Triceps Augmentation

4

Introduction

As men are increasingly becoming interested in cosmetic surgery, surgeons have to modify procedures and create new ones to meet the needs of the male population [1, 2]. With the advent of the biceps augmentation in 2004, the introduction of the triceps augmentation procedure was a natural progression. Many patients presented for muscle augmentation surgery and wanted a circumferential upper extremity augmentation. As there was no established procedure or formal implant in use, it was necessary to construct an implant that would easily fit below the long head of the triceps or under the deep investing fascia of the arm, depending on the patient's needs. This implant had to be pliable and yet sturdy enough to resist the constant movement of the arm and contraction of the upper extremity musculature. Using the Chugay Biceps Prosthesis as a starting point, a custom-designed triceps prosthesis was developed to help achieve augmentation in the triceps area for reconstructive and cosmetic needs.

Body Dissatisfaction in Males

It stands to emphasize that many men have some element of body dysmorphic disorder and wish to have a more muscular and "built" physique in order to be better accepted in society and by the opposite sex [3–8]. Society has created an idealistic model of the male that is oftentimes hard to attain with simple diet and exercise alone. For this reason, muscle augmentation surgery of the upper extremity, both biceps and triceps augmentation, gives a male the opportunity to achieve this ideal.

History of the Procedure

Triceps augmentation really takes its early steps in the work done by various surgeons to augment the bicipital region. The biceps implant, as mentioned previously, was initially used by surgeons to help in the reconstruction of soft tissue defects of the upper extremity left by significant trauma or post-oncologic surgery [9]. Hodgkinson further added to the literature on the use of solid silicone implants for restoration of symmetry and addition of volume to traumatized extremities [10]. In his paper from 2006, he discusses the use of silicone implants to add volume to the upper extremity after ruptures of triceps and biceps muscles and in cases of axillary nerve injury that showed degeneration of the deltoid muscle.

Using his experience with biceps augmentation and having a good understanding of the upper extremity musculature and neurovascular structures, the primary author sought to begin performing triceps augmentation not only for restoration of volume following traumatic injury or as a result of congenital abnormalities but to aid those patients who wished to increase the volume of the triceps region purely for vanity [11, 12]. In 2010, the primary author published his work on

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14 patients that received triceps augmentation from 2008 to 2010 [13]. All of the initial procedures were performed via an incision in the axilla and placement of the implant primarily in the submuscular plane. In the primary author's experience, greater risks for complications were possible with placement of the implant under the muscle, as in biceps augmentation, and for that reason the author routinely uses the subfascial plane for augmentation in the vast majority of cases. With placement solely beneath the fascia, the improved contour was similarly noted but without the increased risk of damage to vital neurovascular structures.

In 2012, Abadesso and Serra [14] published their work on 32 cases of biceps augmentation for improving the cosmetic appearance of the arms. They used calf implants in the submuscular plane to achieve the desired augmentation. Although the majority of their cases were performed for biceps augmentation, the authors do note that they were able to achieve a triceps augmentation in one patient who very much liked the aesthetics of his biceps augmentation. Using two stacked calf implants secured by a 3-0 nylon suture as they did for biceps augmentation, the authors placed this stacked set of implants beneath the triceps muscle to achieve a triceps augmentation. The incision used is the same one described for their biceps augmentation, namely, an S-shaped incision in the midarm region over the intermuscular septum.

Indications

Initially, triceps augmentation was introduced as a means to treating asymmetries in the arm region left due to congenital anomalies and trauma producing atrophy of muscles in the upper extremity and in those patients who suffered volume deficits secondary to trauma or post-oncologic surgery. Triceps augmentation, for purely aesthetic reasons, is indicated for the patient who has hypoplasia in the area of the triceps muscle. It can be used in the patient who has a condition from birth resulting in hypoplasia or may be applied to a patient who is unsuccessful in achieving the desired volume in the region of the triceps, despite aggressive weight training (e.g., bodybuilders).

Contraindications

While not every male presenting for triceps augmentation suffers from muscle dysmorphia/body dysmorphic disorder, the surgeon must be aware of this and take it into consideration when considering a patient for muscle augmentation surgery. A patient who seems unrealistic in the goals of his surgery should be turned away.

Limitations

In any initial triceps augmentation, patients are instructed on the fact that they can achieve an augmentation of approximately 1 inch in added circumference of the arm. Larger augmentations may require a second operation with larger, custom implants. Also, patients are instructed that while biceps and triceps augmentations can be performed, it is safer to separate this into two separate surgeries to avoid the risk of compartment syndrome in the upper extremity.

Relevant Anatomy

The technique described herein is ideal in that it avoids major neurovascular structures in the upper extremity. The posterior compartment of the arm is relatively devoid of major structures in the superficial planes. However, for completeness sake we will review some of the basic anatomy that is pertinent to the discussion of triceps augmentation.

An axial section through the midarm shows much of the relevant anatomy for triceps augmentation (Fig. 4.1). Two distinct muscular compartments (anterior and posterior) exist and are separated by the medial and lateral intermuscular septa and humerus [15]. The medial and lateral intermuscular septa arise from the humerus and insert into the brachial fascia, which covers the superficial muscles of the anterior compartment. The anterior compartment is composed of the biceps brachii, brachialis, and coracobrachialis.

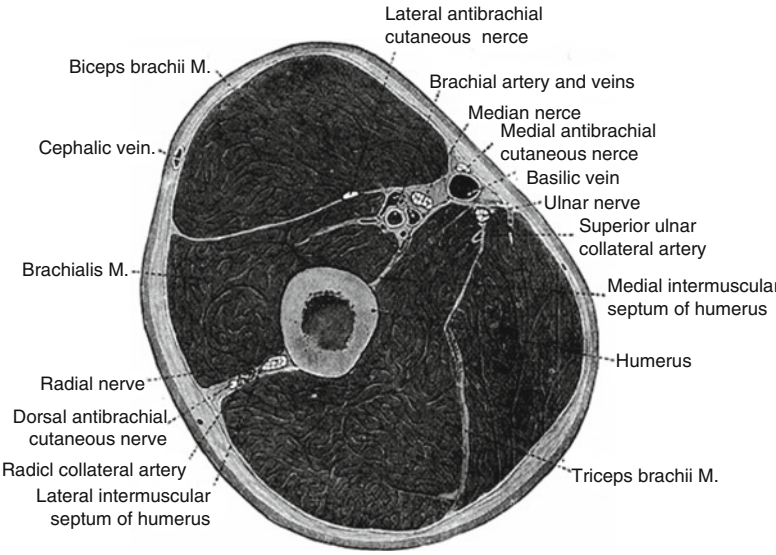


Fig. 4.1 Axial cross section of the arm showing the humerus with medial and lateral intermuscular septa that separate anterior from posterior compartments of the arm. The anterior compartment is composed of the biceps brachii, brachialis, and coracobrachialis. The posterior compartment is composed of the triceps muscle. Major neurovascular structures are primarily localized to the medial aspect of the arm

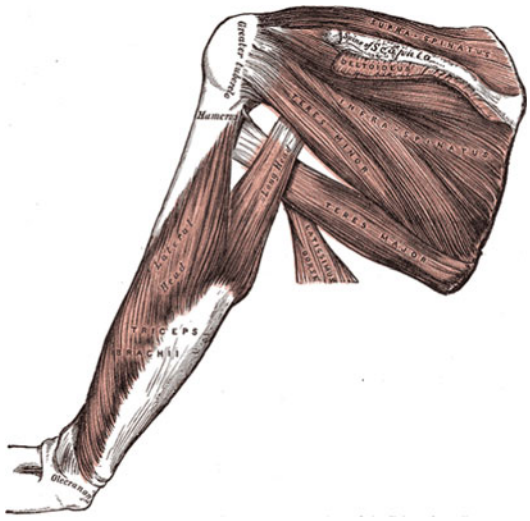


Fig. 4.2 Diagram depicting the triceps muscle, focusing on the lateral and long heads of the triceps which are most superficial and pertinent to the dissection for triceps augmentation. The medial head of the triceps is not visualized

The posterior compartment, also covered by extensions of the intermuscular septa, is comprised of the triceps muscle, which acts in extension of the forearm. The triceps brachii is composed of three heads (Fig. 4.2). The long head arises by a flattened tendon from the infraglenoid tuberosity of the scapula. The lateral head arises from the posterior surface of the body of the humerus. The medial head arises from the posterior surface of the body of the humerus, below the groove for the radial nerve. The three heads then converge into one triceps tendon which begins about the middle of the muscle and inserts into the posterior portion of the olecranon of the ulna. Most superficial of these three heads is the long head of the triceps. Also in a very superficial position, but more laterally, is the lateral head of the triceps muscle. The medial head is found deeper, adjacent to the medial aspect of the humerus.

The major neurovascular structures of the arm are located in an extracompartmental location on the medial aspect of the arm (Fig. 4.3). The basilic vein plays a major role in the superficial venous drainage of the upper extremity. It runs upward along the medial border of the biceps brachii; perforates the deep fascia slightly below the middle of the arm; and, ascending on the medial side of the brachial artery to the lower border of the teres major, continues onward as the axillary vein. The brachial artery (a continuation of the axillary artery) commences at the lower margin of the tendon of the teres major and, passing down the arm, ends about 1 cm below the bend of the elbow, where it divides into the radial and ulnar arteries. At first, the brachial artery lies medial to the humerus; however, it gradually moves in front of the bone as it runs down the arm, and at the bend of the elbow, it lies midway between its two epicondyles. The brachial artery is the major supplier of blood flow to

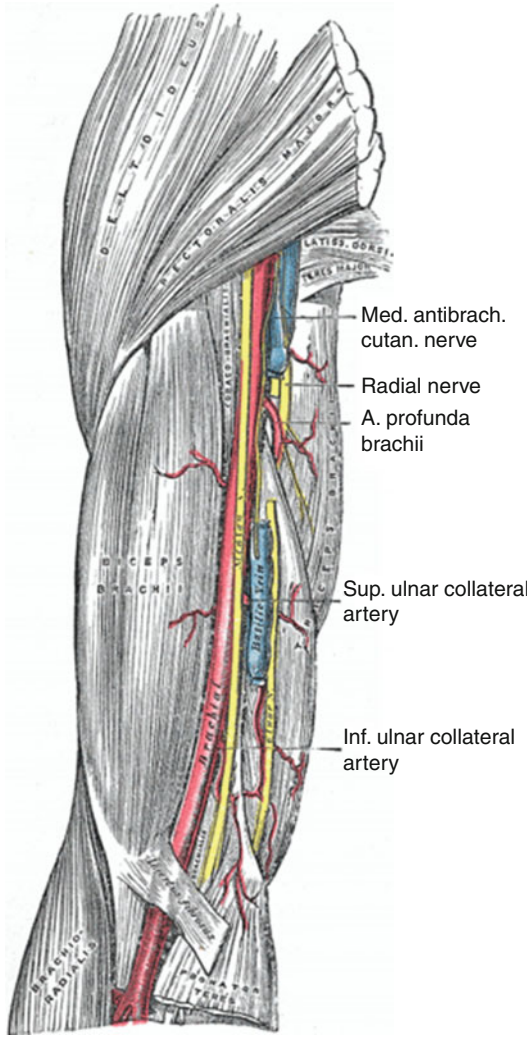


Fig. 4.3 Major neurovascular structures located in medial aspect of the arm in the extracompartmental space

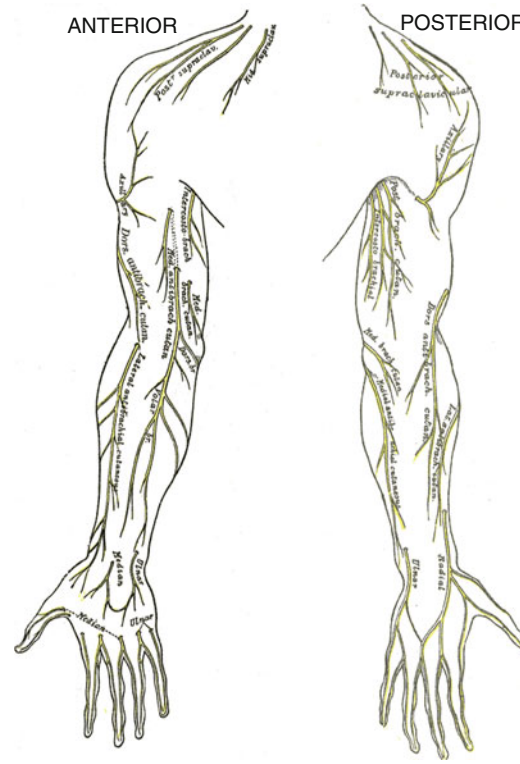
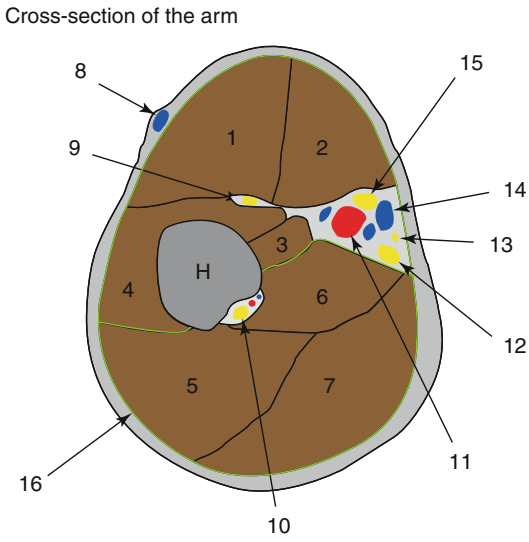


Fig. 4.4 Major sensory nerves of the arm and their distribution

the upper extremities. Because this artery is superficial throughout its entire extent, being covered in front by the integument and the superficial and deep fascia, great care should be taken to preserve its integrity. The ulnar nerve is similarly located in this medial extracompartmental location. It arises from the medial cord of the brachial plexus and descends on the posteromedial aspect of the humerus. The nerve supplies motor function to the forearm and hand. It is only with extensive submuscular dissection that any of these major neurovascular structures can be encountered as they are removed from the proposed planes of dissection for triceps augmentation, particularly when performed in the subfascial position.

When considering triceps augmentation, structures that are significantly at risk of injury are the radial nerve and two of its smaller cutaneous branches, the posterior cutaneous nerve of the arm (posterior brachial cutaneous nerve) and the dorsal antebrachial cutaneous nerve (posterior cutaneous nerve of the forearm) (Fig. 4.4). The radial nerve occupies a position deep within the posterior compartment in close proximity to the posterior aspect of the humerus and medial head of the triceps, approximately 97–142 mm distal to the acromion [15, 16] (Fig. 4.5). The radial nerve is responsible for the innervation of the triceps and arises from the seventh and eighth cranial nerves. It is really only of note in patients receiving submuscular placement of the triceps implant. In this case, overaggressive dissection near the humerus may put the radial nerve at



H- Humerus
1. m. biceps brachii, caput longum
2. m. biceps brachii, caput breve
3. m. coracobrachialis
4. m. brachialis
5. m. triceps brachill, caput laterale
6. m. triceps brachill, caput mediale
7. m. triceps brachill, caput longum
8. v. cephalica
9. n. musculocutaneus
10. n. radialis, a.+v. profunda brachii
11. a.+vv. Brachii
12. n. ulnaris
13. n. cutaneus antebrachii medilais
14. v. basilica
15. n. medianus
16. fascia brachii + septum intermusculare brachii mediale et laterale (green)

Fig. 4.5 Radial nerve in its position deep within the arm and giving off two of its major cutaneous branches at risk for injury in triceps augmentation: posterior cutaneous nerve of the arm and the dorsal antebrachial cutaneous nerve

risk of injury. Immediately adjacent to the radial nerve course some of its cutaneous branches, namely, the posterior cutaneous nerve of the arm and the dorsal antebrachial cutaneous nerve. The posterior cutaneous nerve of the arm provides sensory innervation for much of the skin on the back of the arm (Fig. 4.6). The dorsal antebrachial cutaneous nerve, also a branch of the radial, provides sensation to the posterior aspect of the forearm. Typically the cutaneous branches are at greater risk as they are smaller and more fragile nerves. Injuries, when encountered, are the result of traction injury rather than transection. Traction injuries result in a temporary neurapraxia with loss of sensation in the posterior arm (posterior cutaneous nerve of the arm) or the forearm (dorsal antebrachial cutaneous nerve). Generally these nerves are avoided in the dissection of the subfascial plane and are really only at risk in submuscular augmentation cases.

Consultation/Implant Selection

The consultation begins with a thorough medical history of the patient. Special attention is taken to ask specifically about trauma to the extremity, history of vascular insufficiency which may put blood flow at risk, history of venous insufficiency or arm swelling, and any history of nerve damage or sensory deficits as may be seen in patients with diabetes mellitus. Also, patients with histories of nerve entrapment disorders should be asked about the current state of those nerves and any long-term sequelae. At the time of consultation, the patient is asked what specifically about their arm bothers them as it may be necessary to combine muscle augmentation surgery with adjunct procedures such as liposculpture or brachioplasty to achieve the patient's goals. Preoperative goals are assessed at this point. A patient who has unrealistic expectations and is unable to comply with the strict postoperative instructions is deemed a poor candidate for augmentation. Patients who have congenital anomalies, a significant size disparity between the two arms, or bilateral hypoplasia are informed that several surgeries may be required to attain symmetry and achieve the augmentation they desire. Patients are also asked about their current level of activity and muscle building history, taking care to inform the patient of the need to take at least 1 month of time to recover before resuming any vigorous arm building regimens.

After completion of the history, the patient's arms are evaluated. First, symmetry of the two sides is assessed and any disparity is brought to the attention of the patient. Although the majority of patients present with a preexisting asymmetry

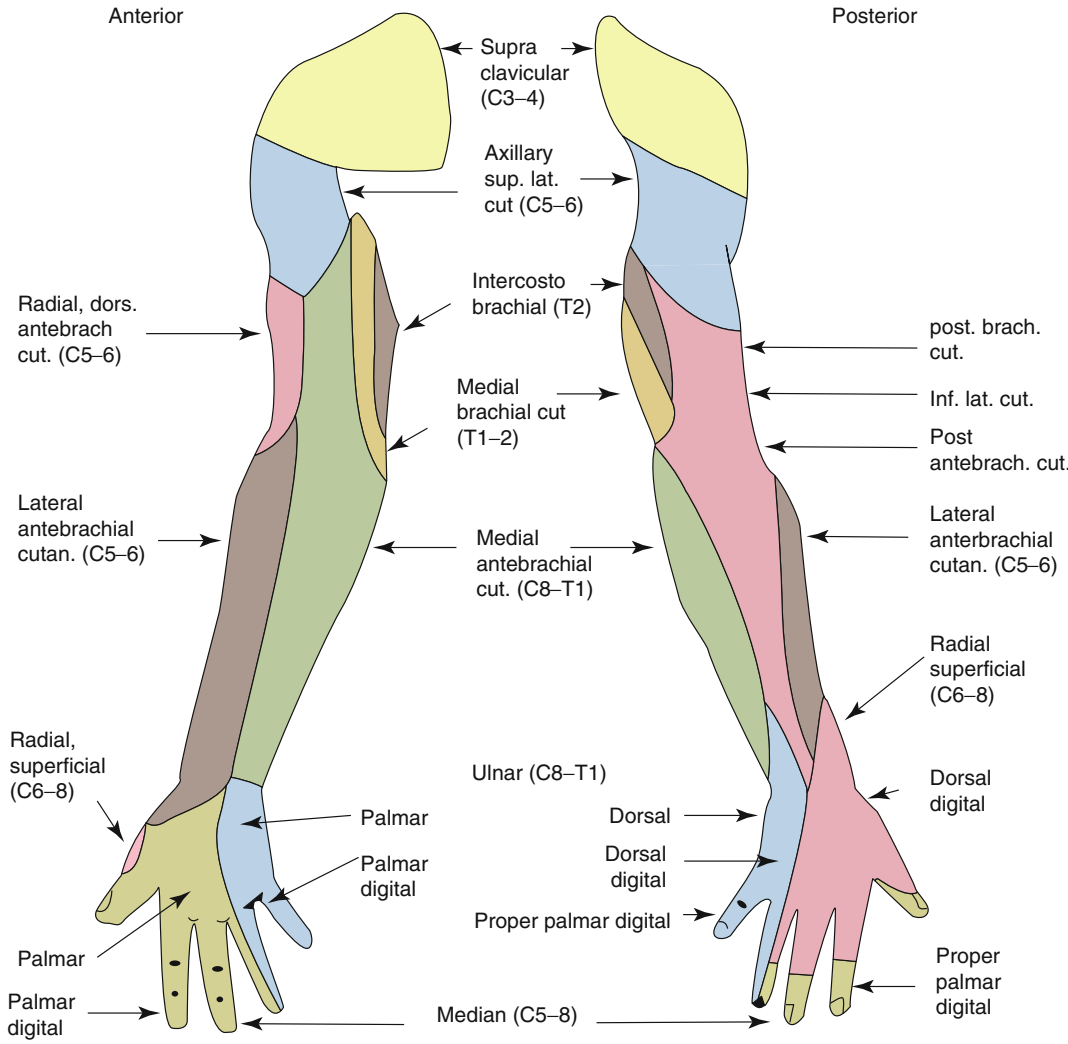


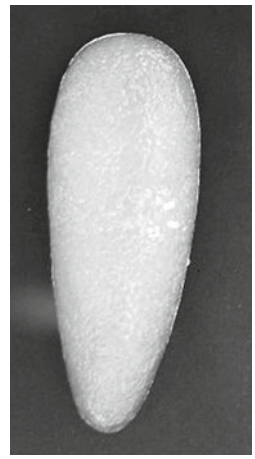
Fig. 4.6 Dermatomes of major sensory nerves of the arm

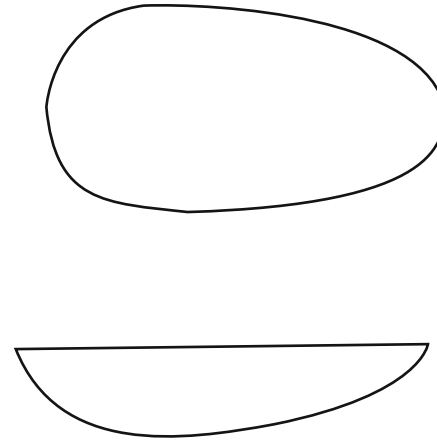
of the arms, not many patients note the difference, and this can be a source of medicolegal matters in the future. The physician then evaluates the quality of the skin, subcutaneous tissue, and muscle. A person who has very thin tissues or significant hypoplasia of the triceps may not be able to adequately accommodate a large implant. Also, a person with thin tissues may have to be counseled about the possible need for a submuscular placement of the prosthesis. This should be accompanied by a discussion of the increased risks associated with triceps augmentation in the submuscular plane.

Next, the patient's arms are measured in circumference at the midportion of the arm, with the patient in flexed and neutral positions. These measurements are primarily used in the postoperative period to demonstrate the results of augmentation. Another measurement is taken with the patient flexing their triceps muscle. The proximal point of the muscle belly is palpated and marked as is the distal portion of the muscle belly and this is measured. Having this second measurement allows one to assess the maximum length of implant that can be accommodated in the triceps region. The width of the muscle belly is measured from its medial to lateral extent while the patient's muscle is flexed. Based on these latter measurements, the surgeon can choose the implant that would best suit the patient's body habitus.

Available Implants (Table 4.1)

Table 4.1 Triceps implants (Aesthetic and Reconstructive Technologies, Inc., Reno, NV)





size	Catalog #	Width	Length	Projection	Volume (cc)
1	600–820	10.0	5.0	2.2	
2	600–825	15.0	6.0	2.2	

Preoperative Planning and Marking

The triceps contour is marked out with a surgical marking pen, taking special care to also mark the apex of the triceps on contraction as the implant must be centered under this point. A marking is then made in the axillary region for the initial incision in the axilla.

Operative Technique

The patient is brought to the operating room, prepped, and draped in the usual supine position with the arms extended. A 3–4 cm incision is made in the axillary region with a number 15 blade scalpel (Fig. 4.7). The skin is elevated by sharp using Metzenbaum scissors and blunt finger dissection (Fig. 4.8). The fascia overlying the long head of the triceps muscle is identified. Next, an incision is made in the fascia with a number 15 blade scalpel in the direction of the muscle fibers (Fig. 4.9). The long head of the triceps is then visualized (Fig. 4.10). Stay sutures are then placed into the muscle fascia to aid in closure at the end of the procedure (Fig. 4.11). If the patient is to have placement of the implant below the triceps muscle, it is at this point that the long head of the triceps is split with a hemostat in line with its fibers. A submuscular plane can then be developed below the long head of the triceps muscle primarily, but also below the lateral head. This plane seats the implant squarely on the humerus. The authors' preference is to create a subfascial pocket for implant placement. Blunt dissection is performed using the operator's digit underneath the fascia overlying the

Fig. 4.7 Axillary incision being made

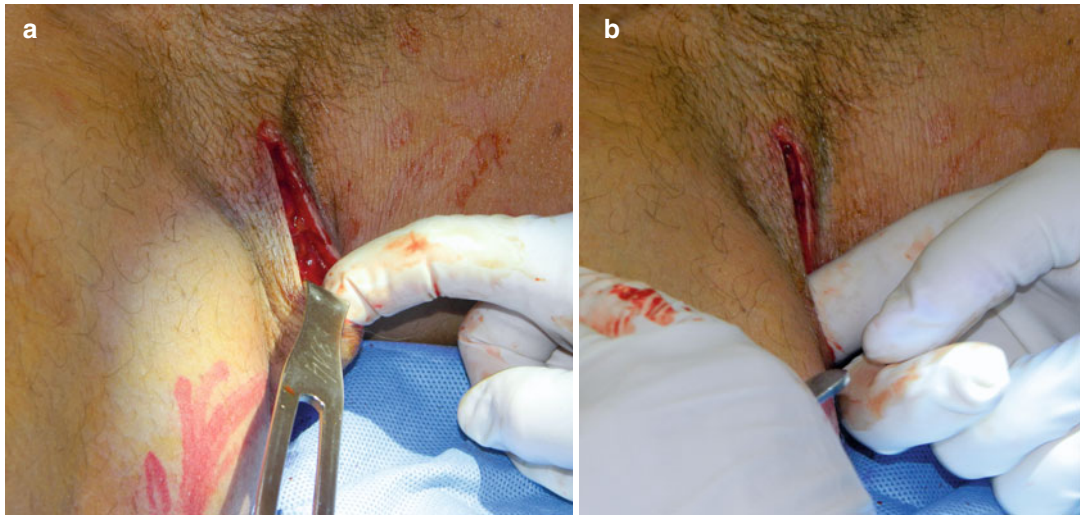


Fig. 4.8 (**a**, **b**) Blunt finger dissection down to triceps fascia with use of army navy retractor to provide adequate exposure

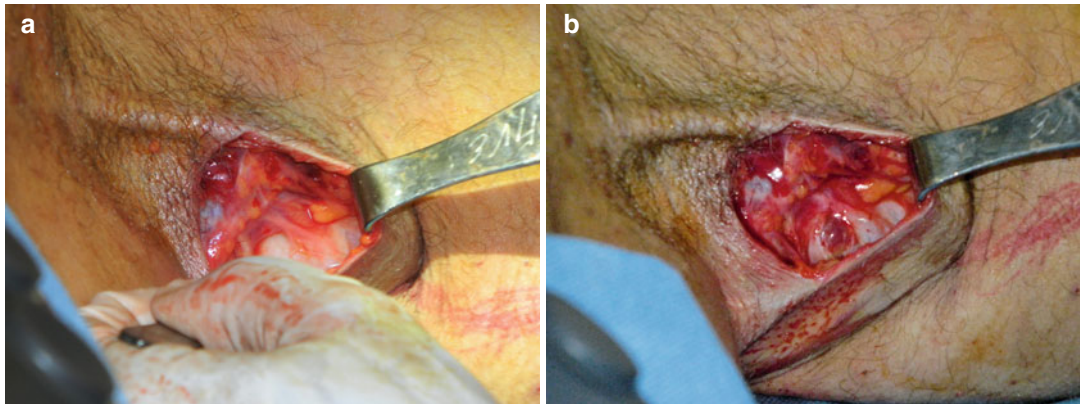


Fig. 4.9 (**a**) Exposed triceps fascia at 3–5 o'clock position (*glistening white*). (**b**) Incision in the triceps fascia

long head of the triceps muscle. Once the pocket dissection is well underway, a spatula dissector is placed underneath the fascia, and the dissection of the pocket is completed (Fig. 4.12). The plane of dissection is continued distally toward the elbow until resistance is met. The pocket is packed with a sponge and attention is turned to the contralateral side to perform the same procedure. Once both sides have been dissected, the lap sponges are removed and hemostasis is achieved as necessary with electrocautery. The pocket is irrigated with a solution containing cefazolin, gentamicin, Betadine, and normal saline. This solution is then aspirated. Then, 10 mL of 0.5 % Marcaine is instilled into the pocket for postoperative analgesia. A custom-made, solid silicone triceps prosthesis is placed underneath the fascia of the long head of the triceps muscle or below the muscle in cases of submuscular augmentation (Fig. 4.13). Once the position of the implant is deemed satisfactory, closure in layers is begun. The fascia is repaired with 3-0 Vicryl suture (Fig. 4.14). The subcutaneous tissues are then reapproximated using 4-0 Vicryl suture. The skin is then closed in subcuticular fashion using 4-0 Monocryl suture. The incision is covered with collodion and Robbins tape. Elastic

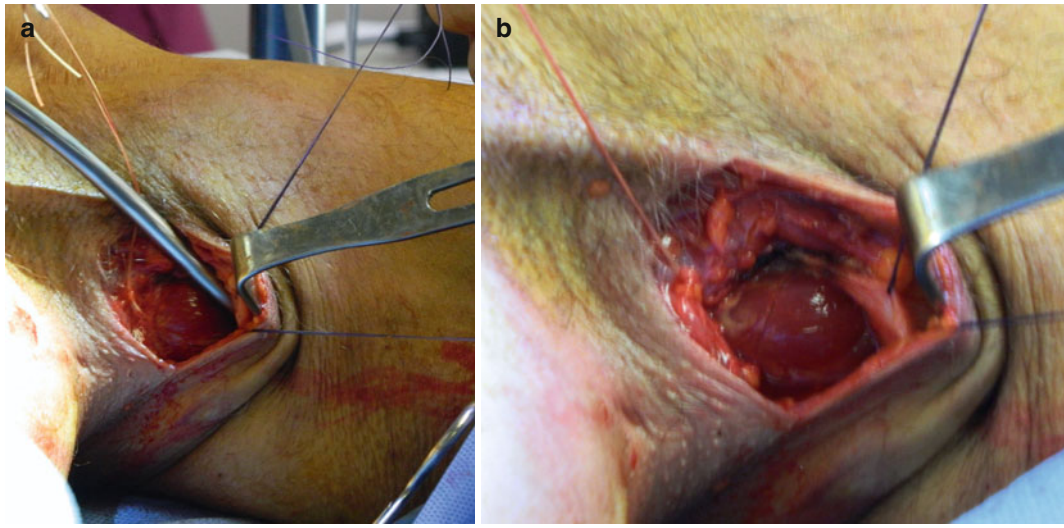


Fig. 4.10 (**a**) Exposed triceps long head. (**b**) Closer view of the exposed triceps long head

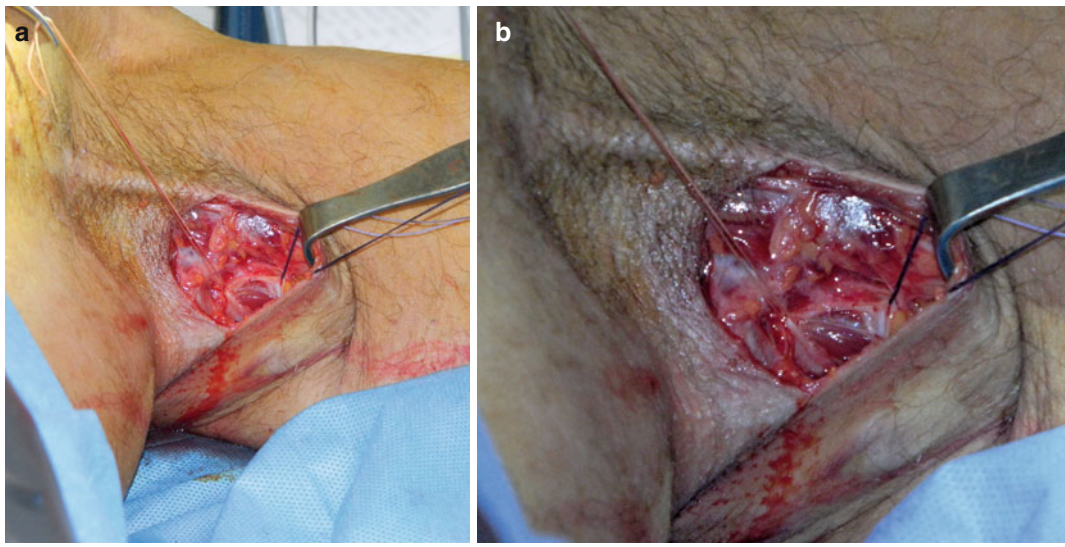


Fig. 4.11 (**a**) Stay sutures in place for use at closure in both ends of the fascia. The authors prefer to use dark sutures as the distal/down and the light, undyed Vicryl as the proximal/up suture. (**b**) Close-up of sutures in triceps fascia

compression wraps are applied to the arms at this time. The patient is then returned to the recovery room and monitored before discharge home.

Postoperative Instructions

On discharge from the office on the day of surgery, the patients have their arms wrapped in elastic compression sleeves to diminish the amount of swelling and potential for seroma formation. These sleeves are to be worn at all times for a period of 4 weeks. Patients may remove the sleeves to shower and to wash the sleeves as needed. Patients may begin showering the day after surgery, taking care to dry the elastic tape over their incisions with a hair dryer on a low heat setting. The patient is instructed postoperatively to limit the use of the upper extremities and to avoid exertion or any heavy lifting.

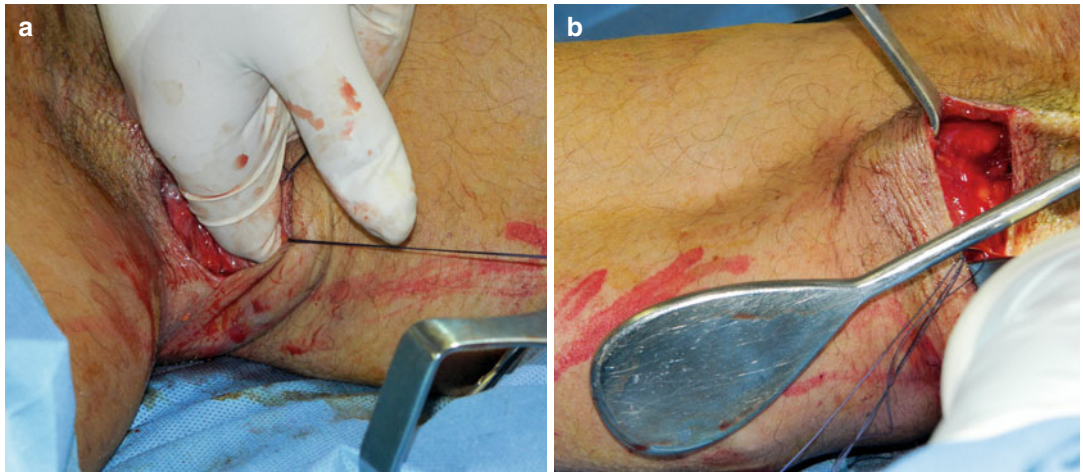


Fig. 4.12 (**a**) Dissection of the subfascial pocket is begun with blunt finger dissection. (**b**) Further dissection of the pocket is performed with the spatula dissector

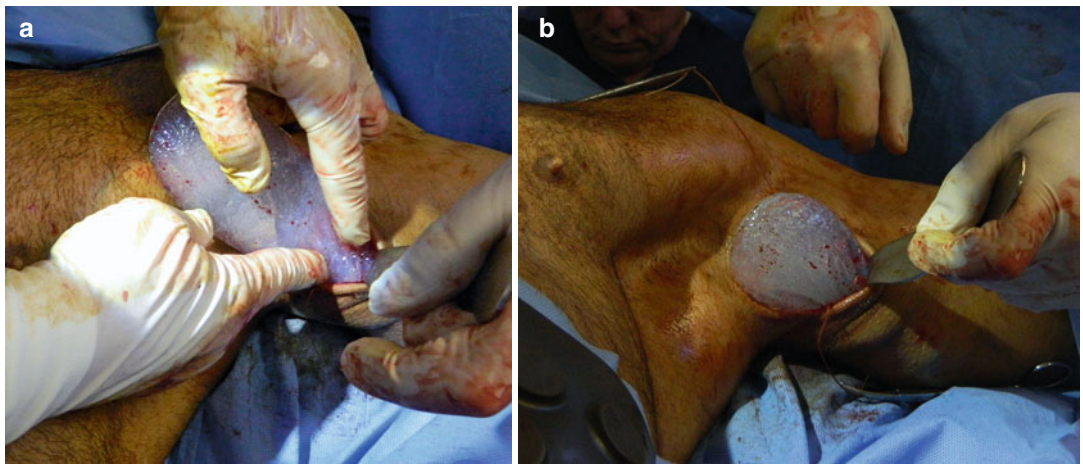


Fig. 4.13 (**a**) Placement of the triceps implant using a folding over technique. (**b**) Triceps implant 50 % introduced

Patients may begin to use their arms as tolerated immediately after surgery but are restricted from heavy lifting or vigorous activity for 4–6 weeks postoperatively.

Complications

In performing triceps augmentation, there is a host of potential complications that can arise (Table 4.2).

Infection

Infection, either superficial or deep, is a possibility in triceps augmentation surgery. The authors' series of 30 patients has demonstrated only one superficial skin infection that grew *Staphylococcus aureus* (MSSA), giving an incidence of 3.3 %. The patient was a health-care provider and presented 1 week after surgery with erythema around the incision with minor serous drainage. Prior to making the incision, standard practice should be

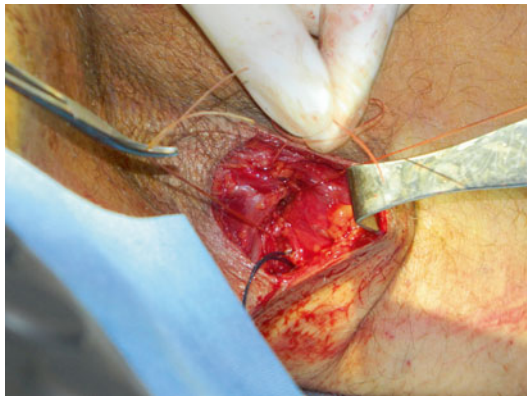


Fig. 4.14 Closure of the triceps fascia over the implant, completely locking away the implant and hence preventing superficial implant migration

Table 4.2 Potential complications of triceps augmentation

Potential complications of triceps augmentation surgery
Infection
Seroma
Hematoma
Asymmetry
Implant visibility
Hypertrophic scarring
Hyperpigmentation of the scar
Capsular contracture
Wound dehiscence
Nerve injury (permanent or temporary, motor or sensory)
Compartment syndrome

the administration of 2 g of Ancef IV (or 300 mg IV clindamycin in a penicillin or cephalosporin allergic patient). During the procedure, irrigation of the pocket with a standard antibiotic solution containing normal saline, Betadine, Ancef, and gentamicin should be performed. Postoperatively, a 5–10-day regimen of oral antibiotics covering normal skin flora should be administered. If a deep infection occurs, the standard of practice is removal of the implant, closure, and possible reimplantation in 3–6 months. There are reports in other forms of implant surgery that conservative management and implant salvage are possible. This should be left at the discretion of the surgeon and performed with careful counseling of the patient.

Seroma

Seromas are statistically the most common complication occurring in implant surgery. In the authors' series of patients, a seroma rate of 3.3 % (1/30) was noted. They typically present as new onset pain, swelling, or asymmetry. The treatment of choice remains percutaneous aspiration. This complication is best prevented with patient compliance with compression sleeves and proper implant placement at the time of surgery, thereby minimizing dead space. In the senior author's experience, it is noncompliance with compression garments and postoperative early return to vigorous activity that result in seroma formation rather than technical issues.

Hematoma

Although a rare occurrence due to the relatively avascular plane of dissection for the triceps augmentation procedure, a hematoma is always possible. In the event of a hematoma, rapid evacuation, pocket irrigation, and reimplantation are the mainstays of therapy. This complication is best prevented by meticulous hemostasis at the time of surgery and good compression of the arm postoperatively to prevent potential space creation.

Asymmetry

This can occur as a product of preexisting variability in the patient's arms or variability in dissection of the pocket bilaterally. This is best minimized by good preoperative photography and noting any asymmetries preoperatively. To avoid creation of asymmetry, it is important to maintain the same pattern of dissection and pocket creation bilaterally. Ideally, the pocket created should be tight and minimize the chance of implant migration. Should

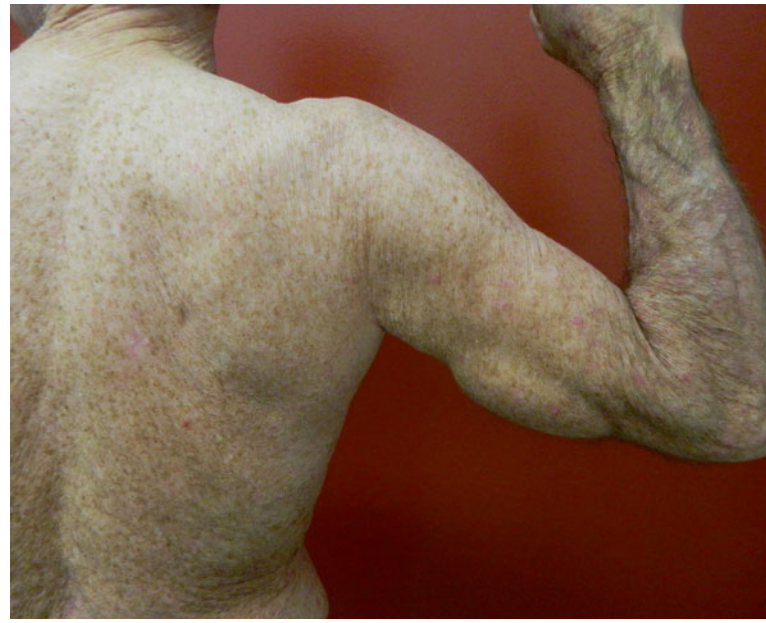


Fig. 4.15 A 64-year-old HIV-positive patient (RS) underwent triceps augmentation with custom triceps implants for poor definition in the triceps area. He presented 3 weeks after surgery with a distally displaced implant on the right arm after resuming exercise early in his postoperative period

a pocket be overdissected and patients note postoperative asymmetry due to a pocket's overdissection, the patient may require a return to the operating room to adjust the pocket. A revision case should be planned for no sooner than 3 months postoperatively, allowing a capsule to form around the implant. On return to the operating room (OR), the capsule can be tailored to more appropriately fit around the implant, producing a more snug fit and bringing greater symmetry to the arms. In the authors' series of cases, there was one such case with one implant being more distal in the underarm region than the contralateral side. The patient was taken to the operating room where a lighted retractor was used to collapse the pocket distally and prevent distal displacement of the implant. The roof of the capsule was sewn down to the underlying triceps muscle with a 2-0 Vicryl suture. After surgery, the patient experienced no further issues.

Implant Visibility

Regardless of position below the muscle or below the fascia, implant visibility is a rare complication. However, those patients that have very thin and atrophic arms to begin with may suffer from implant palpability and visibility. Patients should be counseled on this fact preoperatively if there is a feeling that the patient could be at risk. If a patient is determined to be thin and have minimal development of the triceps muscle, the surgeon may elect for placement of the implant in a submuscular plane to better camouflage the implant. However, a discussion must be had with the patient to discuss the increased risk of neurovascular injury and a greater potential for muscle injury and compartment syndrome.

Implant Dislodgment/Migration

In the authors' series there were two cases of implant extrusion/migration (6.6 %). The two cases were noted in patients who began vigorous activity before the recommended 4–6-week cutoff point. In both cases, the patients noted that the implants were shifted out of position, one being flipped on itself and the other migrating distally (Fig. 4.15). The flipped implant was manually manipulated into its correct position with subsequent resumption of compression garments to the arm. This patient had no further sequelae. The patient with the distally migrated implant opted for the removal of the implants to avoid future issues.

Scar Hyperpigmentation and Hypertrophy

There were no any cases of hypertrophic scarring for triceps augmentation in the authors' series. The key to reduction of these problems is careful layered closure.

Capsular Contracture

This is a possible late sequela of any implant placement, most frequently described in the breast augmentation literature. To date, the authors have not experienced such a complication. This may be due to the short experience with the procedure and small number of cases. However, if it were to occur, the patient would likely be started on Accolate 10 mg orally BID for 3 months in the hope of softening the capsule. If this was unsuccessful, then a return to the OR would be warranted for capsulotomies. A capsulectomy would be difficult to perform in triceps augmentation cases as the arm's position may be prohibitive for attaining good visualization to perform such a procedure.

Wound Dehiscence

Wound dehiscence is a product of poor wound closure under too much tension typically. In order to prevent this, meticulous closure in three layers is paramount: fascia, deep dermis, skin. To date, the authors have not experienced any wound dehiscence in triceps augmentation.

Nerve Injury

Permanent nerve injury is rarely a problem with this procedure as the majority of dissection is performed in a blunt, atraumatic fashion. It is quite common for patients to complain of some numbness over the area of the triceps; however, this returns within 1–3 months postoperatively. This risk can be minimized with the dissection being performed bluntly with the operator's digit rather than using dissectors and potentially creating greater traction injury. Major motor and sensory deficits can accompany compartment syndrome, and this must be ruled out immediately if any significant deficits are appreciated.

The authors experienced one case of neurapraxia. A 32-year-old male, who underwent a unilateral triceps augmentation to correct a congenital defect, presented the day after surgery with weakness in the hand on the operative side, with difficulty writing. His compartments were appropriately swollen. A palpable pulse was appreciated at the radial and ulnar arteries. Gross sensation in the distal hand was intact, except for numbness in the fourth and fifth digit. The patient was noted to have a weak grip with difficulty grasping objects. This was consistent with ulnar nerve injury. Conservative management was decided on with patient consultation. The patient's condition spontaneously resolved within 3 weeks of surgery, suggesting a traction injury. Admittedly, this was one of the first patients who underwent triceps augmentation, and the dissection performed was more aggressive than is currently the authors' practice. This may have put unnecessary tension on the ulnar nerve resulting in neurapraxia in the distal distribution of the nerve, affecting the muscles of the hand. In this patient, the prosthesis was placed in a submuscular plane beneath the long head of the triceps muscle. It is now the authors' practice to perform subfascial placement of the prosthesis to prevent excessive dissection, decrease the incidence of bleeding complications, and decrease the incidence of neurapraxia due to nerve injury. The authors had two cases of neurapraxias consistent with traction injury of the dorsal antebrachial cutaneous nerve, resulting in numbness over the posterior aspect of the forearm. These resolved spontaneously within the first 3 months postoperatively and had no further sequelae. These three neurapraxias have given us an incidence of temporary nerve injury of 10 % (3/30).

Compartment Pressure Problems/ Compartment Syndrome

Volkmann, who first described the phenomenon of compartment syndrome, believed that the pathophysiology was related to massive venous stasis associated with simultaneous occurrence of arterial insufficiency [17]. This in turn prevents proper circulation of blood to the muscles and nerves in a given compartment of an extremity, as tissue pressure increases. Nerve and muscle cells start to die within 4–8 h. Compartment syndrome typically presents as a tensely swollen compartment with extreme pain, out of proportion to examination, on palpation. This is sometimes accompanied by referred pain to the affected compartment with passive stretch of muscles distal to the compartment. There may or may not be a neuropathy, typically described as a burning or prickling sensation, appreciated over the skin of the affected region. Finally, the patient may experience frank pulselessness or paralysis of muscles in the affected compartment. However, the patient who presents with these final findings has typically progressed beyond the point of muscle salvage.

In patients with a compatible history and a tense extremity, clinical diagnosis may be sufficient. If the diagnosis is in doubt, compartment pressures may be measured with a handheld Stryker device. An absolute pressure greater than 30 mmHg in any compartment, or a pressure within 30 mmHg of the diastolic blood pressure in hypotensive patients, or a patient with a concerning history who demonstrates the constellation of signs and symptoms of compartment syndrome are all possible indications for surgical compartment release via fasciotomy [18].

In the authors' experience in triceps augmentation, this complication did not occur. However, the clinician must always have this diagnosis in the back of his mind with any patient in the immediate postoperative period who presents with neurovascular issues in the treated extremity, particularly when pain is out of proportion to examination and poorly controlled with prescribed medications.

Adjunct Procedures for Upper Extremity Contouring/Treatment of Skin Laxity in the Triceps Region

Patients seeking contouring of the upper extremity can present with a constellation of problems including lipodystrophy, skin laxity, and muscle hypoplasia. In addition to treating the hypoplastic muscle with triceps implants, a patient may require some combination of liposuction of the arm and/or excision of excess skin with formal brachioplasty. The authors avoid overzealous tissue manipulation at the time of triceps augmentation and would recommend that any liposuction or skin excision be performed at a separate procedure (before or after an implant surgery) as excessive swelling associated with these procedures when combined with the swelling produced by triceps augmentation may precipitate a compartment syndrome.

In patients that present with significant lipodystrophy of the arm but with little in the way of laxity of the skin, isolated liposuction of the arm may be sufficient [19, 20]. The surgeon must be careful in performing circumferential and superficial liposuction of the arms as it may lead to unaesthetic irregularities particularly in the anterior and medial aspects of the arm [19]. Best results are had with liposuction in the deeper layer of adipose tissue, using small-diameter cannulas no larger than 2.5–3 mm. Chamosa even goes so far as to recommend taking some of this harvested fat and grafting to the deltoid region to improve the contour of the upper extremity, placing the maximum width of the arm at the deltoid region.

Although the authors have used muscle implants to augment the triceps region in patients with laxity of the skin in the underarm region, either due to aging or after massive weight loss, the results have been mixed. The authors rarely recommend triceps augmentation for pure skin laxity in the underarm region as it tends to produce a hanging mass rather than a filling out of the lax tissue. This pathology is best treated with some form of brachioplasty and direct skin excision to better contour the extremity.

Case 1 (Fig. 4.16)
A 78-year-old female presented for significant laxity to the underarm region. It was recommended that she undergo brachioplasty for correction of this problem. However, the patient did not wish to have significant scars. As an alternative, triceps augmentation was offered in the hope of filling out the underarm region. After augmentation, the patient complained of having a significant weight in the underarm region without a feeling of significant improvement. For this reason, the author has elected to be very selective in patients receiving triceps implants for skin laxity correction. The patient is shown preoperatively and 2 weeks after surgery with an improvement in overall contour and better filling of the skin envelope.

With advances in bariatric procedures, there has been an increase in the number of patients presenting to the cosmetic surgeon with laxity of the skin in the arms after massive weight loss. While adding volume with implants can at times camouflage the overall volume loss in the arm and liposuction can take care of stubborn fat deposits, at times excision of skin is the only way to produce an aesthetic result in the upper extremity. Appelt et al. [20] recommend an algorithmic approach to upper arm contouring to help surgeons best manage the spectrum of patients who present for improvement in arm contour. Using the skin pinch test as a starting point, patients with greater than 1.5 cm of fat detectable with the pinch test could potentially benefit from

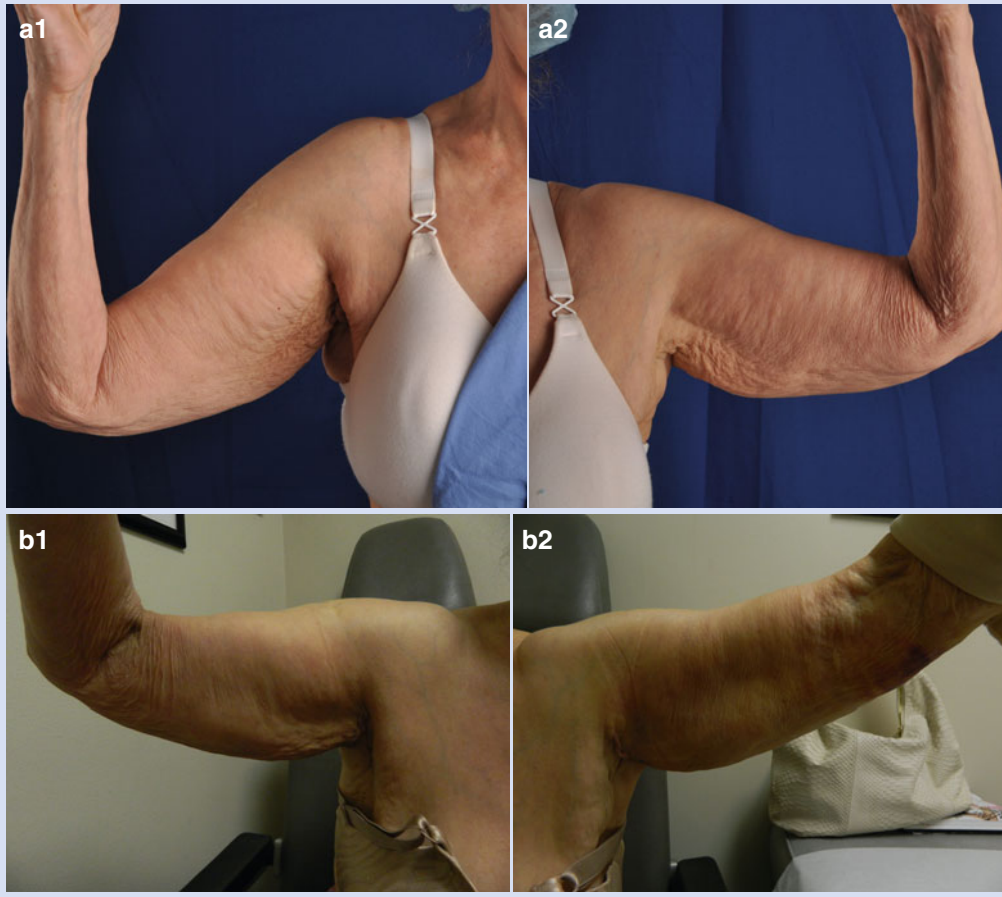


Fig. 4.16 (**a**) Preoperative. (**b**) Postoperative

liposuction. However, the surgeon must take into account skin laxity to assess if liposuction alone is the best option. Rohrich [21] has devised a three-tier classification system that has been modified to better define issues of skin laxity and fat excess in the upper extremity, helping surgeons determine which procedures may be applicable to the patient seeking upper arm contouring. His initial classification described three classifications of upper extremity dystrophy: (I), minimal skin excess and moderate fat excess; (II), moderate skin excess with minimal fat excess; and (III), moderate skin excess with moderate fat excess. Based on his system, Rohrich recommends upper arm contouring with liposuction alone for class I patients. He emphasizes the need for long, uniform strokes to prevent contour irregularities. Patients with type II dystrophy have moderate skin laxity with minimal fat excess and are best treated with some form of brachioplasty and excision of the excess skin. Patients who are type III suffer from moderate skin excess and moderate fat excess and are best treated with a multimodality therapy (liposuction and brachioplasty) in either a single stage or staged approach [21].

The surgeon may elect to augment the biceps and triceps region at the same time. In cases that have been performed, the relative augmentation to each muscle group is small compared to an isolated biceps or triceps augmentation. This smaller augmentation is performed to avoid complications associated with compartment syndrome. The surgeon may elect to offer both procedures at the same time but must always err on the side of caution to avoid major complications with excessive addition of volume to the arms.

Triceps Augmentation with Fat Grafting

Work in autologous fat grafting has prompted patients to ask about fat grafting to the triceps region. While it might be possible to achieve some augmentation in the biceps region due to the greater muscle mass in the anterior compartment, it is our belief that fat grafting to the posterior compartment of the arm would likely not take well but may also result in an unaesthetic result. For that reason, we do not recommend or perform fat grafting to the triceps region.

Authors' Personal Results

In reviewing the primary author's (NVC) own experience with the procedure, there have been a total of approximately 30 triceps augmentations performed since introducing the procedure in 2008. There has been an overall satisfaction rate of 96.7 % (29/30). The patient who was dissatisfied underwent triceps augmentation for severe skin laxity in the underarm region. She did not wish to undergo any form of brachioplasty, even though it was recommended that she undergo a traditional, long incision brachioplasty. As an alternative, the patient was offered a small triceps implant to give volume to the area and perhaps fill in all of the loose skin. While she had a moderate improvement, the patient felt that the arm now appeared more bulky and had hanging skin on top of it.

Since starting the procedure, ten procedures have been performed in the submuscular plane and 20 in the subfascial plane. During that time, the seroma rate cumulatively has been 3.3 % (1/30). The infection rate has also been 3.3 % (1/30). Asymmetry was also noted in one case, giving an incidence of 3.3 % (1/30). There were two cases of implant migration in the group of 30 patients (6.7 %). There were three cases of neurapraxia in patients receiving a submuscular triceps implant (10 %). There have been no cases of wound dehiscence or capsular contracture.

Patient Cases

Case 2 (Fig. 4.17)
A 38-year-old female presented for biceps and triceps augmentation secondary to mild underdevelopment. Bilateral style 8, size 3 biceps implants were placed along with custom triceps implants (style 8, size 20). She also underwent breast augmentation with 400 mL Mentor moderate plus silicone gel implants.

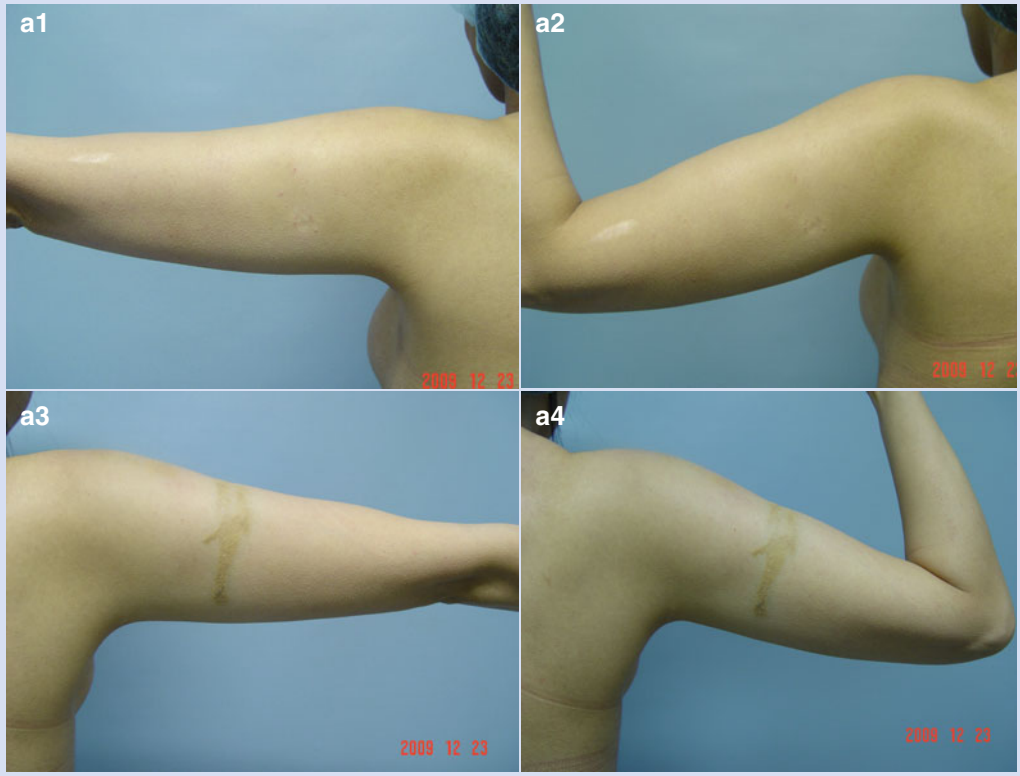


Fig. 4.17 (**a**) Preoperative. (**b**) Postoperative

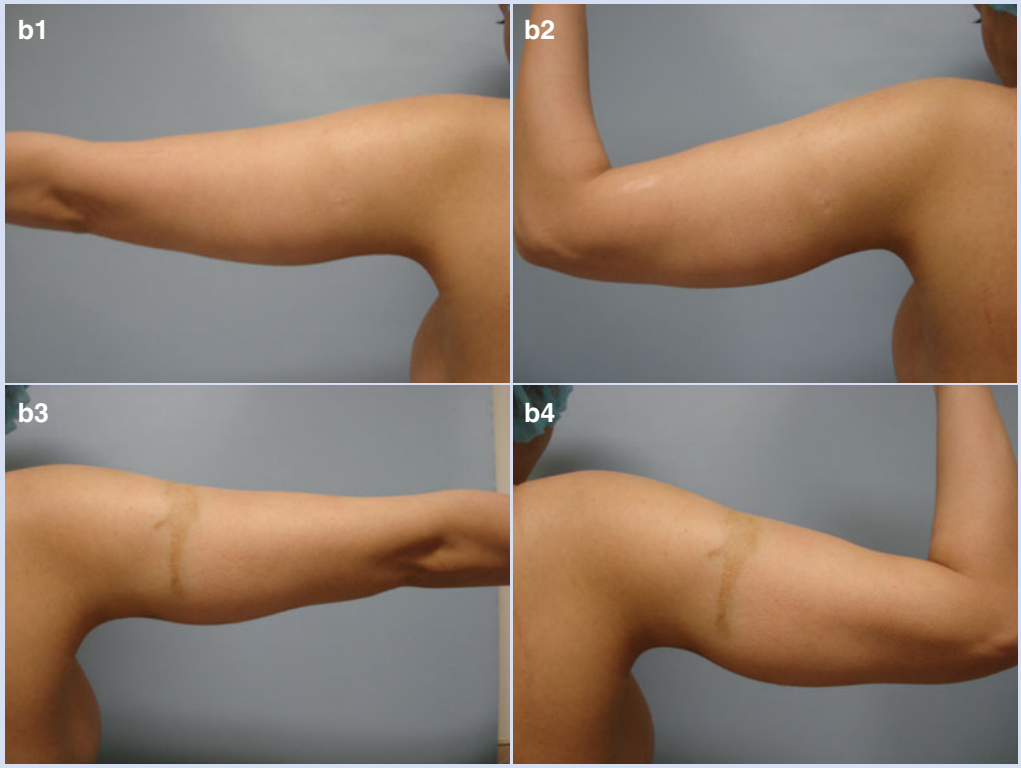


Fig. 4.17 (continued)

Case 3 (Fig. 4.18)
A 29-year-old male underwent biceps and triceps augmentation with custom implants. The biceps implants were style 8, size 1 and the triceps implants were style 8, size 20.

Fig. 4.18 (**a**) Preoperative. (**b**) Postoperative

Case 4 (Fig. 4.19)
A 24-year-old male underwent triceps augmentation with a custom triceps implant. He complained primarily of a poorly developed triceps muscle despite a rigorous weight training program.

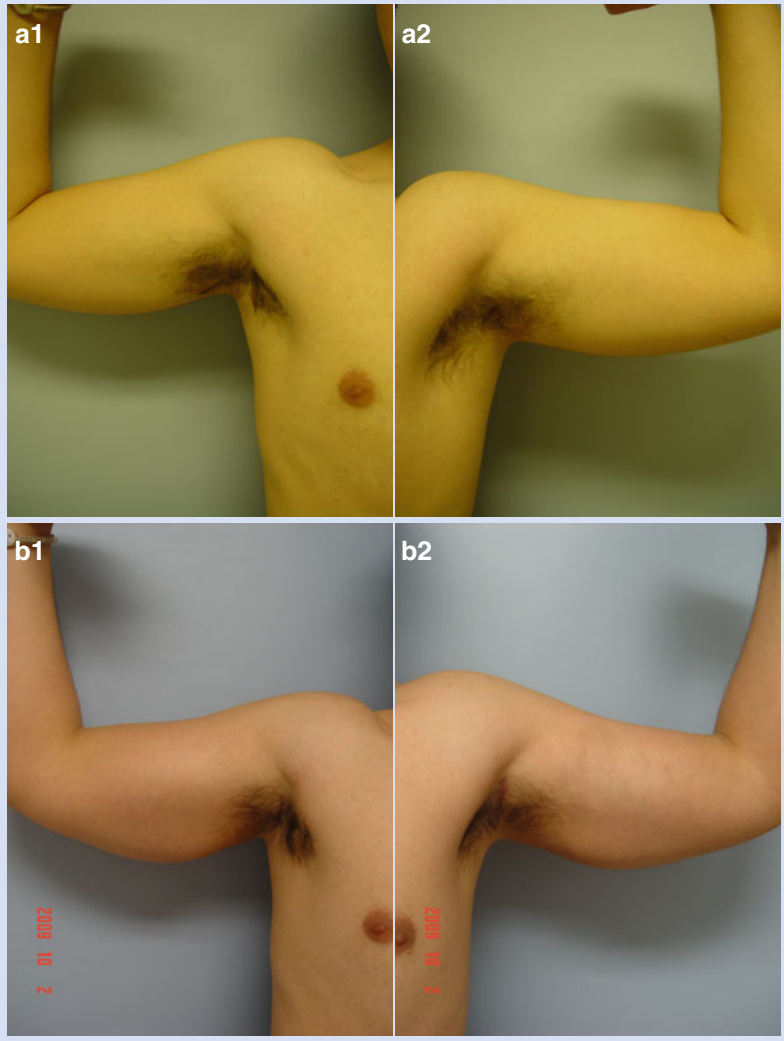


Fig. 4.19 (**a**) Preoperative. (**b**) Postoperative

Case 5 (Fig. 4.20)
A 44-year-old male underwent liposuction of the abdomen with bilateral biceps, pectoral, and triceps augmentation. The patient received style 2, size 1 pectoral implants (not demonstrated). He received style 8, size 1 biceps implants. Lastly, style 8, size 20 triceps implants were placed.

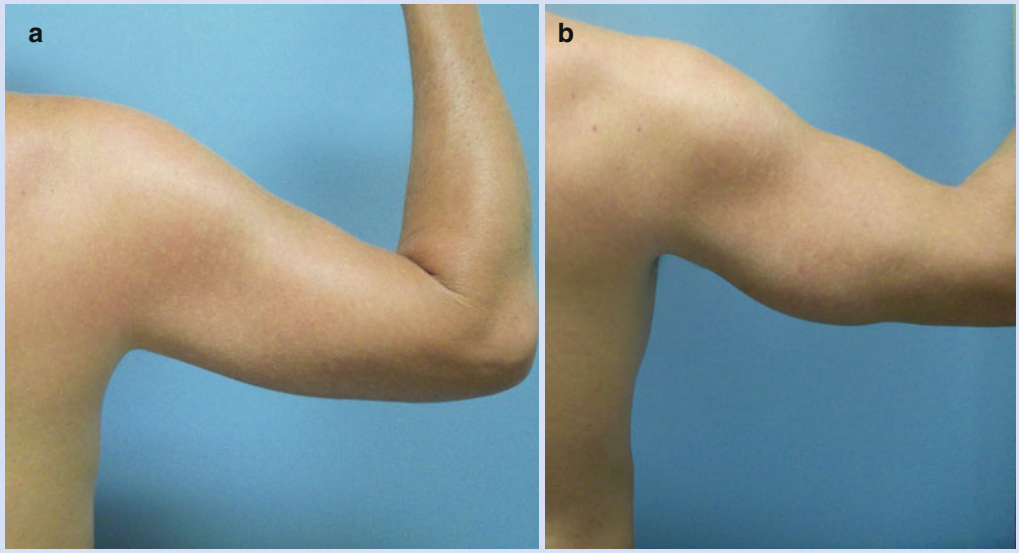


Fig. 4.20 (**a**) Preoperative. (**b**) Postoperative

Case 6 (Fig. 4.21)
A 27-year-old male underwent triceps augmentation with style 8, size 25 triceps implants as he was unable to develop adequate triceps definition with conventional workouts.

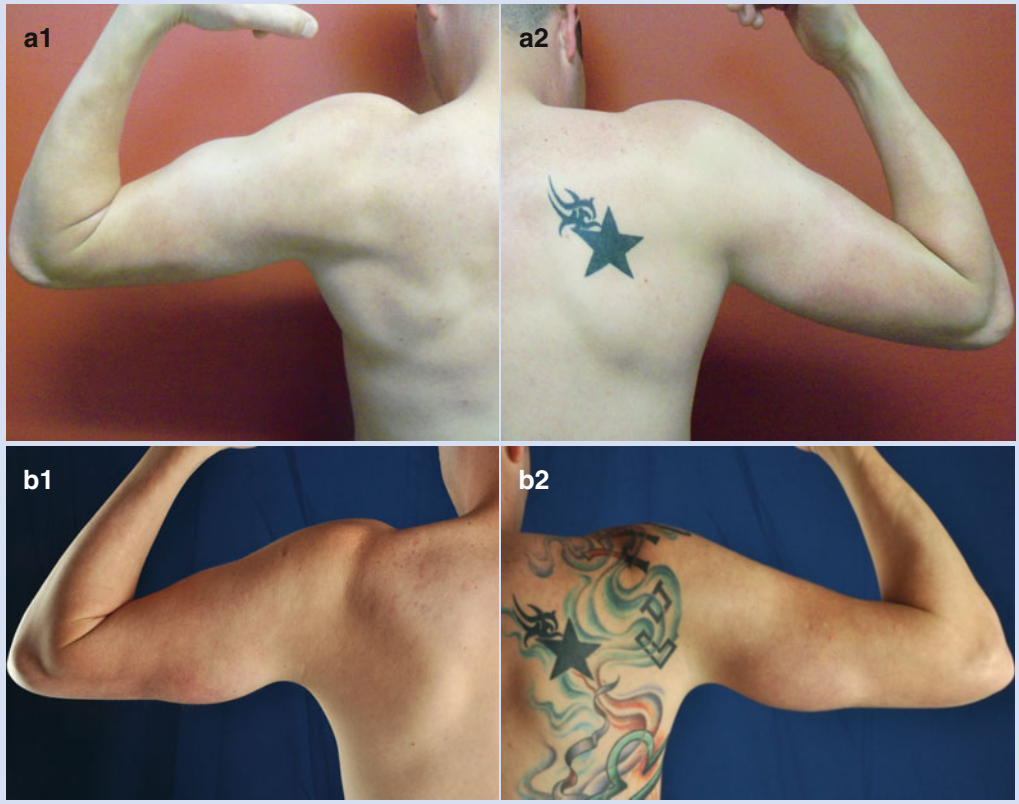


Fig. 4.21 (**a**) Preoperative. (**b**) Postoperative

Case 7 (Fig. 4.22)
A 44-year-old male underwent biceps and triceps augmentation. He received style 8, size 25 triceps implants and style 8, size 3 biceps implants.

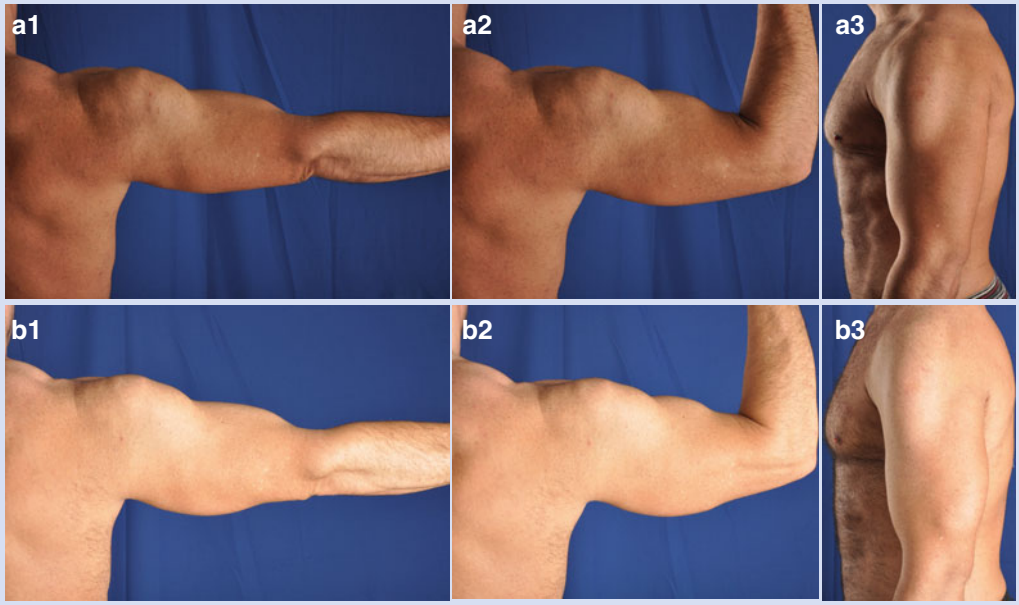


Fig. 4.22 (**a**) Preoperative. (**b**) Postoperative

Case 8 (Fig. 4.23)
A 54-year-old male underwent bilateral biceps augmentation with style 8, size 1 implants and triceps augmentation with style 8, size 25 triceps implants.

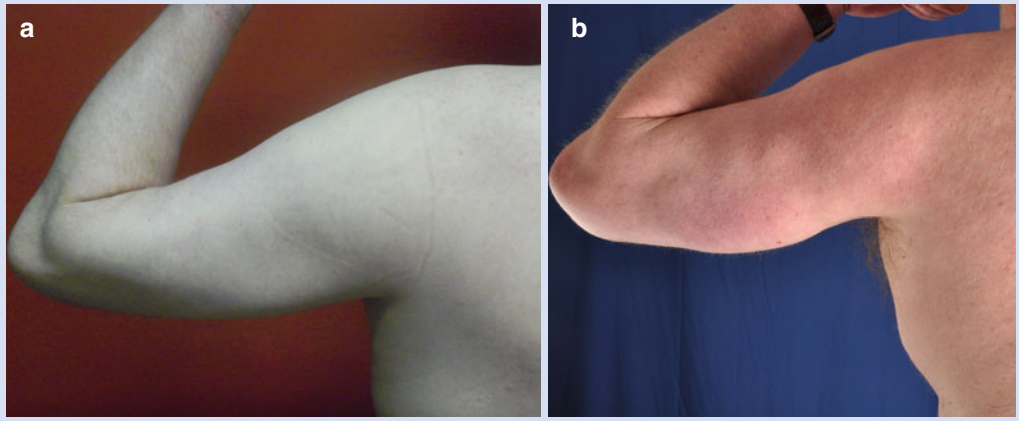


Fig. 4.23 (**a**) Preoperative. (**b**) Postoperative

Case 9 (Fig. 4.24)
A 47-year-old male underwent bilateral biceps and triceps augmentation with style 8, size 1 implants (biceps) and style 8, size 25 implants (triceps). He had normal development but wanted better definition and increased volume.

Fig. 4.24 (**a**) Preoperative. (**b**) Postoperative

Conclusions

The triceps augmentation procedure is an excellent complement to the augmentation of the biceps region. While it is not recommended to perform both augmentations at the same time due to the risk of compartment syndrome, they can very easily be performed 3–6 months apart with excellent results. Although triceps augmentation does have significant utility in the realm of reconstructive surgery to bring about greater symmetry between the two arms, it is clear that it can be successfully used to augment a hypoplastic triceps region, giving the patient a more musculature and defined upper extremity.

References

1. Plastic surgery statistics report. 2012. http://www.plasticsurgery.org/Documents/news-resources/statistics/2012-Plastic-Surgery-Statistics/full-plastic-surgery-statistics-report.pdf. Accessed 9 Jun 2013.
2. American Academy of Cosmetic Surgery Procedural Census. 2008. http://multivu.prnewswire.com/mnr/aacs/36867/docs/36867AACS2008ProceduralSurveyResults.pdf. Accessed 9 Jun 2013.
3. Phillips KA. Body image and body dysmorphic disorder. In: Cash TL, Smolak L, editors. Body image: a handbook of science, practice, and prevention. 2nd ed. New York: The Guilford Press. 2012, p. 305–13.
4. Pope HG, Gruber AJ, Mangweth B, Bureau B, deCol C, Jouvent R, Hudson JI. Body image perception among men in three countries. Am J Psychiatry. 2000; 157(8):1297–301.
5. Olivardia R, Pope HG, Borowiecki JJ, Cohane GH. Biceps and body image: the relationship between muscularity and self-esteem, depression, and eating disorder symptoms. Psychol Men Masculinity. 2004; 5(2):112–20.
6. Leit RA, Pope HG, Gray JJ. Cultural expectation of muscularity in men: the evolution of playgirl centerfolds. Int J Eat Disord. 2001;29(1):90–3.
7. Cafri G, Thompson JK, Riccciardelli L, McCabe M, Smolak L, Yesalis C. Pursuit of the muscular ideal: physical and psychological consequences and putative risk factors. Clin Psychol Rev. 2005;25(2):215–39.
8. Pope HG, Olivardia R, Gruber A, Borowiecki J. Evolving ideals of male body image as seen through action toys. Int J Eat Disord. 1999;26(1):65–72.
9. Bonnecarrere ER, Butler B. Case report: upper extremity soft-tissue reconstruction by alloplastic implant: long-term result and follow-up. Ann Plast Surg. 1997;38:74–6.
10. Hodgkinson DJ. Contour restoration of the upper limb using solid silicone implants. Aesthetic Plast Surg. 2006;30(1):53–8.
11. Chugay N, Racanelli J, Hsu J, Chugay P. Bicipital augmentation. Am J Cosmet Surg. 2006;23(1):33–6.
12. Chugay N, Chugay P. Bicipital augmentation: a retrospective review of 94 patient cases. Am J Cosmet Surg. 2009;67(4):241–5.
13. Chugay NV, Chugay PN. Triceps augmentation: early experience with the procedure. Am J Cosmet Surg. 2010;27(4):200–3.
14. Abadesso I, Serra F. Augmentation brachioplasty: surgery for improving the appearance of the arms. Rev Bras Cir Plast. 2012;27(1):97–101.
15. Toomayan GA, Robertson F, Major NM, Brigman BE. Upper extremity compartmental anatomy: clinical relevance to radiologists. Skeletal Radiol. 2006;35(4):195–201.
16. Mazurek MT, Shin AY. Upper extremity peripheral nerve anatomy. Clin Orthop Rel Res. 2001;383:7–20.
17. Amendola A. Compartment syndromes. In: Browner BD, Jupiter JB, Levine AM, Trafton BG, Krettek C, editors. Skeletal trauma: basic science, management, and reconstruction. Philadelphia: Saunders; 2003.
18. Cothren CC, Biffl WL, Moore EE. Chapter 7. Trauma. In: Brunicardi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Matthews JB, Pollock RE, editors. Schwartz's principles of surgery. New York: McGraw-Hill Professional; 2010.
19. Chamosa M, Murillo J, Vazquez T. Lipectomy of arms and lipograft of shoulders balance the upper body contour. Aesthetic Plast Surg. 2005;29(6):567–70.
20. Appelt EA, Janis JE, Rohrich RJ. An algorithmic approach to upper arm contouring. Plast Reconstr Surg. 2006;118(1):237–46.
21. Rohrich RJ, Beran SJ, Kenkel JM. Back and arms. In: Rohrich RJ, Beran SJ, Kenkel JM, editors. Ultrasound assisted liposuction. 1st ed. St Louis: Quality Medical Publishing; 1998. p. 231–51.