Radial Forearm

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KEYWORDS

• Forearm • Flap • Penile • Phallus • Transgender men • Neourethra

KEY POINTS

- The forearm flap is an excellent option for phalloplasty.
- The more subcutaneous fat there is, the wider the flap needs to be.
- The wider the flap, the more veins need to be anastomosed.
- Urethral stenosis and fistulas are the most frequent complication, especially in transgender men.
- An unsightly donor site scar is the primary disadvantage.

INTRODUCTION

The radial forearm free flap (RFFF) was originally developed by plastic surgeons at the Shen-Yang Military General Hospital (in China) in 1978. The first publication describing this flap was in a Chinese medical journal in 1981.[1] In 1982 Ruyao Song and his group from The Plastic Surgery Hospital in Ba-Da-Chu, Beijing, China, brought this concept to the English-speaking world by reporting on their initial experience using the forearm flap in 31 patients with burn scar contractures of the neck.[2] In 1988, Biemer reported that the first use of the radial arm flap for penile construction in transsexuals was performed by his group in the early 1980s.[3] They incorporated a portion of the radius as a stiffener, coapted nerves for sensation, and fabricated the urethra with a skin graft. The next major advance in penile reconstruction was in 1984, when Chang and Hwang[4] as well as Kao and colleagues[5,6] independently reported their (almost exactly alike) 1-stage tube-within-a-tube design of the RFFF. The primary advance that this design brought to the field was the creation of a vascularized urethra incorporated into the neophallus (a tube-within-a-tube) in 1 stage. Prior to this, the neourethra was fabricated with a skin graft or prefabricated with a multistaged tubed pedicle flap. It should be noted that the urethral construction made of skin grafts or marginally perfused flaps invariably led to increased urethral complications. Despite the great advance of the tube-within-a-tube design, during the next 3 decades, the design of the forearm flap for neophallic construction has gone through many modifications as there remained some issues to be resolved, particularly in transgender men. This article will highlight these issues and discuss how the author and others have attempted to address them.

Fat

Most patients in the Western hemisphere have more subcutaneous fat and hair on their forearms than patients from Asia. Because of the increase in subcutaneous tissue, the width of the flap needs to be wider than initially described, occasionally requiring close to the entire circumference of the forearm or supplementing closure of the neophallic shaft with a skin graft. Because of the difficulty with 3-dimensional rolling and folding with increased subcutaneous tissue, morbid obesity precludes the use of the tube-within-a-tube design of the forearm flap.

Hair

Hair seems to be less of an issue than originally thought. The fine hair of forearm may be aesthetically displeasing when on the shaft but does not cause stones and tends to cause fewer of the issues typically caused when pubic hair-bearing skin (from scrotal inlays) was used to line the urinary tract. Many patients concerned about the

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aesthetics elect to get their forearm hair removed by electrolysis or laser prior to flap elevation.

Urethra

Urethral strictures, stenosis, leaks, and fistulas have plagued almost all designs and techniques, especially in transgender men. The stenoses tend to be at the circumferential sutures lines proximally and distally, Semple and colleagues[7] eradicated distal/meatal stenosis by eliminating the distal circumferential suture line using a cricket bat shaped flap design. The downside of this design was the need to fold the flap in half, resulting in a neophallus that was generally too short, especially for transmen who have a naturally short native urethra where a longer proximal neo-urethral extension is helpful. The author and colleagues have incorporated this concept with a centrally placed urethra with a distal extension that gets folded over to create a semblance of a neoglans and eliminates the distal/meatal suture line.[8]

Proximal urethral reconstruction without leaks or strictures has been a formidable challenge. Because the short, more posteriorly located female urethra lacks the bulbous portion of a male urethra, either the constructed neourethra needs to be long enough to reach the native orifice or the native female urethra needs to be lengthened, or some of both needs to be done to avoid anastomotic tension or the inadvertent positioning of the entire construct too posteriorly. Inadequate vascularity of these extensions (either from the native tissues or from the flap) leads to fistulae and strictures. This has led the author recently to extend the female urethra (along with performing a vaginectomy) at a preliminary surgical stage at least 3 months before phalloplasty to ensure a healed, patent urethral extension at the time of urethral anastomoses.

Anatomy

The beauty of the RFFF is its relative thinness, flexibility, and reliable anatomy, which includes the forearm skin, its underlying adipose tissue, the sensory medial and lateral antebrachial cutaneous sensory nerves, superficial and deep veins, and part of the deep fascia. The flap is connected to the radial artery and its venae comitantes by a thin intermuscular septum that contains cutaneous perforating vessels. Typically, 4 to 6 perforating vessels emerge from the proximal and distal thirds of the radial artery, and there is a paucity of perforators found in the middle third of the artery. From its earliest descriptions, adequate venous drainage has been emphasized. The most inconsistent component of the forearm anatomy is the arrangement of the superficial venous drainage, particularly when wide flaps are designed. The fact that the deep and superficial venous systems are usually connected via the profundus cubitalis vein allows for 1 large-caliber venous anastomosis to drain both.[9,10] Moving more proximal up the arm, all the veins coalesce into 1 large vein, or they continue to drain independently. It is imperative to be sure that the all components of the flap (radial, central, and ulnar) have adequate venous drainage.

ROOM SETUP

Patients are initially placed in the lithotomy position. Urologists then place a suprapubic tube. If vaginectomy and urethral lengthening have already been performed at a previous surgery, the patient is then taken out of lithotomy and placed supine in a frog-leg position with knees supported on pillows. The donor (usually nondominant) arm is placed on an arm table. The thighs should be prepared into the sterile field to allow for harvesting of the saphenous vein transposition loop/graft as well as skin graft harvest for donor site closure. Sequential pneumatic lower extremity compression boots are used to decrease the risk of deep venous thrombosis.

FLAP DESIGN AND DIMENSIONS

A preoperative Allen test should be performed on all patients for whom a radial forearm flap is being considered. Arteriograms are usually unnecessary. Patients with an equivocal Allen test may undergo duplex Doppler imaging to delineate the vascular anatomy of the palmar arch of the hand.

Patients who did not undergo preoperative electrolysis or laser hair removal of the arm should not be shaved, as this allows for neourethral markings to be planned reliably in an area with the least amount of hair. It is also helpful to mark the course of the radial artery and any visible veins during this time.

The flap is designed with a centrally located neourethra in continuity with a neoglans. This design avoids a circumferential meatal suture line without sacrificing length and leads to an improved aesthetic result. The dimensions of the flap depend on the patient's needs and desires, as well as the size of the forearm and the amount of subcutaneous tissue present. The width of the flap should vary directly with the amount of subcutaneous tissue present; the more subcutaneous tissue, the wider the flap needs to be to allow for constructing the tube-within-a-tube design. In most cases, the author's flap dimensions are a