Brachioplasty Techniques in Plastic Surgery: Achieving Aesthetic and Functional Outcomes

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Abstract

Brachioplasty, commonly referred to as an arm lift, is a plastic surgical procedure aimed at improving both the aesthetic contour and functional outcomes of the upper arm. With increasing demand for body contouring procedures, particularly following significant weight loss, the evolution of brachioplasty techniques has become a focal point in plastic surgery. This review explores the spectrum of brachioplasty techniques, including traditional brachioplasty, mini brachioplasty, extended brachioplasty, and minimally invasive approaches, highlighting their respective indications, surgical methodologies, and outcomes. Emphasis is placed on achieving optimal aesthetic results while addressing functional concerns such as skin redundancy and associated discomfort. Advances in technology, including the use of liposuction-assisted brachioplasty and laser-based skin tightening, are also discussed as adjuncts to improve outcomes and minimize scarring. Furthermore, the article reviews patient selection criteria, preoperative planning, and postoperative care, as well as common complications such as lymphedema, scar hypertrophy, and wound dehiscence. By analyzing current evidence and surgical innovations, this review aims to provide a comprehensive guide for plastic surgeons in selecting and implementing the most appropriate brachioplasty technique to meet the individual needs of patients while ensuring long-term satisfaction and functionality

Keywords: *Brachioplasty Techniques, Plastic Surgery, Aesthetic and Functional Outcomes.*

1. Introduction

The arm's superficial anatomy comprises structures that lie close to the skin surface, including skin, subcutaneous tissue, superficial veins, cutaneous nerves, and fascia. These structures are crucial for both clinical examination and surgical interventions. Understanding these superficial components allows clinicians to assess injuries, vascular access, and peripheral nerve functions. The skin is the outermost structure of the arm, functioning as a protective barrier and thermoregulator. The skin thickness varies, being relatively thin over the flexor surfaces and thicker over the extensor areas due to mechanical stress [1]. Underneath the skin lies the superficial fascia, composed of loose connective tissue and fat, which provides a cushioning layer for superficial veins and nerves [2]. This layer is also critical for the mobility of skin over underlying muscles.

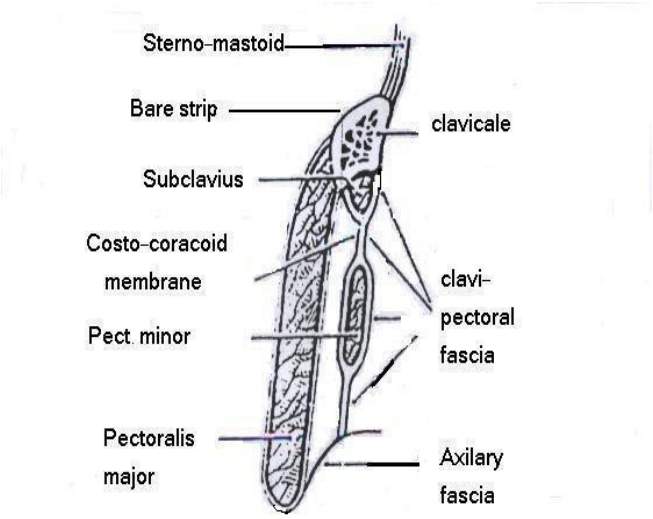

Figure1. 1: Superficial fascial system suspension

The superficial veins of the arm are among the most prominent features. The cephalic vein originates from the lateral aspect of the dorsal venous network of the hand and runs along the radial side of the forearm and arm. It courses through the deltopectoral groove before draining into the axillary vein [3]. The basilic vein, on the other hand, arises from the medial aspect of the dorsal venous arch and ascends along the ulnar side, piercing the brachial fascia to join the brachial vein [4]. The median cubital vein, connecting the cephalic and basilic veins at the cubital fossa, is a common site for venipuncture due to its accessibility [5].

Superficial cutaneous nerves provide sensory innervation to the skin of the arm. These include branches of the brachial plexus, primarily the lateral, medial, and posterior cutaneous nerves of the arm. The lateral cutaneous nerve, a branch of the musculocutaneous nerve, supplies the lateral forearm, while the medial cutaneous nerve of the arm originates from the medial cord of the brachial plexus and supplies the medial arm's skin [6]. The posterior cutaneous nerve, a branch of the radial nerve, provides sensation to the posterior arm [7].

The lymphatics of the superficial arm follow the veins. Superficial lymphatic vessels accompany the cephalic vein and drain into the infraclavicular (deltopectoral) lymph nodes. Vessels along the basilic vein drain into the cubital and lateral axillary lymph nodes [8]. These pathways are essential for understanding lymphatic spread in infections or malignancies.

The superficial fascia also contains subcutaneous fat, the amount of which varies with age, sex, and nutritional status. This adipose tissue serves as an energy reservoir, provides insulation, and acts as a protective cushion [9]. Clinically, the subcutaneous layer is significant for subcutaneous injections and lipoma development.

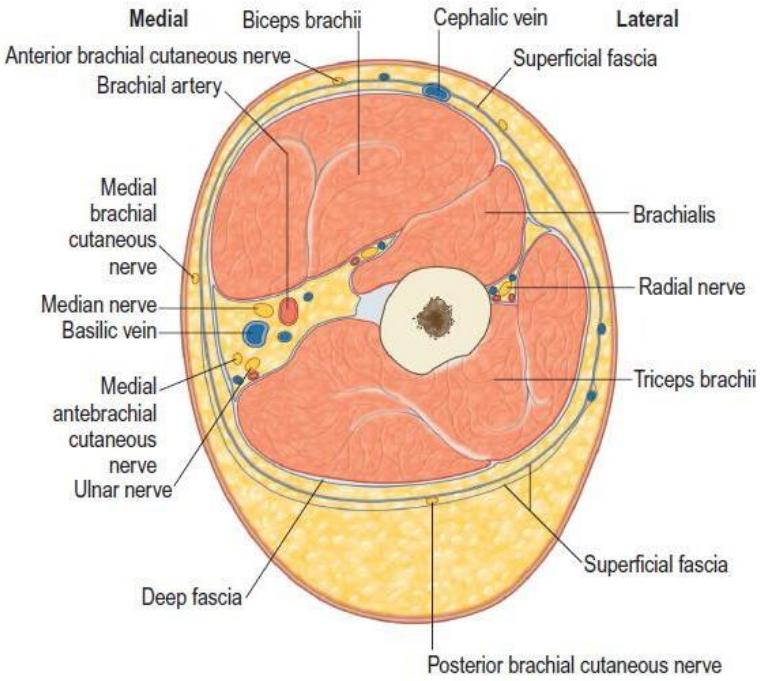

Figure 2: Cross-section through the middle of upper arm, [10].

The deep fascia of the arm lies beneath the superficial fascia and forms an important fibrous layer that encloses muscles. It gives rise to septa that divide the arm into anterior and posterior compartments [10]. However, at the superficial level, the fascia provides stability to the superficial structures.

Muscles of the arm, although deeper, influence the overlying superficial structures. For example, the biceps brachii creates a palpable bulge on the anterior arm, while the triceps brachii forms the posterior arm's contour [11]. These muscular landmarks are important for identifying venous pathways and nerve trajectories.

The vascular supply to the superficial structures is primarily derived from branches of the brachial artery, including smaller perforating branches that nourish the skin and subcutaneous tissues [12]. Venous drainage, as mentioned earlier, is predominantly through the superficial veins.

Clinically, superficial structures of the arm are frequently involved in injuries, phlebotomy, and intravenous access. The cephalic and median cubital veins are routinely used for cannulation due to their superficial course and accessibility [13]. The superficial cutaneous nerves are vulnerable to compression injuries, leading to sensory disturbances.

Superficial anatomical landmarks are also vital for physical examination. For instance, the bicipital groove can be palpated between the biceps' tendons, and the deltopectoral groove marks the cephalic vein's path [14]. These surface markings assist in identifying deeper structures for clinical procedures.

Anatomical variations exist within the superficial structures. For example, the cephalic vein may communicate with the external jugular vein, or the median cubital vein may be absent [15]. Awareness of such variations is critical during surgeries or interventions.

Brachioplasty, commonly referred to as an arm lift, is a surgical procedure designed to address excessive skin and fat in the upper arms. It is primarily performed to restore a more youthful and

toned appearance to the upper extremities, especially in individuals who have experienced massive weight loss, aging, or genetic predisposition. Over time, these factors contribute to skin laxity and localized fat accumulation, which can cause functional and aesthetic concerns for patients. As an increasingly sought-after body contouring procedure, brachioplasty has evolved with various techniques to meet patient needs and minimize complications [12].

The goal of brachioplasty is to remove excess tissue, tighten the underlying supportive structures, and contour the arm for improved cosmetic results. Candidates often pursue the surgery due to dissatisfaction with the arm's appearance, especially in situations where traditional methods like exercise and diet prove ineffective. The procedure has gained popularity in post-bariatric surgery patients as part of a comprehensive body contouring approach [13].

Classification of Patients in Need for Brachioplasty

Patients requiring brachioplasty can be classified based on the severity of skin laxity, fat accumulation, and the underlying cause of their condition. One of the most common classification systems includes three major groups: minimal skin redundancy with localized fat deposits, moderate skin laxity, and severe dermatochalasis combined with fat deposits [14].

For individuals with minimal skin excess and good skin elasticity, liposuction alone may suffice. In contrast, those with moderate or severe skin laxity require traditional or extended brachioplasty techniques. Additionally, patient classification depends on BMI, age, weight loss history, and the quality of their skin. Proper classification ensures an optimal surgical plan that addresses both functional and aesthetic goals [15].

Post-bariatric surgery patients form a significant proportion of brachioplasty candidates. These individuals often experience large amounts of redundant skin following massive weight loss, which can lead to physical discomfort, hygiene difficulties, and self-image concerns. Careful preoperative evaluation is essential to determine the most suitable surgical technique for this patient group [16].

Table 1 :Different arm ptosis classifications[16].

Classification	Degrees	Proposed treatment accordingly
(Teimourian & Malekzadeh 1998)	CLASS 1: *Minimal to Moderate Subcutaneous Fat with Minimal Skin Laxity*	Circumferential suction lipectomy
	CLASS 2: *Generalized Accumulation of subcutaneous Fat with Moderate Skin Laxity*	Liposuction with minimal incision brachioplasty
	CLASS 3: *Generalized Obesity and Extensive Skin Laxity*	Liposuction with brachioplasty extending to elbow
	CLASS 4: *Minimal Subcutaneous Fat and Extensive Skin Laxity*	Brachioplasty is the procedure of choice
(De Souza Pinto et	1) Localized fat,	1) Liposuction

al. 2000)	good skin laxity and normal weight 2) Moderate fat excess, moderate skin laxity and overweight 3) Minimal fat excess, poor skin laxity and massive loss of weight	2) Brachioplasy and liposuction 3) Brachioplasty
(Strauch et al. 2004)	zone I is defined as the forearm. zone II is defined as the region between the olecranon and the anterior axillary fold zone III is defined by the borders of the axilla zone IV is defined as the subaxillary lateral chest wall	Liposuction is recommended for patient with zone I or II sinusoidal excision with Z plasty in axilla for patient with zone II and III sinusoidal excision with Z plasty in chest wall for patient with zone II, III, IV
(Appelt et al. 2006) Fig :	1) Type I Patients with relative excess of fatty deposits in the upper arm but good skin tone and minimal skin laxity. 2) Type II patients with moderate skin laxity and minimal excess fat 3) Type III patients have moderate excess fat and moderate skin laxity.	1) Liposuction alone 2) Brachioplasty using excisional techniques according to location of skin laxity the pattern of excision is designed. 3) Down staging is recommended by further weight loss or staged fashion ultrasound-suction-assisted liposuction. Then revisional brachioplasty can be done
(El Khatib 2007) fig	Stage1: minimal adipose tissue deposit (300 ml lipoaspirate) with no ptosis Stage 2a: moderate adipose tissue deposit with grade 1 ptosis (5 cm) Stage 2b: severe adipose tissue deposit	Circumferential liposuction Staged circumferential liposuction Liposuction of the lower posterior and medial

	with grade 2 ptosis (5–10 cm) Stage 3: severe adipose tissue deposit (¬500 ml lipoaspirate) with grade 3 ptosis (>10 cm) Stage 4: minimal or no adipose tissue deposit with grade 3 ptosis	arm Assisted proximal short scar brachioplasty Liposuction of the lower posterior and medial arm assisted longitudinal scar brachioplasty Traditional brachioplasty as described by the author
(Mahmoud et al. 2010)	A)Excess fat with no skin redundancy or Excess fat with anticipated skin retraction B1)Skin redundancy of proximal one third of inferior border B2)Skin redundancy of more than proximal one third but not reaching the elbow B3)Skin redundancy of more than proximal one third but reaching the elbow B4)Skin redundancy of the whole inferior border with skin redundancy at the lateral chest wall Secondary zone of adherence	Liposuction Semilunar Axillary Resection Modified Ted Lockwood Technique Non Excisional Brachioplasty Extended Brachioplasty Severance of the adherent zone and lipoinjection

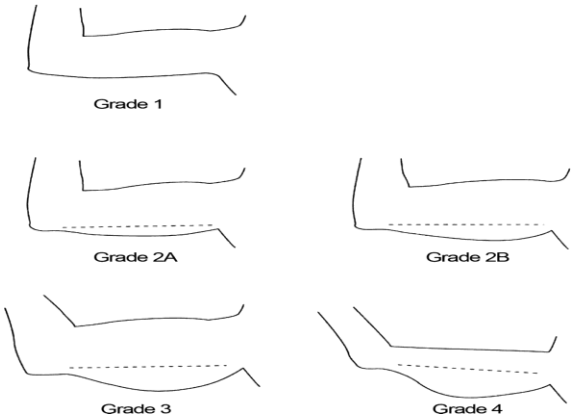

Figure 3: schematic drawing of the classification of brachial ptosis. The dotted lines denote the brachial sulcus and note the distance between the inferior curve of the arm and the brachial sulcus[16].

Liposuction in Brachioplasty

Liposuction is a critical adjunct to brachioplasty, particularly for patients with minimal skin redundancy and significant localized fat deposits. This technique allows surgeons to contour the arm by removing excess adipose tissue through small incisions, minimizing scarring and reducing recovery time [17].

When combined with skin excision techniques, liposuction enhances the results by improving the overall contour and smoothness of the upper arms. It is particularly beneficial in patients who do not require extensive skin removal but seek refinement of arm proportions. The technique is less invasive compared to traditional brachioplasty, making it appealing for individuals with mild to moderate concerns [18].

The efficacy of liposuction depends on proper patient selection, skin elasticity, and surgeon expertise. Patients with poor skin elasticity may experience suboptimal outcomes when relying solely on liposuction. In such cases, combining liposuction with surgical skin excision is necessary to achieve satisfactory results [19].

Different Brachioplasty Techniques

Brachioplasty techniques vary based on patient needs and the degree of skin and fat excess. The most common techniques include traditional brachioplasty, extended brachioplasty, minimal incision brachioplasty, and liposuction-assisted brachioplasty [20].

Traditional Brachioplasty

Traditional brachioplasty is the most commonly performed technique and is indicated for patients with moderate to severe dermatochalasis. The procedure involves excising excess skin and fat along the inner aspect of the arm, extending from the axilla to the elbow. This results in a significant improvement in contour and a dramatic reduction in arm circumference [21].

The surgical process begins with preoperative marking to determine the precise area of excision. The incision is typically placed along the medial or posterior arm to minimize scar visibility. After the removal of excess tissue, the underlying fascia and supportive structures are tightened to provide long-lasting results. The procedure concludes with meticulous closure to minimize tension and optimize healing [22].

One of the advantages of traditional brachioplasty is its ability to address substantial skin redundancy and deliver predictable outcomes. However, the long scar remains a concern for many patients. Surgeons must ensure proper counseling preoperatively to align patient

expectations regarding scarring and outcomes [23].

Traditional brachioplasty is especially beneficial for post-bariatric patients who exhibit significant upper arm laxity. In this group, skin excision provides relief from physical discomfort, hygiene difficulties, and skin irritation caused by redundant tissue. Proper patient selection and preoperative preparation are key to achieving satisfactory results [24].

Despite its benefits, traditional brachioplasty carries risks, including seroma, hematoma, wound dehiscence, and hypertrophic scarring. Proper surgical techniques, such as the use of drains and tension-free closure, can mitigate these complications. Postoperative care, including scar management and compression garments, plays a significant role in the recovery process [25].

Surgeons must pay close attention to incision placement and tissue handling to minimize aesthetic concerns. By carefully balancing functional and aesthetic goals, traditional brachioplasty continues to be a reliable and effective technique for addressing severe upper arm laxity [26].

Extended Brachioplasty

Extended brachioplasty is an advanced technique designed for patients with extensive skin redundancy that extends beyond the upper arms to the lateral chest wall. This procedure is particularly beneficial for post-bariatric patients who have experienced massive weight loss [27].

The incision for extended brachioplasty begins at the axilla, travels along the inner arm, and extends laterally across the chest wall. This allows for comprehensive contouring of the upper torso, addressing skin laxity in both the arms and the adjacent chest area. Preoperative marking is critical to ensure proper incision placement and symmetrical results [28].

During the procedure, the surgeon excises excess skin and fat while preserving critical neurovascular structures. The underlying tissue is tightened to improve contour and provide long-term support. The extended incision enables the removal of significant amounts of redundant tissue, resulting in a dramatic transformation for patients [29].

Extended brachioplasty is ideal for individuals with severe skin laxity following massive weight loss. These patients often face functional challenges, such as skin irritation, chafing, and difficulty in fitting clothing. By addressing both the arm and chest wall, extended brachioplasty provides functional and aesthetic benefits [30].

However, the extensive nature of the procedure also increases the risk of complications, including prolonged wound healing, seroma, and hypertrophic scarring. Careful patient optimization, such as smoking cessation and nutritional support, can help reduce these risks. Surgeons must discuss the potential for extended scars with patients to ensure realistic expectations [31].

Postoperative care is crucial for recovery and includes the use of compression garments, scar therapy, and close monitoring for complications. Despite the longer recovery time and scar burden, extended brachioplasty remains a highly effective solution for patients with significant skin redundancy [32].

Minimal Incision Brachioplasty

Minimal incision brachioplasty is a less invasive technique suitable for patients with mild to moderate skin laxity confined to the upper portion of the arms. This approach involves a smaller incision placed within the axillary crease, which significantly reduces visible scarring [33].

The procedure is ideal for patients with localized skin laxity and good skin elasticity. During surgery, the excess skin is gathered and excised through the small axillary incision, followed by tightening of the underlying tissue. Liposuction is often performed simultaneously to enhance arm contour and achieve smoother results [34].

One of the primary advantages of minimal incision brachioplasty is its limited scar visibility, making it appealing for patients concerned about postoperative scars. However, its effectiveness is limited to patients with minimal skin excess. Individuals with more extensive skin laxity may not achieve satisfactory results with this technique alone [35].

Figure 4:Design of minimal incision brachioplasty

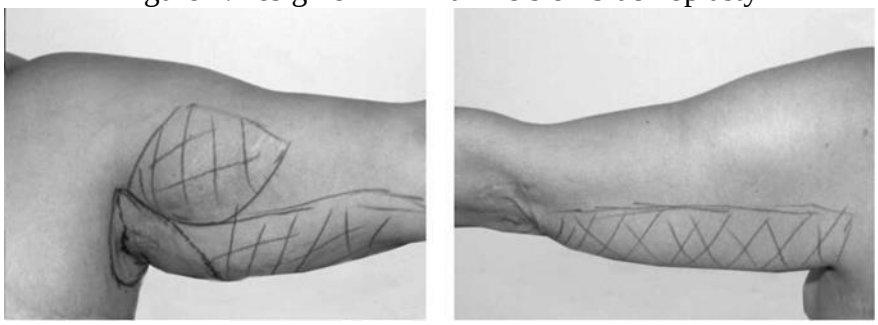

Figure 5: Zones for liposuction in minimal incision brachioplasty[35].

The procedure is typically performed on an outpatient basis, with a shorter recovery time compared to traditional and extended brachioplasty. Patients can expect mild discomfort, swelling, and bruising postoperatively, which usually resolve within a few weeks. Proper compression garment use is essential to support healing and optimize results [36].

Surgeons must carefully evaluate patient candidacy for minimal incision brachioplasty, as improper selection can lead to suboptimal outcomes. By targeting a specific patient population, this technique provides excellent contouring with minimal scarring and downtime [37].

Minimal incision brachioplasty is an excellent option for younger patients or those with good skin quality who wish to address localized skin laxity. Combining the procedure with liposuction further enhances the aesthetic outcome, providing patients with a balanced and natural arm contour [38].

Liposuction-Assisted Brachioplasty

Liposuction-assisted brachioplasty combines liposuction with limited skin excision to address localized fat deposits and mild to moderate skin redundancy. This technique is particularly suitable for patients with good skin elasticity who seek less invasive contouring [39].

The procedure begins with tumescent infiltration to facilitate fat removal and minimize bleeding. Liposuction is performed using small cannulas to remove excess fat and sculpt the upper arms. If necessary, a small incision is made to excise limited amounts of redundant skin, providing additional contouring [40].

Liposuction-assisted brachioplasty is advantageous due to its minimally invasive nature and reduced scarring. Patients experience shorter recovery times and less discomfort compared to traditional techniques. However, its success relies heavily on the patient's skin quality and the

surgeon's expertise [41].

Patients with poor skin elasticity may not achieve optimal results with liposuction alone. In such cases, combining liposuction with traditional or minimal incision techniques ensures a more satisfactory outcome. Proper patient evaluation and counseling are essential to set realistic expectations [42].

This approach is particularly beneficial for individuals with disproportionate fat deposits in the upper arms. By combining liposuction with limited skin excision, surgeons can achieve smoother contours and a more natural appearance while minimizing the extent of surgery [43].

Postoperative care involves wearing compression garments to support the arms, reduce swelling, and enhance results. While the procedure has a lower risk of complications, patients must adhere to recovery guidelines to achieve optimal outcomes [44].

Liposuction-assisted brachioplasty represents an excellent option for patients seeking subtle improvements with minimal downtime. By addressing both fat and mild skin redundancy, this technique delivers significant aesthetic benefits with reduced scarring and faster recovery [45].

The "Double-Ellipse" Marking Technique Brachioplasty

Preoperative Measurement The "double-ellipse" technique begins with precise preoperative measurements to determine the amount of excess skin and fat that need removal. The arm is positioned abducted to 90 degrees, and the surgeon evaluates the extent of skin redundancy and laxity. Measurements are taken along the arm's medial aspect, starting from the axilla down to the elbow. The width of the ellipse is determined based on the degree of sagging, ensuring that the excision will achieve both aesthetic contour and functional improvements [39].

Steps The process begins with marking the double-ellipse design, where two elliptical lines are drawn longitudinally along the arm's inner surface. The upper ellipse typically extends from the axillary fold, tapering distally toward the elbow. The medial placement avoids visibility of scars in the posterior or anterior views. This technique minimizes the risk of excessive tissue removal, preserving the contour and allowing for easier closure [40].

Technique The procedure starts with a longitudinal incision along the marked lines of the double ellipse. The skin and subcutaneous fat are excised carefully to preserve the underlying neurovascular structures. Adequate hemostasis is achieved using electrocautery. Meticulous dissection helps prevent injury to the brachial plexus and medial cutaneous nerve. Once the tissue is excised, attention is given to achieving symmetry between both arms [41].

Wound Closure Wound closure is performed in layers to reduce tension and improve healing. Deep sutures are placed using absorbable material like polydioxanone (PDS) to close the subcutaneous tissues. The dermis is approximated using interrupted sutures, followed by a running subcuticular closure for the skin. A drain may be inserted to prevent seroma formation, and compression garments are applied postoperatively to reduce swelling and support tissue adherence [42].

Figure 6 :Demonstrates the completed procedure,with the Z-plasty located at the axillary crease [42].

Pascal and Louran Technique of Brachioplasty

Preoperative Measurement The Pascal and Louran technique focuses on precise measurements of both horizontal and vertical laxity. Preoperative markings are made with the arm abducted, and attention is given to balancing the arm's shape. Measurements are conducted along the length and circumference of the upper arm, ensuring the markings account for both dimensions of sagging [43].

Steps This technique involves designing markings with a combination of vertical and horizontal tissue excision. The surgeon creates a fusiform pattern that transitions from the axilla to the elbow. The excision design ensures optimal skin removal while maintaining natural arm curvature. Accurate alignment during marking is crucial to avoid contour irregularities or excessive tightening [44].

Technique A fusiform excision is performed, starting with incisions along the pre-marked lines. The skin and subcutaneous tissue are removed en bloc while ensuring protection of the underlying musculature and neurovascular structures. The method prioritizes a smooth tapering of tissue excision to produce a uniform contour. The Pascal and Louran technique is known for achieving superior results in patients with significant skin redundancy and diffuse arm laxity [45].

Wound Closure Wound closure begins with layered sutures to minimize tension. Deep sutures close the subcutaneous layer, and running subcuticular sutures close the skin edges. Precise closure techniques reduce the risk of widening scars or dehiscence. Compression garments are applied to maintain the contour and decrease postoperative edema [46].

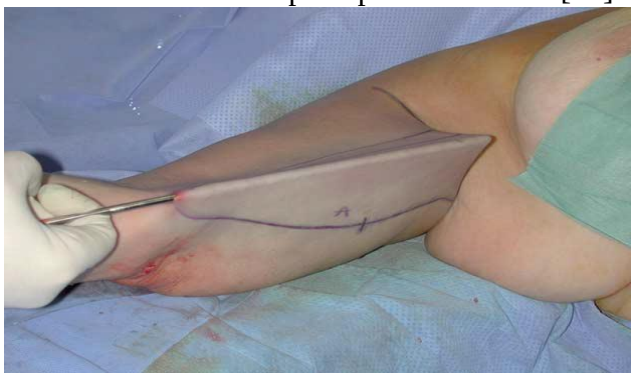

Figure 7: Liposuction under the area of resection [46].

The L-Brachioplasty

Preoperative Measurement The L-brachioplasty technique is ideal for patients with moderate to severe skin redundancy. Measurements are performed to assess the extent of excess tissue from the axilla to the elbow, as well as the lateral chest wall if required. The markings include an L-shaped design that extends from the inner arm into the axillary region [47].

Steps The L-shaped marking begins with a longitudinal line along the arm's medial aspect, which intersects with a transverse line in the axillary region. This combination allows for efficient removal of excess tissue while also addressing axillary folds. The design ensures an aesthetically pleasing result while avoiding excessive scarring [48].

Technique The excision follows the L-shaped marking, starting with a longitudinal incision. The skin and subcutaneous fat are excised, and care is taken to avoid injury to the axillary structures. The L-shape allows the surgeon to address both the arm's laxity and any axillary redundancy in a single procedure. Hemostasis is ensured, and precise dissection avoids contour deformities [49].

Wound Closure Closure begins with layered suturing using absorbable material for the deeper layers, while the skin edges are approximated using a running subcuticular technique. A drain may be used to manage seroma formation, and compression garments are recommended postoperatively. Proper closure reduces scar tension and improves healing [50].

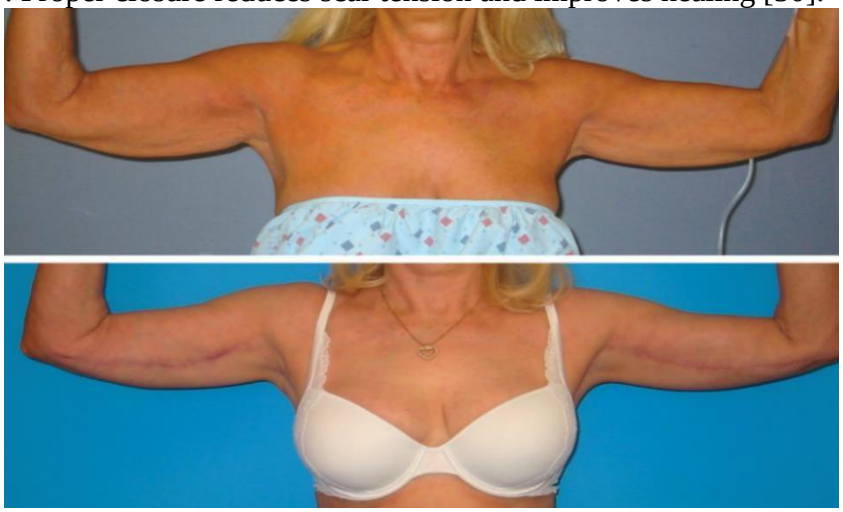

Figure 8 :(Above) Preoperative frontal view of the patient (Below)The 7-month result shows the symmetrical improvement [50].

Fish-Incision Brachioplasty

Preoperative Measurement The fish-incision technique involves detailed preoperative assessment of excess tissue, primarily focusing on skin folds in the medial and posterior arms. Measurements are performed with the arms abducted, allowing accurate marking of the elliptical "fish" shape [51].

Steps The marking follows a fish-shaped incision pattern to provide an ideal contour and address moderate to severe skin laxity. The broader portion of the "fish" accommodates significant tissue excision, while the tapering ends blend naturally into the surrounding arm areas [52].

Technique The fish-shaped incision begins with careful dissection along the pre-marked lines. Tissue is excised in a manner that preserves the arm's contour. This design minimizes scarring visibility and avoids abrupt edges. The fish-incision technique is particularly effective for

patients with significant skin folds who require precise contouring [53].

Wound Closure Wound closure involves layered sutures to ensure stability. Deep sutures address the subcutaneous layer, and the skin edges are approximated with a running subcuticular closure. Compression garments are used postoperatively to support the tissue and reduce swelling [54].

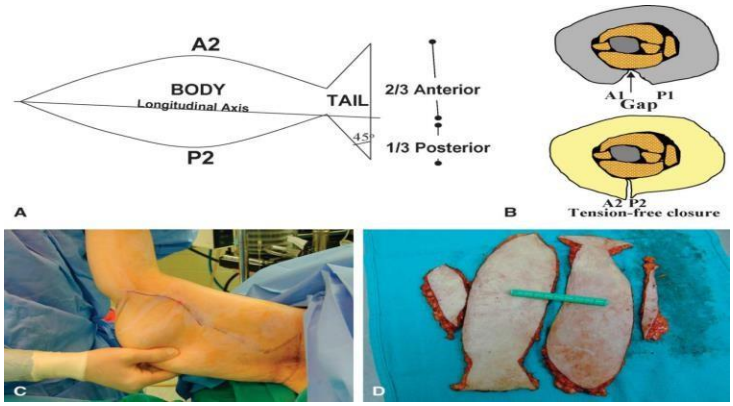

Figure 9. 1 :Fish incision brachioplasty (A)Mathematical dimensions of the 'fish-incision'. (B)Upper panel: showing a cross sectional view of the arm with the gap caused if A1 and P1 were to be used for the width of the fish-incision. As shown this leads to a tissue gap and makes approximation difficult. Lower panel: adding the correction factor, i.e. marking points A2 and P2, which account for the thickness of the skin flap allows more tissue for a tension-free closure.(C)Intraoperative view of the fish incision. (D)Intraoperative view of the excised portions of the arm [54].

Brachial Dermolipectomy (W-Plasty)

Preoperative Measurement In W-plasty, measurements involve evaluating the medial and posterior arm's tissue excess. The W-shaped pattern is drawn, ensuring each triangular flap accommodates redundant tissue while promoting tension-free closure [55].

Steps The W-shaped marking involves multiple triangular flaps along the arm's axis, providing controlled tissue excision. This design avoids linear scars that can contract and deform the arm contour [56].

Technique The excision follows the W-shaped incisions, removing excess skin and subcutaneous fat. Each triangular segment is carefully dissected and excised. The W-plasty approach improves scar camouflage and allows for greater flexibility during closure [57].

Wound Closure Closure follows a layered method, approximating the triangular segments to reduce tension and achieve a smooth contour. Running sutures for the dermis and subcuticular sutures for the epidermis promote wound healing. Compression garments are essential for postoperative care [58].

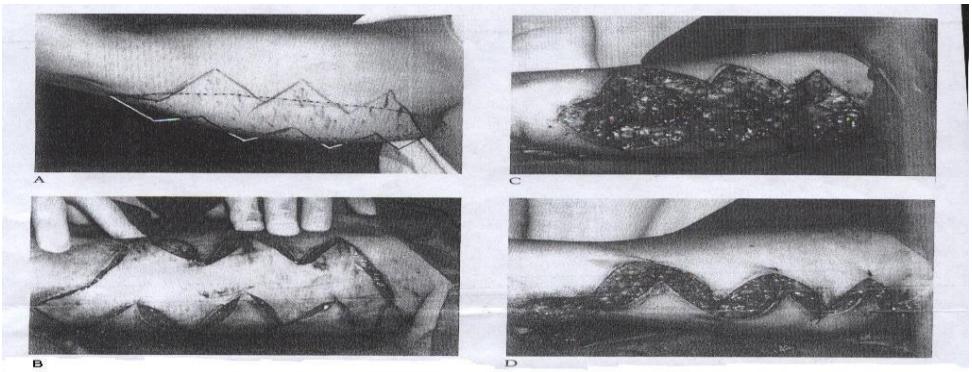

Figure 10: W- brachioplasty Design of the W-plastic excision over a fusiform segment of redundant skin and subcutaneous tissue. (B) Incision has been made. (C) After excision of W-plastic segment of skin and fat. (D) Following first horizontal mattress suturing [58].

The Four Zones Brachioplasty and Sinusoidal Technique is an advanced approach to arm contouring surgery, aiming to address excess skin and fat in the upper arms. Traditional brachioplasty techniques often focus on a single linear incision, which, while effective, can sometimes lead to noticeable scarring and suboptimal contouring. The Four Zones method divides the upper arm into specific regions for precise targeting and better aesthetic results. By treating the arm in distinct zones, surgeons can achieve smoother, more natural outcomes tailored to the patient's unique anatomy and level of skin laxity. [58].

The Four Zones include the medial arm, posterior arm, lateral arm, and the transition zone near the axilla. Each of these areas has unique challenges in terms of excess tissue and contour definition. This segmentation allows for a more strategic approach, where the degree of tissue removal, fat contouring, and skin tightening is carefully customized. By focusing on all four zones, surgeons can create a more harmonious and balanced result, ensuring that no area is disproportionately addressed or neglected. [58].Complementing the Four Zones Brachioplasty is the Sinusoidal Technique, which revolutionizes the method of incisional design. Instead of a straight linear incision, the sinusoidal (wave-like) incision follows a natural curve along the arm. This innovative approach helps to minimize visible scarring by blending the incision into the body's natural contours. The wave-like design also reduces tension on the wound edges during closure, which is known to improve healing and decrease the risk of hypertrophic scarring or widening. [58].

The Sinusoidal Technique is particularly effective in enhancing arm mobility and maintaining a natural arm contour post-surgery. A linear scar can sometimes result in tethering or stiffness, especially when excess skin removal is significant. The wave-like incision, on the other hand, adapts more flexibly to the arm's movement, reducing post-operative complications. Combined with modern liposuction techniques, this approach ensures that the soft tissue envelope is sculpted and repositioned optimally for both functional and aesthetic outcomes. [58].

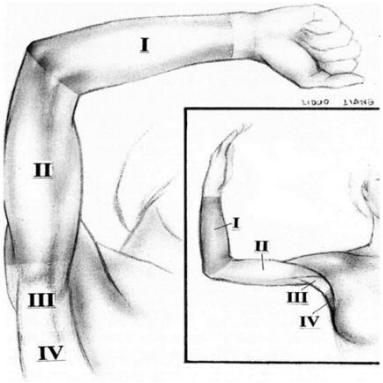

Figure 11 :The 4 Zones brachioplasty [58].

Brachioplasty by Deepithelialization Technique

Preoperative Measurement The deepithelialization technique focuses on assessing the arm's skin redundancy without extensive tissue removal. Measurements are taken longitudinally, marking areas where skin deepithelialization will occur [59].

Steps The marked areas are deepithelialized, preserving the dermal layer while removing the epidermis. This avoids excessive skin excision and is ideal for patients with mild to moderate skin laxity [60].

Technique The deepithelialization process involves precise removal of the epidermis while retaining the dermis and underlying fat. This promotes skin retraction and adherence to the underlying tissue without visible scars [61].

Wound Closure Closure involves approximating the deepithelialized skin edges with minimal tension. Compression garments aid in contour improvement and reduce swelling [62].

Figure 12: Goddio technique in 2ry brchioplasty A,B: removing the surface epidermis of the scar and the surrounding skin. C, Subcutaneous undermining of the deepithelialized flap and also of the opposite side.The denuded flap is buried beneath the skin flap on the other side. D, Final suture in secondary brachioplasty [62].

Non-Excisional (Non-Invasive) Brachioplasty

Preoperative Measurement Non-excisional brachioplasty focuses on determining the degree of skin laxity and fat deposits. Preoperative measurements involve assessing arm circumference and identifying treatment zones for non-invasive procedures like radiofrequency or ultrasound

therapy [63].

Steps The non-invasive treatment begins with marking target areas for energy delivery. Techniques such as radiofrequency or cryolipolysis are used to tighten skin and reduce fat deposits without incisions [64].

Technique Devices deliver controlled energy to the dermal and subcutaneous layers, inducing collagen production and fat apoptosis. Treatments are performed in multiple sessions for optimal results. This method suits patients with mild laxity [65].

Wound Closure Since no incisions are made, no formal wound closure is necessary. Patients are advised to wear compression garments to support tissue adherence and improve outcomes [66].

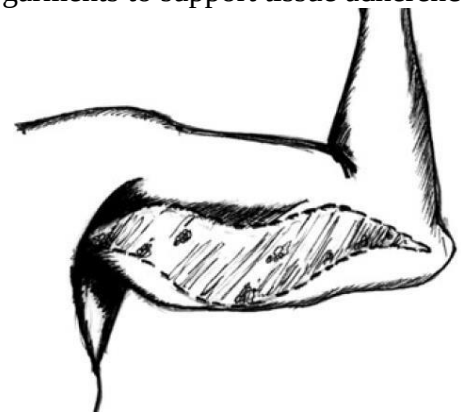

Figure 13 Depithelialization technique in non excisional brachioplasty [65].

Risk Factors and Complications of Brachioplasty

While brachioplasty is generally a safe procedure, it is associated with certain risks and complications. Common complications include seroma formation, hematoma, wound dehiscence, infection, hypertrophic scarring, and lymphedema [26].

Seroma and hematoma are among the most frequently reported complications. These conditions can arise due to inadequate drainage or excessive tissue manipulation during surgery. Proper surgical technique and the use of drains can help minimize the risk of fluid collections [27].

Wound healing complications, such as dehiscence and delayed healing, are more common in patients with poor nutritional status, diabetes, or smoking history. Ensuring patient optimization before surgery, including smoking cessation and nutritional support, is critical for reducing these risks [28].

Hypertrophic scars and scar dissatisfaction are significant concerns for patients undergoing brachioplasty. Proper incision placement, meticulous surgical technique, and postoperative scar management can help improve aesthetic outcomes. Silicone therapy, laser treatments, and steroid injections are commonly used to manage hypertrophic scars [29].

Lymphedema is a rare but serious complication that occurs due to disruption of lymphatic channels during surgery. Patients with predisposing factors, such as previous axillary surgeries or radiation therapy, are at higher risk. Careful surgical dissection and patient counseling are necessary to mitigate this risk [30,31].

Conclusion

Brachioplasty is an effective procedure for addressing excess skin and fat in the upper arms, improving both function and aesthetics. By understanding patient classification, incorporating liposuction when appropriate, and selecting the most suitable technique, surgeons can achieve optimal outcomes. However, careful preoperative planning and patient education are crucial to

minimize complications and ensure satisfaction. Advances in surgical techniques continue to refine brachioplasty outcomes, offering patients safer and more predictable results.

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