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Comparative Study Between Lipoabdominoplasty Using Progressive Tension Suture Techniques Versus Classic Lipoabdominoplasty

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Abstract:

It is now widely recognized that the rate of obesity has increased dramatically over the last few decades. Bariatric surgery is the best choice of treatment for extremely obese patients. The proliferation of bariatric surgery has also resulted in the increased use of body contouring surgery to address the hanging, redundant skin that is often seen after dramatic weight loss. Obesity-related issues increase, leading to patients being advised to lose weight to achieve abdominoplasty. The best indication for abdominoplasty is patients with loose skin, rectus muscle diastasis, and minimal abdominal fat. However, obesity-related issues are rare, and many obese patients are denied abdominoplasty. A two-step approach involves abdominoplasty followed by liposuction six months later or vice versa. However, both approaches are less ideal due to potential complications, fibrosis, and secondary skin laxity. Abdominoplasty has evolved as a very effective and satisfactory procedure, especially when combined with liposuction and the repair of diastasis recti. However, local complications, including hematoma and seroma formation, flap necrosis, and hypertrophic scars is not uncommon. Sutures are an adjunct in abdominoplasty procedures. Patients are marked in recumbent and standing positions, with planned incisions and liposuction areas. Sequential compression devices are placed before induction, and VTE-prevention modalities are individualized. Posterior liposuction is performed in the prone position. The patient is supine, secured on arm boards, and a pillow is placed under the knees. Wide skin prep and draping is used for midthighs

Keywords: Aesthetic Lipoabdominoplasty, Progressive Tension Suture, Abdominoplasty

1. Introduction

Quality of life is often questioned both within the bariatric context and on cosmetic surgery, especially in women. An abdominoplasty is usually mandatory for such patients. This desired goal of this surgical procedures to reduce the redundancy of fat and skin, to recreate the competence of the abdominal wall and to correct pubic ptosis and reshape the Mons pubis (1)

Abdominoplasties are classified according to the type of incision used: Transverse, vertical, or combined. The navel is the most important anatomical and aesthetic unit of the anterior abdominal wall. It is a scar itself, resulting from the detachment of the umbilical cord in the newborn, and it is physiologically located in the mid- line, 1 or 2 cm above a horizontal line that joins both iliac crests, about 18–20 cm above the beginning of the vulvar commissure. It may have a round or oval vertical shape (2)

Seroma and skin necrosis are potential complications following abdominoplasty. Many methods had been employed to prevent these complications, including the progressive tension suture technique(3)

During an abdominoplasty, it is important to carry out an adequate neo-omphaloplasty resulting in an anatomically preserved navel, with its depressions, umbilical groove and located in the right position, which means 13–14 cm above the horizontal abdominal scar (4)

The aim of study to decrease incidence of complication (hematoma-seroma-infection) of lipoabdominoplasty, to evaluate the effect of progressive tension suture technique in lipoabdominoplasty and to evaluate patient expectation and satisfaction

Lipoabdominoplasty

Anatomy of the abdominal wall

The abdominal wall is a three-dimensional structure with the following tissue types and planes (5)**.**

Skin

Surface boundary delineations are the costal margin, mid-axillary line, iliac crest, and symphysis pubis. Skin variables include age, body mass index (BMI), weight change, and pregnancy (5)**.**

Subcutaneous Fat

Two layers of abdominal wall adipose tissue exist, superficial and deep, relative to Scarpa’s fascia. The superficial layer contains dense adipose tissue and a robust dual blood supply based on myocutaneous perforators and the subdermal plexus. Contrastingly, the deep layer has a single vascular supply from individual perforators and is therefore more susceptible to ischemia during abdominal flap elevation (5)**.**

Muscle, Fascia, and Rectus Sheath

Scarpa's fascia defines the superficial facial system, suggested to contain lymphatic channels. Full-thickness tissue resection divides Scarpa's fascia, adipose layers, and lymphatics. Deep to the sub-Scarpa's fat is deep fascia and the 4 paired muscle groups of the anterior abdominal wall: (1) rectus abdominis; (2) external oblique; (3) internal oblique; and (4) transversus abdominis (6)**.**

Vascularity of the Abdominal Wall

Abdominoplasty is a procedure that involves removing the abdominal wall to create a more stable abdominal space. This is achieved through blood supply and venous drainage, which are crucial for minimizing ischemic complications. The survival of the abdominal flap is determined by the vascular contributions of deep or superficial systems, axial perforators, or choke vessels. However, there is a "tipping point" when tissue demand exceeds supply. With proper planning and execution, most patients can have viable flaps. Lockwood's high lateral tension abdominoplasty (HLTA) and its modifications ensure safe and effective surgery.(7)**.**

Umbilicus: The umbilicus, originating from embryos and fetal circulation, has anatomically distinct features, with the ligamentous stalk serving as the obliterated umbilical artery and vein. The deep inferior epigastric artery supplies the adult umbilicus, with subdermal plexus supply. (8)**.**

Nerves: The lower thoracic spine's anterior and lateral cutaneous intercostal branches provide abdominal skin sensation. Anterior branches connect transverse and internal oblique muscles, entering the posterior rectus sheath. Lateral branches traverse the subcutaneous plane at the midaxillary line. 10% of patients experience iatrogenic nerve division due to this.(9)**.**

Lymphatics: The presence of lymphatic channels in Scarpa's fascia and a plexus on the anterior rectus sheath is debated, with abdominal wall draining into superficial inguinal nodes and cranial tissue into axillary lymph nodes.(10)**.**

Intra-abdominal Fat: Fat deposits within the peritoneal cavity affect abdominal aesthetics. Age-associated intraabdominal fat contributes to truncal obesity, typically affecting the anterior abdomen of male patients with increased wound complications (11)**.**

Obesity: Obesity is the excessive accumulation of fat or adipose tissue, leading to health issues like diabetes, cardiovascular disease, hypertension, and hyperlipidemia. It's a significant public health epidemic with a multifactorial etiology and is the second most common cause of preventable death after smoking. Treatment strategies may require lifelong care, but a 5% to 10% weight loss can significantly improve health, quality of life, and economic burden for individuals and countries.(12)**.**

Obesity is defined by the body mass index (BMI), which is calculated as weight/height. However, BMI may not be as accurate in Asians and elderly individuals, as a normal BMI may conceal

excess fat. Obesity can also be estimated by skin thickness in triceps, biceps, subscapular, and supra-iliac areas, and by using Dural energy radiographic absorptiometry (DEXA) scans. (13)**.**

Health risks associated with obesity

Obesity negatively affects most bodily systems. It is linked to the most prevalent and costly medical problems seen in our country, including type 2 diabetes, hypertension, coronary artery disease, many forms of cancer, and cognitive dysfunction (14).

Type 2 diabetes and prediabetes: BMI, abdominal fat distribution, and weight gain are important risk factors for the development of type 2 diabetes. It is estimated that 90% of individuals with type 2 diabetes are obese. It is further estimated that 30% of U.S. adults have prediabetes (15)**.**

Dyslipidemia: Visceral obesity is associated with elevated triglycerides, low HDL cholesterol, and increased small, dense LDL particles (16)**.**

Coronary artery disease (CAD): Obese persons, particularly those with abdominal fat distribution, are at increased risk for CAD. The American Heart Association added obesity to its list of major risk factors for CAD in 1998 (17)**.**

Sleep apnea: Obese individuals are at a high risk for sleep apnea, a condition where the upper airway is blocked during sleep, leading to episodes of apnea or hypopnea, which can cause daytime somnolence, morning headache, systemic hypertension, pulmonary hypertension, and right heart failure.(18)**.**

Cognitive dysfunction: The link between obesity and cognitive dysfunction is unclear, with studies showing a correlation between obesity and cognitive issues such as worse executive function and memory deficits. However, some imaging studies have found lower brain volume and grey and white matter in obese individuals without weight-related comorbidities, as well as in those with mild cognitive impairment and Alzheimer's disease.(19)**.**

Non-alcoholic fatty liver disease: Obesity is linked to non-alcoholic fatty liver disease (NAFLD) or non-alcoholic steatohepatitis (NASH), characterized by hepatomegaly, abnormal liver function tests, and abnormal liver histology like macrovesicular steatosis, steatohepatitis, fibrosis, and cirrhosis. (20)**.**

Cancer: Obesity increases cancer risk in various organs, including endometrial, esophageal, renal, pancreatic, ovarian, breast, colorectal, thyroid, gallbladder, leukemia, multiple myeloma, non-Hodgkin's lymphoma, and malignant melanoma. (21)**.**

Health risks of obesity in children and adolescents

Obesity among children and adolescents is increasing risk factors for chronic diseases like dyslipidemia, hypertension, and hyperinsulinemia, which are typically seen later in life. Type 2 diabetes is becoming more prevalent among obese children and adolescents, and obesity is linked to the progression of cardiovascular disease.(22)**.**

Lipoabdominoplasty

Abdominoplasty, a common aesthetic surgery operation, has undergone technical improvements but remains based on extensive undermining, resection, and closure, despite a high complication rate, morbidity, and prolonged convalescence.(23).

Complications have included flap necrosis, seroma, haematoma, infections, fat necrosis, dehiscence of wound and delayed healing. There is also a high incidence of aesthetic flaws and need for secondary correction, rates as high as 27.9 % being reported (24)**.**

Extensive undermining in traditional abdominal surgery results in denervation and reduced vascularity of the flap, leading to ischemia-related complications and permanent numbness of the lower abdominal skin. The technique also divides lymphatics, leading to a high rate of postoperative seroma, and may not always be aesthetically pleasing, despite the use of drainage. (24)**.**

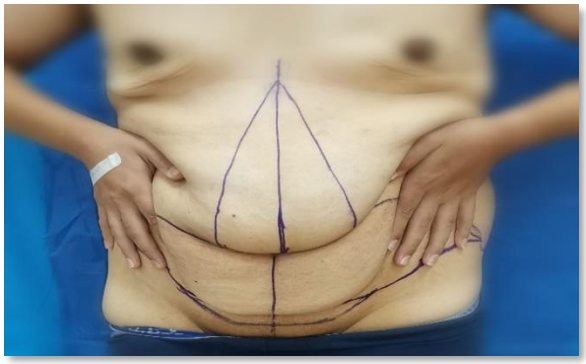
Figure (3): Left: An ideal patient for abdominoplasty. Right: the type of obese patient that one often gets (24)**.**

Lipoabdominoplasty technique

Preoperative markings

The procedure involves a vertical line drawn using the anterior vaginal commissure as a reference for the true midline, and two parallel lines marked over the linea semilunaris bilaterally. The patient is then positioned and the skin creases are marked bilaterally. A horizontal line is marked, 5-7 cm superior to the superior labial commissure, marking the inferior resection margin. Male patients with higher undergarments tolerate higher incisions, which can be marked based on their

undergarment height. Lateral extensions are marked with a stencil for symmetry, with the inclination dependent on the shape of the pelvis. The key is to keep the incision parallel and superior to the inguinal ligament to provide thicker, more robust soft tissue for closure and mitigate the risk of injuring the lateral femoral cutaneous nerve of the thigh. The upper incision joins a point 1 cm above the umbilicus to each apex to finalize the ellipse. Intraoperative bed flexion is simulated by having the patient lean forward and performing a pinch test to evaluate closure tension. All markings are confirmed intraoperatively after liposuction with the operating room bed in the beach chair position (24).



(A)

(B) (C)

Figure 4: Surgical markings with the patient standing upright. In A, anterior view. In B, left side. In C, right side (24).

Figure 5: A patient who underwent lipoabdominoplasty for aesthetic treatment of the abdomen., preoperative and postoperative appearance in anterior views (24).

Anesthesia, positioning and enhanced recovery after surgery protocol

Enhanced Recovery After Surgery (ERAS) protocols are evidence-based guidelines that aim to reduce narcotic consumption, improve patient satisfaction, and accelerate recovery after plastic surgery procedures, especially abdominoplasty. These protocols are crucial as abdominoplasty is the most painful and risky procedure, and they facilitate earlier mobilization and return to activities.(25).

Intraoperatively, anesthesiologists limit opioid administration and add 10 mg metoclopramide, 10 mg dexamethasone, and 8 mg ondansetron solution to the IV fluid bag. Surgeon-administered anesthesia consists of tumescence (1 L of Ringer's lactate, 200 mg lidocaine, 1 mg of epinephrine) infiltration at the start of the case, in addition to a Transverse Abdominus Pane (TAP) blocks with 133 mg of Liposomal Bupivicaine (Exaparel, Pacira Pharmaceuticals, SanDiego, CA) and 25 mg Bupivicaine with epinephrine mixture in 80 mL of normal saline) (26).

Postoperatively, patients are encouraged to consume early oral intake and receive a 7-day stool softener, along with Acetaminophen, celecoxib, gabapentin, and oxycodone. This standardized protocol leads to less postoperative pain, reduced opioid consumption, and decreased nausea, vomiting, and constipation. The most effective intervention is Exparel, which eliminates post-operative opioid consumption in most patients. Patients are also encouraged to shower postoperatively and wear an abdominal binder.(27).

Liposuction

Liposuction is crucial for abdominal aesthetics after abdominoplasty. New adjuncts like ultrasound, laser, and radiofrequency-assisted devices are used safely. However, power-assisted liposuction with superwet tumescent anesthesia is used exclusively. One liter of tumescent solution is injected into the flanks, upper abdomen, and suprapubic area, with a maximum dose of 35-55 mg/kg and 0.7 mg/kg, respectively. (28)**.**

Abdominoplasty

When concomitant breast surgery is performed with an abdominoplasty, our practice is to operate on the breasts first. However, in our experience, the order does not necessarily matter as the breasts are anatomically distinct from the abdominoplasty flap pull, and closure does not affect intramammary fold position. In addition, abdominoplasty is performed in the flexed position rendering it difficult to do additional surgery afterward (29)**.**

The procedure involves incising the umbilicus, freeing the stock from the abdominoplasty flap, and dissecting the superior marking. Monopolar cautery is used to create a narrow tunnel up the xiphoid, preserving perforators from the epigastric arteries medially and intercostal arteries laterally. The table is flexed to confirm the upper flap meets the proposed inferior incision, and the inferior marking is made. The pannus is excised with a 20-blade scalpel, and hemostasis is

achieved with an insulated forceps and monopolar cautery. The inferior incision is performed cautiously in massive weight loss patients due to potential distortion of anatomy.(24)

Following pannus removal, a plastic ocular conformer is sutured to the umbilical stock to facilitate easy retrieval following closure. It is worth noting that palpating the ocular conformer is indicative of the vertical position of the umbilicus, but the surgeon's original meridian dictates the horizontal position following closure (30)**.**

Before diastasis repair, we examine for signs of an umbilical hernia. If a hernia is present, it should be repaired prior to midline plication, and this is routinely discussed with the patient preoperatively and included in the consent process. It is our practice to repair small umbilical hernias with a minimal access Ventralex mesh, while larger ones with bioresorbable (Phasix) underlay mesh (31)**.**

The diastasis is then marked, and a running, double-stranded, 0-Nylon is run above and below the umbilicus with the knots buried. An additional layer of interrupted nylon sutures is placed for additional strength. An assessment of the fascial tension and the waistline then determines whether additional rows of facial plications are required lateral to the umbilicus. In thin patients that desire a narrower waistline, in addition to aggressive flank liposuction, we perform horizontal waistline sutures at the level of the umbilicus (32)**.**

Following final hemostasis, the fascia is bathed in a human fibrinogen sealant (VistaSeal^{TM}) to promote flap adhesion. The abdominoplasty flap is then tailor-tacked into place with staples. Final closure is performed using a double layer of barbed sutures. The deep layer involves a large bite of Scarpa's fascia and dermis with 2-0 PDO Quill. One suture is typically required for each half of the wound. This is followed by a second subcuticular layer of 3-0 PDO Quill, which provides closure of the skin and typically requires a single suture for each half of the abdomen. Minor skin bunching and contour irregularities after closure are common and settle in the postoperative period (33)**.**

The last step is to mark a 2.5 cm inverted V incision over the central meridian at the vertical level of the palpated conformer. A 1 cm donut of fat is trimmed on the overlying abdominoplasty flap to improve contour, the conformer is removed, and the umbilicus is inset with 3-0 deep dermal PDS suture followed by simple interrupted 4-0 nylon sutures (24)**.**

While progressive tension sutures have been used effectively to decrease seroma rates and obviate the use of drains, two 14-French Jackson Pratt drains were placed (and four in massive weight loss patients) exteriorized and sutured into the incision to decrease scar burden. While advocates of the drainless abdominoplasty report reduced pain and discomfort, the authors' experience is that most postoperative discomfort comes from fascial plication rather than drain placement, and the role of drains in decreasing postoperative swelling accelerating recovery cannot be understated (26).

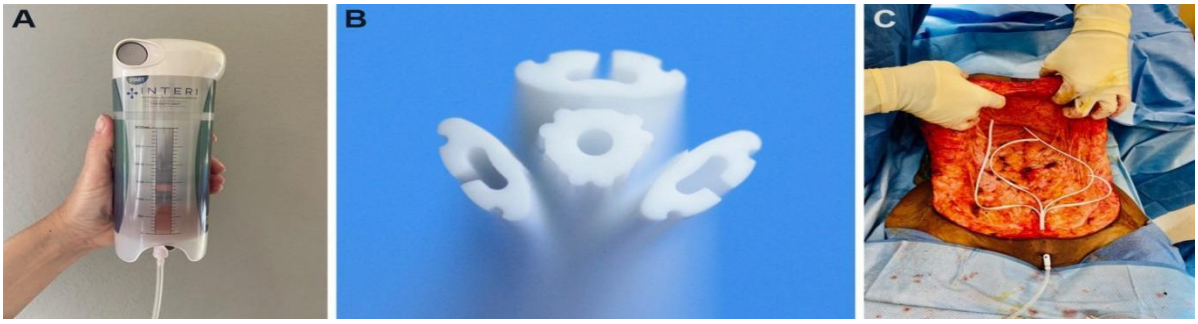


Figure (8): (A, B, C) The Interi internal suction system: ideal for obliterating abdominal dead space, decreasing seroma rates, and reducing patient-directed maintenance (24)

Clinical outcomes and complications

Necrosis

Skin necrosis can occur without cause, but it can be minimized by avoiding excessive flap mobilization, resection, undermining, thinning, manipulation, or tension. This risk is higher in diabetic patients, as the abdominal wall has 18% of its untouched preoperative state after abdominoplasty. Risk factors like diabetes, smoking, and high BMI also increase the risk of necrosis, so "operative conservatism" should be practiced in such patients. (5).

Seroma

Seroma is a common complication after abdominoplasty, often due to factors like obesity, dissection, and liposuction. The lymphatic anatomy of the abdomen is poorly understood, with evidence suggesting anatomical variability. Seroma pathogenesis is postulated as secondary to surgical division of lymphatic channels. However, the exact depth of lymphatic channels as they course the abdominal wall is contentious, with cadaveric studies suggesting a shift from superficial to deep channels during an oblique caudal descent.(34)**.**

Venous Thromboembolism

Thromboembolic disease is a significant healthcare issue based on Virchow's Triad, causing venous stasis, endothelium injury, and blood hypercoagulability. Preoperative, intraoperative, and postoperative factors can precipitate stasis. Obesity significantly influences outcome, with VTE risk less than 1% in nonobese patients undergoing aesthetic surgery. However, MWL patients have higher VTE rates, reaching 10% after belt lipectomy. Opposing efforts should promote venous flow, stabilize endothelium, and reduce blood viscosity. (35)**.**

Infection

Necrotizing fasciitis is the most serious postoperative soft tissue infection and largely responsible for the 0.01% mortality rate after body contouring surgery. A high index of suspicion should be exercised in the unwell postoperative patient with a rapidly expanding rash, deranged blood markers, and metabolic acidosis. The laboratory risk indicator for necrotizing fasciitis is a useful adjunct for distinguishing necrotizing fasciitis from minor soft tissue infections (36)**.**

Progressive Tension Sutures in Abdominoplasty

In the plastic surgery literature, many theories have been proposed concerning the etiology of seroma as a complication of abdominoplasty; these include concomitant liposuction, dead space due to extensive dissection, disruption of abdominal lymphatics, and postoperative movement by the patient. Although the etiology of seroma formation in abdominoplasty has not been determined, the low incidence of seroma when the flap is affixed securely to the deep fascia with progressive tension sutures (PTS) suggests that flap motion may play a significant role (37)

Concept and function of PTS: A PTS procedure is not an operation, but simply an adjunct to the abdominoplasty procedure that can be used with most current techniques. As the abdominal flap is advanced, it is secured in an advanced position by sutures placed between the superficial and the deep fascia. As each suture is placed in succession, tension is transferred distally and the flap is advanced (Fig. 10). Tension is placed on the superficial fascial system and not on the skin and its underlying subdermal plexus. The tension is distributed not only at the vulnerable distal flap but over the broad area of the flap (38)**.**

Surgical technique

The procedure began with infiltration of the local anesthetic into the planned incision sites, and areas of planned elevation and liposuction were infiltrated with standard tumescent solution (1000 mL normal saline, 30 mL lidocaine, and 1 mL epinephrine 1:1000). If the upper abdomen was particularly bulky, liposuction was performed in the upper abdomen and flanks prior to flap elevation. Care was taken to suction deeply to Scarpa’s fascia to avoid flap devascularization and to prevent oversuctioning and mismatch between the thinner upper abdominal skin and the thicker mons area (39)**.**

Circumumbilical and low transverse suprapubic incisions were made to the muscle fascia, with the flap elevated at the deep fascia level. Dissection was carried out using sharp and electrocautery, with the technique and extent based on the surgeon's judgment and individual aesthetic needs. A triangular dissection was used in most cases, with the widest inferiorly and narrowest at the xyphoid level. If rectus diastasis was present, it was repaired with a 0-0 braided nylon suture and a second layer of 0-0 PTS barbed suture.(5)**.**

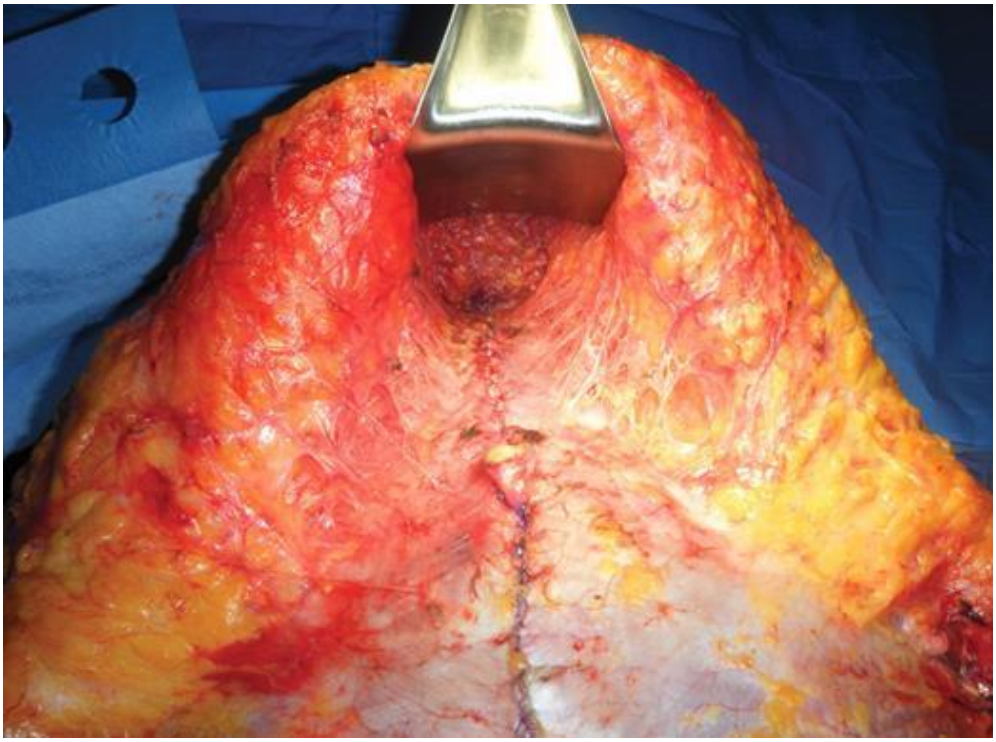


Figure (11): Typical degree of flap elevation. Rectus diastasis has been repaired, and lateral areas show preserved septi from liposuction performed in the deep plane of the flap (40).

The patient was positioned in a flexed position at 45° to 60° at the hips, with the bed in the Trendelenburg position to visualize PTS placement. A large retractor was placed to visualize the superior extent of dissection. The surgeon advanced the flap with the nondominant hand, placing a 0-0 PDS II (polydioxanone) needle into the midline of the flap. Scarpa's fascia was included in the bite. The depth of the suture was felt with the nondominant hand, and the assistant's dominant hand replaced the surgeon's hand on the skin side of the flap to stabilize and relieve tension. Repeating this process at intervals of approximately 2 cm until the umbilicus was reached, typically requiring 2 to 3 sutures in the supraumbilical midline. Once the flap was secured, the umbilicus was inset in continuity with the flap advancement, allowing the suture line and final scar to be hidden in the depths of the umbilicus and creating an attractive umbilical dimple. (41)**.**

The procedure involved inset of the umbilicus and continued flap advancement using a triangular pattern of sutures. Midline sutures were placed 2-3 cm apart, with the greatest advancement. Lateral sutures were placed sparsely and symmetrically, with less advancement needed laterally due to the flap already advanced by midline sutures. Typically, 4 or 5 sutures were placed in the infraumbilical midline, and 3 to 5 were placed peripherally on either side. A total of 10 to 18 PTS were placed, depending on the dissection degree, patient size, and surgeon's judgment.(42)**.**

After securing the flap, excess tissue was determined, marked, and resected. Three-point sutures were placed between Scarp's fascia and muscle fascia, and the skin was closed with 3-0 Vicryl

deep dermal sutures and a running subcuticular suture. Simple Prolene sutures were used to approximate the umbilical skin edges.(43)**.**

Postoperatively, some patients stayed overnight at the surgeon's discretion or patient request. Patients were encouraged to walk upright and not maintain a hip-flexed position. A compressive binder was used for comfort and abdominal support. Patients were advised to avoid strenuous exercise, abdominal exercise, and lifting over 5 pounds for the first 6 weeks postoperatively.(40).

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