 15 patients with an average follow up of 4.6 years. This flap does not typically require additional skin grafting and allows for primary closure. The long-term reproducibility and functional outcome of the bilobed flap are quite predictable. With appropriate application and incisional planning, it can make an excellent tool for the podiatric surgeon.

Case #2 V-to-Y Advancement Flap

Presentation/History

A 46-year-old female returns to the clinic with continued frustration and pain of her left fifth toe. The toe has caused her discomfort for a number of years. Conservative offloading and padding have been unsuccessful. On exam, there is tenderness of the digit with noted soft tissue contracture of the fifth digit, without an overlying skin lesion.

Diagnosis/Assessment

Congenital overlapping fifth toe

Surgical Technique

The V-to-Y advancement type flap moves in a single direction, without any lateral or rotational components. One can only expect approximately 20% skin lengthening with the use of a V-to-Y technique [9]. The length of the V arms can vary on the degree of contracture present. The length of each individual arm should be equal. The acuity of the angle and arm length determines the lengthening achieved. The apex of the V should bisect the axis or orientation of the contracture. Undermining the surrounding tissue should be minimally performed, releasing enough tension to allow closure with 4-0 or smaller suture as undermining can violate the local vascular supply. Reapproximation of skin edges is planned with the toe held in its corrected position. It can be helpful to mark this level with a hash mark as to where the apex of the flap should be sutured to its adjacent skin edge. An apical stitch can then be thrown followed by simple interrupted closure of the remaining portion of the newly formed Y. The remaining closure can be performed with simple interrupted suturing technique (Fig. 13.2).

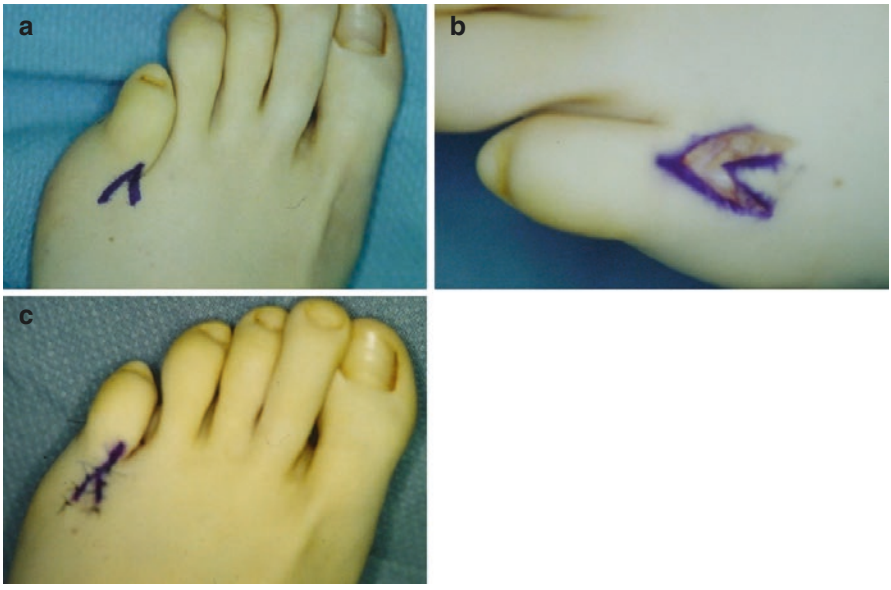

Fig. 13.2 (**a**) Congenital deformity noted at the left fifth toe with planned incision outlined with skin marker (**b**) Incision made and ready for advancement. (**c**) Closed with simple suturing technique being sure to not overly tighten sutures

Outcomes

Hand surgeons have routinely used V-to-Y flaps for digital reconstruction following traumatically amputated terminal phalanges [10], and their long-term viability has been proven.

Pearls

The V-Y advancement flap, commonly used in fingertip injuries, when indicated and carefully performed, gives excellent contour and padding. This advancement flap maintains toe length and provides good cosmesis for digital surgery [10].

Case #3 Combined Advancement Flap (Butler Procedure)

Presentation/History

A 67-year-old woman who previously underwent corrective surgery of her overlapping fifth toe was referred for a second opinion. The patient reports a history of increasing deformity and pain. She had poor results with conservative therapy consisting of padding and careful shoe gear selection. She was not pleased with her previous surgical result (Fig. 13.3). On exam, her deformity was reducible with pain on palpation to the lateral and dorsal fifth toe.

Diagnosis/Assessment

Recurrent cock up deformity of the fifth digit following hammertoe correction surgery

Surgical Technique

A modification of the Butler procedure incorporates the use of the V-to-Y and a Y-to-V to correct the deformity and was used in this revision.

The Y-to-V plasty is the opposite of the V-Y flap by increasing tension in line with the Y-to-V and releasing tension perpendicular to the flap. The incisions of the Y-V plasty are carried deep into the subcutaneous tissue layer with gentle undermining of the surrounding tissue. The subcutaneous tip of the flap should be gently

Fig. 13.3 (**a**) Recurrence of overlapping fifth toe deformity with minor scar contracture noted (**b**) Incision planned (**c**) Incision made with delicate soft tissue handling (**d**) Closed with simple interrupted suture technique

held in position with a skin hook with care taken not to damage the skin layer of the tip. Dorsally the V incision is created for planned lengthening. After the incision is made, the digit should be manually reduced, held, and marked for length of the stem of the Y. Next, the Y-to-V portion of the incision is outlined plantarly for planned excision of redundant tissue. The Y-to-V should be checked to ensure enough tissue has been resected. Once pleased with the tailoring of the final skin plasty, any adjunctive procedures can be performed as needed. The surgical incision can be closed primarily with an assistant holding the toe in a corrected position. Again, a focus on delicate tissue handling while placing apical stitches and closing the incision is imperative. It is advocated that the toe be bandaged to help hold the toe in the desired position for several weeks while healing.

Outcomes

The patient was pleased with her result and had excellent deformity correction with significant pain relief. In 1993 DeBoeck published a retrospective study of 23 cases of overriding of the fifth toe treated by Butler's arthroplasty. Satisfactory results were obtained in all but one patient, and all could wear normal shoe gear [11].

Pearls

The use of the V-Y and V-to-Y/Y-to-V combination tools is helpful in the correction of revisional surgery, as well as the congenital overlapping fifth toe. They can both provide soft tissue lengthening and have excellent exposure for adjunctive osseous and capsulotendon procedures in digital correction.

These flaps can be done in series to release a contracture over the dorsum of the forefoot, in areas of burn scar contracture or applied to contracted digits.

Case #4 Z-Plasty Presentation

A 64-year-old male presents with a recurrence of a second digit contracture of his left foot. He complains of pain at the distal tip of the toe and as a diabetic is concerned about possible ulceration. He would like to have the toe corrected to prevent a future ulceration and possible infection (Fig. 13.4).

Diagnosis

Complications including scar contracture following digital arthroplasty are not uncommon [12]. Scar formation and contracture in digital correction can produce a reducible deformity at the surgical site, thus the need for revisional surgery with soft tissue correction.

Surgical Technique

To design the z-plasty, the central limb is placed parallel to the contracture axis or along the direction of the desired length increase. The extending limbs should be of equal length with all angles created equal and parallel to the RSTL. Keeping the

Fig. 13.4 (**a**) Long arm of Z parallel to scar contracture (**b**) Incision made with delicate tissue handling (**c**) Arthrodesis of the proximal interphalangeal joint with primary closure (**d**) Incision is healed with additional length provided by Z-plasty

length and angle of each flap precisely equal is key to avoid mismatched flaps that may be difficult to close [13]. Z-plasties designed with 90° angles can create dog ears that are also difficult to excise and close primarily [14]. On the other hand, angles created too acutely can lead to necrosis of the flap tip [15]. The flaps should be fully elevated to slightly beyond their bases to allow for ease of rotation; however, care must be taken to avoid undermining the tip of the flaps. An imaginary line connecting the two noncentral incisions becomes the new central line or diagonal of the final Z after the flaps have been transposed. Careful closure is imperative to prevent dehiscence at the surgical site. Closure should be performed with simple interrupted technique and with suture no larger than 4-0 nylon to avoid suture-induced ischemia.

The first stitch should first be placed in the midpoint of the newly formed central arm. The base of the flaps should then be reapproximated followed by oblique sutures to advance the tip of each Z-flap. Finally an apical or Gillies' corner stitch can be applied to the tip of each flap for final closure.

Clinical Pearls/Pitfalls

Tissue lengthening procedure such as the Z-plasty, with or without tendon and osseous work, is a useful technique for the correction of digital deformities. It is especially useful in the correction of revisional digital procures via lengthening a linear scar contracture, dispersal of a scar tissue, and realigning a scar within the RSTL [16]. A Z-plasty should only be considered if there is sufficient skin laxity perpendicular to the direction of the skin to be lengthened, as length is gained at the expense of width [13]. The Z-plasty should also not be used if the original scar lies within the RSTL, as the newly formed central arm wound lies perpendicular to the RSTL [17]. The amount of length achieved is determined by both the arm length and angle. The basic Z-plasty (typically 60° arm angles) can be modified by varying arm length and angle [9]. Z-plasty is a useful technique in revisional digital surgery and can lengthen a scar by up to 75% and reorient the direction by 90 degrees [18–20].

Atraumatic technique with delicate tissue handling is critical for success. This involves the use of the use of skin hooks and fine-toothed forceps for tissue handling. Care should be taken to avoid compromising the flap's blood supply by traumatizing the base or twisting or kinking the base during advancement. Hemostasis is also crucial as hematoma formation can have devastating effects on flap survivability and can be performed with bipolar cautery. Hematoma increases the risk of tissue necrosis, infection, and subsequent flap failure. Nonreactive sutures are preferred for closure, and deep absorbable sutures should be avoided when possible.

Possible complications of z-plasty include flap necrosis, hematoma formation under the flaps, wound infection, trapdoor effect, and sloughing of the flap caused by high wound tension. These can be avoided by careful design planning with correct patient selection, meticulous dissection and tissue handling, appropriate hemostasis, and closing the incisions under minimal tension.

Case #5 Double Z-Plasty Presentation

A 64-year-old African American male who suffered extensive third-degree burns to the left lower extremity from a campfire accident >10 years ago presents for evaluation. He relates pain to the distal dorsal second toe from rubbing in shoe gear and

difficulty in wearing steel-toed boots required for his work. He has failed all conservative measures of tapping and padding and would like to pursue surgical correction.

Diagnosis/Assessment

Ridged elevated second digit secondary to scar contracture from third-degree burns to the left foot

Surgical Technique

A double Z-plasty, a modified version of the single Z-plasty, can be used when there is insufficient laxity of adjacent soft tissues in an area that does not permit the use of a large single Z-plasty. Two Z-plasties are designed so that their central incision or diagonal stem of the Z is parallel (Fig. 13.5b). The initial incision, which will become the diagonal line of the Z, is made longitudinally along the length of the scar or along the direction to be lengthened. The other incisions are then made off of this central line at 45°–60° angles and should parallel the RSTL. The limbs of the Z-shaped incision should be of equal length. The flaps are then elevated and transposed in a manner similar to the single Z-plasty reviewed in the previous case.

Outcomes

Three cases of necrosis of tip of Z-plasty flaps occurred which were under 3 mm and resolved gradually in a cohort of 23 patients who underwent double Z-plasties for burn contractors of the hand [21]. In three contractures, the release was inadequate, and an additional procedure under local anesthesia was performed to achieve deformity correction [21].

Pearls

The repair of postburn deformities must prioritize function over form, must be based on careful assessment of the patient's goals and desires, and should respect the timing and duration of physiologic scar maturation [22]. Achauer noted that the optimum timing of reconstructive surgery from a biological standpoint is diametrically

Fig. 13.5 (**a**) Significant scaring present from full-thickness burns (**b**) Incision outlined with skin marker (**c**) Incision made full thickness (**d**) Incision reapproximated in improved position

opposed to the optimum timing from the standpoint of rehabilitation and the patient's mental well-being [23]. Scar maturation usually occurs around 12 months post burn, and therefore most corrective procedures should be delayed at least this long. Others advocate waiting up to 2 years for full scar maturation before proceeding with reconstructive surgery [24]. Surgical manipulation of an active, red, immature scar is not only technically more difficult but also may be associated with renewed and more aggressive scar formation postoperatively. Furthermore, many hypertrophic scars tend to involute over time [22].

Clinical Pearls/Pitfalls

The successful incorporation of a tissue transfer for digital reconstruction should include several steps. A surgeon must identify the goals of the flap which ultimately provide landmarks for design, orientation, and anatomic application. This will allow for correct incision planning. The general health assessment of the patient, the source of blood flow to the flap, donor site and recipient site selection, and the optimum positioning and design of the flap are paramount to its success. The viability of the flap is directly and proportionally affected by the level of atraumatic technique used and the reduction in undermining peripherally to the flap. Hemostasis must remain a priority because hematoma formation can have devastating effects on flap survivability. Hematoma increases the risk of tissue necrosis, infection, and subsequent flap loss. The donor site must be evaluated for tissue mobility and elasticity in order to reduce tension after transposition. The manual pinch test is very useful for this indication. One should always have a backup plan when considering flap elevation and division due to the possibility of the flap failure. The adverse outcome can leave the patient with a large tissue deficit and impact healing and function. The intraoperative care of the flap does play a direct role in the success of the flap. Atraumatic dissection and careful handling of the flap are highly recommended. This involves the use of bipolar cautery, sharp dissection rather than cautery dissection, the use of skin hooks or fine-toothed forceps to handle tissue, and delicate handling of the flap. Care should be taken to avoid compromising the flap's blood supply by traumatizing the base or twisting or kinking the base during movement. Nonreactive sutures are preferred for closure, and deep absorbable sutures should be avoided when possible.

Advancement flaps should be placed so as to benefit from the elasticity of the surrounding skin while bearing in mind the regional blood supply. They should be perpendicular to the RSTL and advance in a movement parallel to the LME. Although advancement flaps allow for closure of the donor and defect simultaneously, their use can be limited in the foot, due to mobility restrictions and the need for broad exposure to underlying osseous pathology.

Summary

The bilobed flap, V-Y skin plasty, and Z-plasty are extremely useful adjunctive procedures for correction of digital deformities. Multiple geometric constructs have been described, and each has its own unique principles which can be adapted to certain locations and conditions. The versatility, reproducibility, and long-term functional outcomes that these flaps provide are well known and should be utilized where appropriate by today's foot and ankle surgeon.

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