Groin Flap Design and Versatility

David C. C. Chuang, M.D., L. H. Colony, M.D., H. C. Chen, M.D., and F. C. Wei, M.D.
Taipei, Taiwan, and East Lansing, Mich.

The groin flap is a reliable and well-established reconstructive option for pedicled or free-tissue transfer. Concern regarding its variable vascular origin and caliber has limited its use. To overcome this, a simplified guideline based on the transverse diameter of the patient's index and long fingers at the distal interphalangeal level has been developed. Thus “rule of two finger widths” positions the origin of the vascular pedicle from the femoral vessels two finger widths below the inguinal ligament, the upper flap border two finger widths above the inguinal ligament, the lower flap border two finger widths below the vascular origin, and both parallel to the flap axis, which lies along a line from the vascular origin to the anterosuperior iliac spine. This new groin flap design provides the necessary guidelines for vascular identification, accommodates pediatric and adult stature, and ensures primary donor-site closure if flap dimensions are within the prescribed boundaries.

In addition, a new sartorius-cutaneous groin flap is presented. This combines the cutaneous groin flap with the proximal sartorius muscle (up to 15 cm), which is supplied by the deep vessels of the superficial circumflex iliac system. The sartorius-cutaneous groin flap further emphasizes the concept of single-pedicle compound or combined flaps and additionally enhances the extensive reconstructive versatility of previously described groin flaps.

Over 200 pedicled and free groin flaps have been performed according to the “rule of two finger widths” over the past 5 years. There have been no complications related to flap design, such as difficulty with flap elevation, marginal necrosis, or donor-site closure. Four cases of free sartorius-cutaneous groin flaps have been performed, with complete survival of the skin flap as well as the skin graft on the sartorius muscle in each patient.

Since first described by McGregor and Jackson in 1972,1,2 the pedicled groin flap modification of the Wood3,4 and Shaw5,6 abdominal flaps has been widely used in reconstructive surgery. In 1973, Daniel and Taylor7 and O’Brien et al.8 expanded the usefulness of this donor site by successfully employing free groin flaps for lower extremity reconstruction. Although initially a popular form of free-tissue transfer, the groin flap has subsequently been used less frequently as other donor sites have emerged. Reasons for this decline in popularity may include the variable origin, limited length, and inconsistent caliber of the vascular pedicle, as well as excessive bulk in obese patients. Despite these disadvantages, the groin flap remains a solidly established method of reconstruction for pedicled or free transfer.9-11 The purpose of this paper is to outline techniques that improve groin flap usefulness and demonstrate the versatility of groin flap reconstruction. Specifically, a simple and reliable method for groin flap design, the “rule of two finger widths,” will be presented, and a new sartorius-cutaneous groin flap will be described that emphasizes the principle of compound or combined flaps from the groin region.

MATERIALS AND METHODS

During the 5-year period from January 1 of 1983 through January of 1988, over 200 pedicled and free groin flaps have been performed at Chang Gung Memorial Hospital. The design and elevation of many of these flaps have been facilitated by the use of the “rule of two finger widths.” The two-finger-widths rule is based on the transverse diameter of the patient's index and long fingers at the distal interphalangeal level. This principle allows for simplified design, safe dissection, and primary donor-site closure. The relative consistency of the width of the radial two fingers among adults (3.5 to 4.0 cm) allows the operator's fingers to serve as the drawing template after initial comparison with the
In clinical practice, the usual operator-patient variability of less than 0.5 cm can be easily adjusted for during marking and has little effect on final flap design. Moreover, no design alterations have been necessary for patients with unusually broad or slender digits. However, pediatric patients do require strict attention to radial finger width assessment and accurate flap marking but still conform to the two-finger-widths rule.

**Design**

Using the two-finger-widths rule, easy and rapid intraoperative or bedside flap design is possible. The bony landmarks of the anterosuperior iliac spine (ASIS) and pubic tubercle are palpated, and the course of the inguinal ligament is marked (Fig. 1, dashed line). The femoral artery (FA) is then palpated and marked. Its course represents the **medial flap border**. Point 1 (Fig. 1), the origin of the superficial circumflex iliac artery (SCIA) from the femoral artery, is located within two finger widths below the junction of the inguinal ligament and the femoral artery. Intraoperative exploration has confirmed the origin of the superficial circumflex iliac artery within this interval in all cases of free or island groin flaps. The course of this artery, also the axis of the flap, is then drawn from its origin on the femoral artery (point 1) to the anterosuperior iliac spine. The superficial circumflex iliac artery divides into a superficial and deep branch medial to the sartorius within the femoral triangle. At point 2 (Fig. 1), two finger widths medial to the anterosuperior iliac spine, the superficial branch of the superficial circumflex iliac artery emerges from beneath the deep fascia to continue a more superficial course, while the deep branch of the superficial circumflex iliac artery enters the sartorius to supply the proximal end of the muscle. The **upper flap border** is identified medially two finger widths above the inguinal ligament parallel to the superficial circumflex iliac artery course. The **lower flap border** is also parallel to the superficial circumflex iliac artery course and is marked two finger widths below the superficial circumflex iliac artery origin (point 1). The position of the **lateral flap border** is usually determined by recipient-site requirements. Flap length-to-width ratio beyond the anterosuperior iliac spine is usually kept at 1:1 for safety. Once markings are complete (Fig. 2), specific flap configuration along the central axis can be outlined depending on donor-site requirements. If drawn within the identified boundaries, direct donor-site closure is ensured. Based on a patient’s two finger widths of up to 4 cm, a flap 12 cm wide can be harvested. In flaps so designed, sufficient undermining and hip flexion have allowed primary closure in 100 percent of patients.

**Dissection**

The bidirectional dissection plan outlined by Daniel and Terzis and others is helpful because laterally the superficial circumflex iliac artery course is constant and medially its origin is variable (from the common femoral, profunda femoral, external pudendal, or superficial epigastric arteries). This allows for a rapid lateral-to-medial dissection and a slow, meticulous medial-to-lateral dissection. Flap elevation is com-
completed as the lateral and medial dissections progress toward one another.

The conventional groin flap is based on the superficial branch of the superficial circumflex iliac artery, which begins its superficial course two finger widths medial to the anterosuperior iliac spine as it exits the femoral triangle (point 2 in Fig. 1). This vessel is best protected by harvesting the anterior sartorius fascia with the cutaneous groin flap, even though this may risk injury to the lateral femoral cutaneous nerve (Fig. 3, A and B). The fascia is incised longitudinally along the lateral muscle border and elevated from lateral to medial. Prior to incising the medial muscle fascia from beneath, the superficial branch is visualized through the fascia and protected, while the deep superficial circumflex iliac artery branch penetrating the fascia is ligated. This deep vessel originates within the femoral triangle at the superficial circumflex iliac artery bifurcation and courses deep and laterally beneath the anterior sartorius fascia supplying the muscle.

Because donor vessels are often small, prior to transection of the vascular pedicle, careful assessment of the required vascular caliber is necessary. During microvascular anastomosis, most vascular discrepancies can be overcome by traditional methods of instrument dilation, oblique sectioning, fish-mouthing, and end-to-side techniques. In the case of the groin flap, additional terminal vascular diameter can be obtained by harvesting a wedge or cuff (Fig. 4, A) of femoral artery and vein with the vascular pedicle. The femoral vessels may be closed directly or with a vein patch if required. A more practical technique can be employed when the superficial circumflex iliac artery and superficial epigastric artery have a common trunk or proximally positioned side branches (even if small). The bifurcation is split and opened by incising longitudinally the inner V portion of the bifurcation from the open vessel ends. This maneuver dramatically increases the diameter available for anastomosis and provides a smooth transition between larger recipient and smaller donor vessels (Fig. 4, B).

**SARTORIUS-CUTANEOUS GROIN FLAP**

Previously described groin flap anatomy has documented the superficial circumflex iliac ar...
Fig. 5. Sartorius-cutaneous groin flap.

tery course and its division into superficial and deep branches. Clinically, as noted in the preceding section, the deep superficial circumflex iliac artery branch and accompanying vein run deep to the sartorius fascia. This pedicle enters and supplies the proximal sartorius muscle and is the basis for a newly devised sartorius-cutaneous groin flap (Fig. 5). Frequently, a more medially located smaller pedicle from the superficial circumflex iliac artery also supplies the proximal muscle and should be preserved. The type IV segmental vascular supply of the sartorius generally prohibits muscle transfer. However, the proximal 15 cm has been reliably transferred in four patients (from January of 1986 through December of 1987) based on the deep vessels of the superficial circumflex iliac system. The length of proximal sartorius transferred in this manner should not extend beyond 15 cm and usually requires division of two distal segmental pedicles. Beyond this level, muscle viability is questionable. In clinical cases, active bleeding from the cut muscle edge and the distally divided segmental pedicles is mandatory to provide assurance of adequate muscle vascularity. Initial muscle coverage with porcine skin followed by delayed split-thickness skin grafting is recommended.

Dissection of this new flap begins identically to that of cutaneous groin flap elevation (Fig. 3, A). The lateral sartorius fascia is similarly incised longitudinally during the lateral to medial dissection. The muscle may then be safely elevated from its posterior fascia beginning posteriorly and inferiorly away from the deep vessels previously described (Fig. 3, C). Once mobilized, the muscle is divided distally at the selected level and proximally at its anterosuperior iliac spine origin, and the medial muscle fascia is divided from beneath after the pedicle is visualized. This flap incorporates both the superficial and deep branches of the superficial circumflex iliac artery, and no direct exploration of the deep branch is necessary. As the muscle is raised from its posterior fascia, ligation of two or more medially located segmental pedicles may be required. The remaining medial groin flap dissection within the femoral triangle follows.

Case Reports

Case 1

A 20-year-old man suffered a severe nonreplantable crushing amputation of the radial border of his nondominant left hand. The amputation level extended obliquely through the base of the first and midpoint of the second metacarpals and through the distal phalanges of the long and ring fingers (Fig. 6, above, left). A salvaged portion of the distal index metacarpal was used acutely as a conventional bone graft to elongate the thumb metacarpal (Fig. 6, above, right). Because well-vascularized muscle coverage of the bone graft was sought, the proximal sartorius was elevated with the groin flap being raised for wound coverage. The muscle demonstrated excellent viability and was wrapped around the bone graft (Fig. 6, center, left). The cutaneous portion of the sartorius-cutaneous groin flap was then employed to cover the muscle and remaining open wound (Fig. 6, center, right). Following uncomplicated pedicle division at 4 weeks, excellent primary healing was achieved in preparation for toe-to-thumb transfer (Fig. 6, below).

Case 2

A 27-year-old man sustained a punch-press injury to the wrist area of his dominant right upper extremity (Fig. 7, above, left). Damage to deep structures included open fracture dislocation of the carpus and first two metacarpals, multiple flexor and extensor tendon ruptures, and transection of the radial and ulnar arteries and ulnar nerve. Following removal of devitalized tissue, fracture fixation, revascularization, and tendon and nerve repair, additional debridement of nonviable skin and soft tissue dorsally was necessary (Fig. 7, above, right). This resulted in a 5-cm-wide volar soft-tissue defect with exposed vascular, nerve, and tendon repairs. Dorsally and radially, extensor tendons over the first, second, and third metacarpals were exposed from the wrist to the metacarpophalangeal joints. Wound coverage in two planes was required, both volar and dorsal.

Reconstruction was accomplished acutely with a free sartorius-cutaneous groin flap. This included the proximal 10 cm of the sartorius muscle and a 6 × 14 cm cutaneous groin flap on a single vascular pedicle. Following transfer and revascularization, the groin flap was positioned over the raw volar wrist surface, and the muscle portion was rotated to cover the dorsal-radial defect and initially dressed with porcine skin followed by delayed split-thickness skin grafting (Fig. 7, center, left). The donor site was closed primarily, and the patient’s postoperative course was uncomplicated. The overall reconstructed appearance and functional recovery were excellent (Fig. 7, center, right, and below).

Discussion

Numerous anatomic and clinical studies have been published regarding groin flap anatomy.
and application since the flap was first described in 1972.12,7-16,18-25 These studies have demonstrated general agreement that the flap axis overlies the superficial circumflex iliac artery course. This axis is consistently directed from the point of superficial circumflex iliac artery origin to the anterosuperior iliac spine. In spite of their constant course, the superficial circumflex iliac vessels have a variable point and pattern of origin. The level of vascular origin has been described as between 2.5 cm16 and 5 cm14 below the inguinal ligament, and four potential vascular patterns have been found at this site by Harii et al.11

Unfortunately, because of this inconsistent anatomy, pinpoint localization of the groin flap pedicle is not possible preoperatively. This va

FIG. 6. Pedicled sartorius-cutaneous groin flap. (Above, left) A 20-year-old man with radial left hand amputation. (Above, right) Acute thumb metacarpal bone graft. (Center, left) Positioning of sartorius muscle. (Center, right) Pedicled cutaneous portion of flap. (Below) Primary healing prior to toe-to-thumb transfer.
Variability may direct some surgeons to other reconstructive alternatives with more definable anatomy, although it need not be a deterrent to utilizing this most easily concealed of all donor sites. The "rule of two finger widths" can help surgeons overcome concerns regarding anatomic variation in the groin region. It provides the necessary guidelines for proper flap design and vascular origin identification within two finger widths below the inguinal ligament. The two-finger-widths rule simply positions key points, accommodates pediatric and adult stature, and ensures primary donor-site closure if the flap dimensions are within the prescribed boundaries. Employing this new groin flap design with previously described dissection plans facilitates time-
saving flap harvest while emphasizing the appropriate caution and flexibility necessary to preserve the vascular pedicle.

While the outlined design format can help eliminate concern regarding vascular variations, the microvascular techniques described can overcome anastomotic size discrepancies due to potentially limited donor-vessel caliber. However, the remaining disadvantage of flap bulkiness in obese patients remains largely unanswered. Positioning the flap more laterally, as in Acland's iliac free flap, only partially improves the situation. The only documented potential solution has been DeHaan et al. 's case report of rapid groin flap expansion (11 days). In addition to providing a large, well-vascularized flap with limited donor-site deformity, the transferred tissue was noted to be dramatically thinned and surprisingly supple. The precise indications for rapidly expanded groin flaps and whether flap bulkiness can reliably be eliminated in obese patients await further application.

The sartorius-cutaneous groin flap presented is a new reconstructive option from a familiar donor region. It is not a true musculocutaneous flap because the cutaneous portion of the flap is not supplied by direct musculocutaneous perforating vessels. This muscle-cutaneous type of donor tissue can have the added flexibility of reconstructing defects at differing levels or depths, as well as in two different planes. It may be employed for upper extremity coverage as a pedicled flap or have broader indications as a free flap.

The concept of compound or combination flaps, such as the sartorius-cutaneous groin flap, is not new and has been widely applied in other regions. Familiar examples include the fibular osteoseptocutaneous flap combined with the lateral soleus and latissimus dorsi combinations with scapular, parascapular, axillary, and serratus anterior. In addition to these naturally occurring flap combinations, artificial single-pedicle flaps such as the free latissimus dorsi and fibular combination also have been devised. The principle of compound or combined tissue transfer on a single pedicle not only increases the area of flap coverage, but also enhances the overall usefulness of existing donor sites.

Nowhere has the concept of compound or combined flaps been so widely applied as in the groin region. Following description of the pedicled and free cutaneous flaps in 1972 and 1973, respectively, Taylor and Watson developed the osteocutaneous flap in 1978, and Taylor et al. documented its deep vascular supply in 1979. This same vascular pedicle was utilized when Ramasastry et al. outlined the internal oblique muscle and myo-osseous flaps in 1984. Wei et al. later outlined the fasciocutaneous (with external oblique aponeurosis) and osteofasciocutaneous (external oblique aponeurosis and iliac crest) groin flaps for Achilles tendon reconstruction with or without associated bony defects. The sartorius-cutaneous groin flap serves to emphasize the concept of compound or combined flaps and additionally highlight the reconstructive flexibility of the groin region. This extensive versatility and applicability of the groin flap and its limited donor-site deformity continue to make it an excellent reconstructive option.

David C. C. Chuang, M.D.
Department of Plastic and Reconstructive Surgery
Chang Gung Memorial Hospital
199, Tung Hwa North Road
Taipei, Taiwan

REFERENCES