Introduction

Massive weight loss and pregnancy occasionally result in permanent abdominal tissue excess, which can cause functional and psychological problems, may inhibit a normal life, and reduce the quality-of-life. In the more severe cases the tissue excess is associated with a musculoaponeurotic laxity in the abdominal wall, which has been hypothesized to cause lumbar pain and reduced respiratory function ***(Toranto, 1990; Tercan et al., 2002).***

According to the American Society for Aesthetic Plastic Surgery's 2013 Cosmetic Surgery National Data Bank, the number of abdominoplasty procedures performed has increased approximately 371% since 1997 ***(Hotta, 2014).***

Complications related to abdominoplasty include seromas, which have a reported incidence of 0.1 and 50 percent, and hematomas, which have a high reoperation rate ***(Fang et al., 2010).***

sThe anatomy and physiology of lymphatic vessels in the abdominal wall have been described to be an important factor in the status of the abdominal wall following abdominal lipectomy ***(Huger, 1979).***

Violation of the deep lymphatic vessels that run just superficial to the abdominal wall muscular fascia is thought to further compromise lymphatic drain- age of the serous fluid produced at the surfaces of the undermined tissue. One technical modification to flap elevation is the dissection of a more superficial plane, which can be found just below the Scarpa's fascia in thin patients ***(Le Louarn, 1996).***

In patients with thicker adipose tissue, this loose areolar tissue and a thin layer of deep fat should be preserved to avoid disturbing the major lymphatic vessels against the abdominal wall. Le Louran had described a similar technique, in which he used a superficial dissection plane below the umbilicus and limited dissection centrally above the umbilicus. In this report, he presented a series of 65 patients without a single occurrence of seroma ***(Le Louran, 1996).***

Costa-Ferreira and his team have been applying this principle of dual plane abdominoplasty for more than a decade and conducted 2 prospective comparative studies on the subject ***(Costa-Ferreira et al., 2016).*** The beneficial effect of using a more superficial plane of dissection on the seroma rate has been fully confirmed along with other very relevant advantages: lower drain volume, earlier drain removal, prevention of long drainers, shorter hospital stay, lower hematoma, and infection rates. The aesthetical result obtained with this technique was very good, considering both physician and patient evaluations.

Aim of the Work

- To estimate the pooled benefits and adverse effects of preserving Scarpa's fascia during abdominoplasty.
- To highlight the evidence and quality of the included studies.

Embryology and Anatomy

Embryology

The abdominal wall begins to develop from the lateral plate of intraembryonic mesoderm. As differentiation proceeds, the intraembryonic mesoderm becomes segmented into proliferating somites forming the abdominal wall. As the lateral plates grow and folds over four unique folds are formed ***(Sabiston, 2013).***

The two internal folds develop into midgut and the lateral segment of the abdominal wall. These segments coalesce in the midline at the umbilicus ***(Sabiston, 2013).***

At an early stage, the abdominal wall is composed of only a membrane of connective tissue that is soon replaced by muscular buds from the dorsal myotomes. These muscular buds are segmentally connected to their corresponding neurovascular bundles. These buds fuse to form the definitive muscles. **Figure (1)** shows the embryo at 12 weeks at time of abdominal wall formation ***(Sadler and Langman, 2013).***

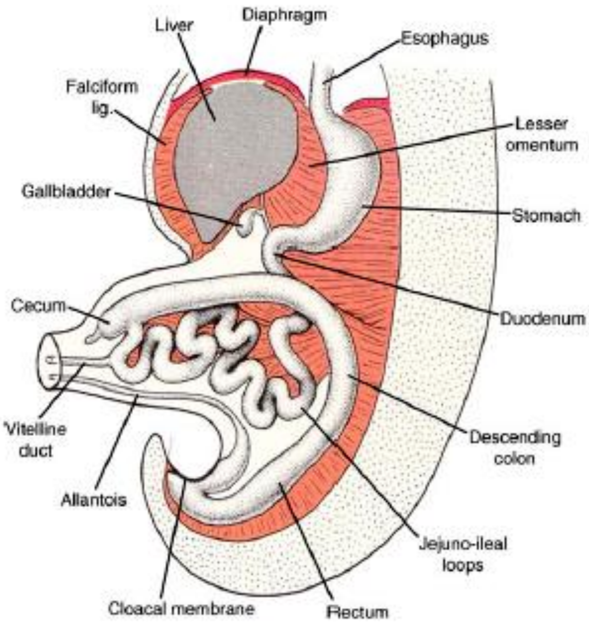

Figure (1): Embryo at 12 weeks at time of abdominal wall formation ***(Sadler and Langman, 2013)***.

Large gap was described by Moore et al in the skeletal system between the lower edge of the thorax and the upper edge of the pelvis. This gap is closed by muscles and their aponeurosis ***(Moore, 2014).*** It provides attachment points for the soft tissue and muscles of the abdominal wall.

Gross anatomy

The anatomical layers of the abdominal wall include 7 layers which are skin, subcutaneous tissue, superficial fascia, deep fascia, muscles, extraperitoneal fascia and peritoneum. This anatomy may vary with respect to different topographic regions of the abdomen. The major source of the structural integrity and strength of the abdominal wall is provided by the musculofascial layer ***(Grevious et al., 2006).***

(i) The skin

Abdominal skin was described to be thinner compared with that of the back and relatively mobile over the underlying layers except at the umbilical region, where it is fixed ***(Mahadevan, 2012).***

Natural elastic traction lines of the skin (Kraissl's Lines) of anterior abdominal wall are disposed transversely, above the level of the umbilicus these lines run almost horizontally while it runs with a slight inferomedial obliquity below the umbilical level.

Incisions made along, or parallel to these lines tend to heal without much scarring, whereas incisions that cut across these lines tend to result in a wide or heaped-up scar.

(ii) The superficial fascia

The superficial fascia was described by ***Lockwood*** as a connective tissue network that extends from the subdermal plane to the underlying muscle fascia ***(Lockwood, 1991).*** It consists primarily of one to several thin, horizontal membranous sheets separated by varying amounts of fat with interconnecting vertical or oblique fibrous septae.

There are two distinct layers of superficial fascia as stated by ***Mahadevan,*** an outer adipose layer immediately subjected to the dermis. An inner fibro-elastic layer termed ***Scarpa's fascia*** which is more prominent and better defined in the lower half of the anterior abdominal wall.

Superiorly, Scarpa's fascia crosses superficial to the costal margin and becomes continuous with the retromammary fascia. Laterally, it fades out at the mid-axillary line. Inferiorly, it crosses superficial to the inguinal ligament. Below the level of pubic symphysis, in male, Scarpa's fascia is prolonged quite distinctly into the scrotum and around the penile shaft where it becomes the Colle's fascia ***(Mahadevan, 2012).***

The superficial fascial system varies with sex, adiposity, and body region, and the topographic landmarks of the human body are largely the result of the superficial fascial anatomy ***(Lockwood, 1991).***

Variations with sex:

The anatomy of superficial fascial system is similar in both sexes except in two significant areas. The layers of trunk superficial fascia splits forming anterior and posterior lamellae at the breast and with extensions forming the heavy fibrous stroma of the breast ***(Lockwood, 1991).***

A sexual difference is also noted in the region of iliac crest, where, in males, the superficial fascial system is tightly adherent to the periosteum of the crest, but in women, it is relatively adherent to muscle fascia in the gluteal depression ***(Lockwood, 1991).***

Variations with adiposity:

The superficial fascial system anatomy varies significantly as the level of adiposity changes. ***Lockwood*** mentioned the presence of a significant amount of fat separating the layers of the fascia. Obesity further separates the superficial fascial layers until they become indistinct and hardly recognizable ***(Lockwood, 1991).***

Variations in different body regions:

The inconsistent anatomy from one body region to another was stated by ***Lockwood*** as a feature of the **superficial fascial system (SFS**). It consists of a well-defined, single membranous sheet, but in other areas as the posterior trunk, it is formed of several layers separating the superficial fat from the deep fat or muscle ***(Scarpa's, 1825).***

Zones of adherence:

Varying zones of adherence of the superficial fascia cover the trunk and extremities along with the fat, produce creases, folds, plateaus and bulges of the normal body contour.

Lockwood outlined that areas where the superficial fascia is adherent to the underlying muscle fascia are the creases of the skin and plateaus, bulges are formed at areas where the fascia is less adherent to the underlying structure.

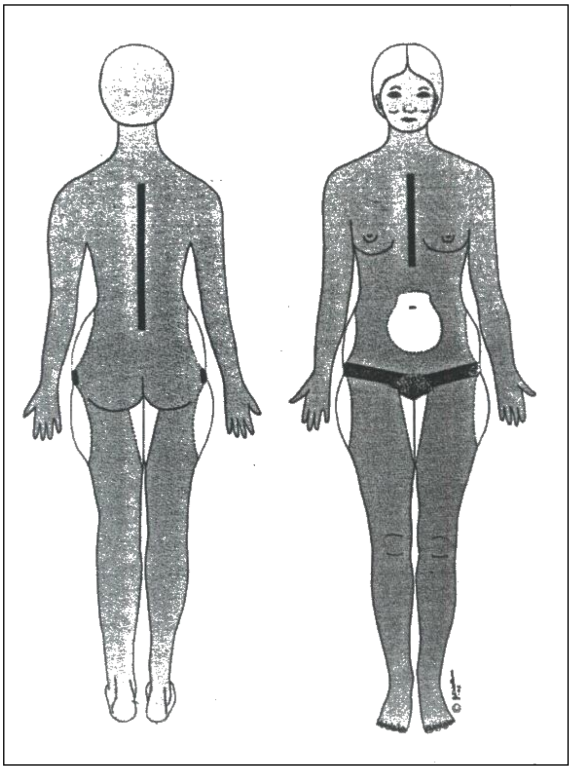

Figure (2): Diagram of superficial fascial system zones of adherence (black bands, most adherent; gray zones, adherent; white zones, least adherent) ***(Lockwood, 1991).***

The most adherent areas are at the skin creases of the inframammary, groin and gluteal creases. The least adherent areas are the areas of localized fat deposits. Table

(1) describes the superficial fascial system zones of adherence ***(Lockwood, 1991).***

Table (1): Superficial fascial system zones of adherence.

- Most adherent:
  - Skin creases: inframammary, groin, gluteal, joint
  - Plateaus:
    - Vertical:
      Posterior midline
      Anterior midline (chest)
    - Horizontal: Inguinal to lateral gluteal depression
- Adherent: All areas of trunk and extremities without significant deep fat.
- Least adherent: Areas of localized fat deposits

The primary function of the superficial fascial system is to encase, support, and shape the fat of the trunk and extremities and hold the skin to the underlying tissues. The skin and fat together with the superficial fascial system provides a protective cushion over the musculo-skeletal framework and supports the position and weight of fat deposits. They also help in preventing shifting of excessively obese or aged soft tissues onto another anatomic region ***(Mahadevan, 2012).***

(iii) The muscles and ligaments

There are five paired muscles of the abdominal wall: three flat muscles and two vertical muscles. The three flat muscles are the external oblique, internal oblique, and the transversus abdominus **(Figure 3).** The three-layered structure, combined with extensive aponeuroses, works in a synkinetic fashion not only to protect the abdominal viscera, but also to increase abdominal pressure facilitating defecation, micturition, and parturition. The two vertical muscles are the rectus abdominis and pyramidalis. Fusion of the fascial layers of these muscles forms three distinct fascial lines: the linea alba and two semilunar lines. The linea alba is formed by the fusion of both rectus sheaths at the midline, while the semilunar lines are formed by the union of the internal oblique, transverse abdominis, and external oblique as they join the rectus sheath ***(Grevious et al., 2006).***

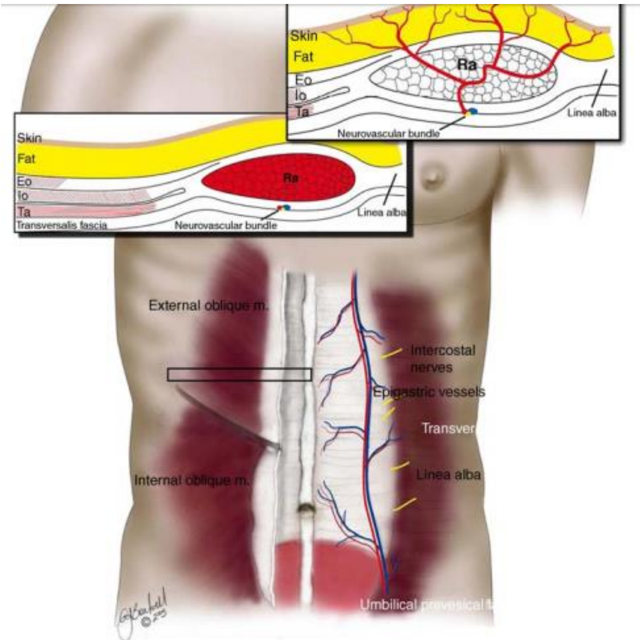

Figure (3): The muscles and ligaments of abdominal wall ***(Grevious et al., 2006).***

(iv) The vascular supply of abdominal wall

a. Arterial blood supply

The superficial epigastric, superficial circumflex iliac, superficial external pudendal, deep circumflex iliac, superior and inferior epigastric arteries, subcostal and lumbar arteries are the main branches of the blood supply to the anterior abdominal wall ***(Schaverien et al., 2008).***

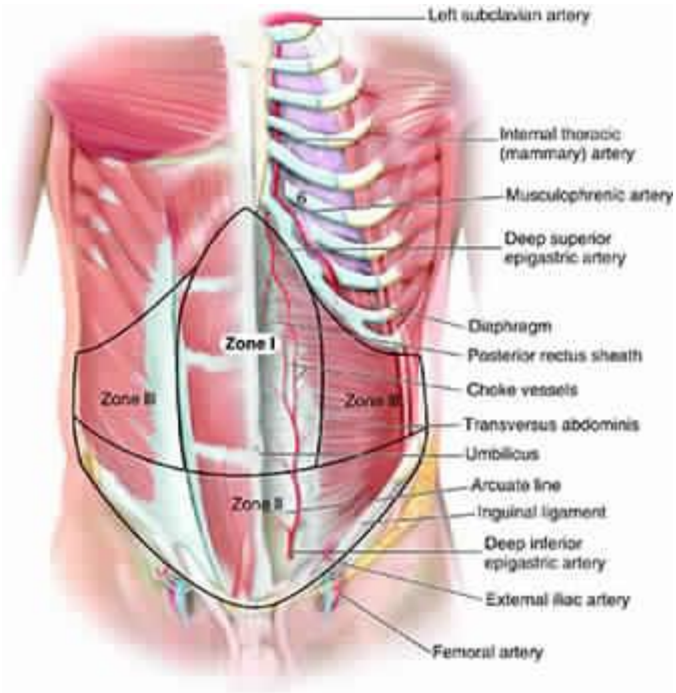

Figure (4): The vascular supply of abdominal wall ***(Netter, 2017)***

The superficial inferior epigastric artery originates from the common femoral vessel. It pierces through the Scarpa's fascia just below the inguinal ligament 8-10 cm lateral to the midline ***(Gray, 1918).***

The deep inferior epigastric artery (DIEA) is a branch of the external iliac artery, which ascends obliquely along the medial margin of the deep inguinal ring piercing the transversalis fascia at a point close to arcuate line. It has two sub-divisions of perforators that course medially and laterally. The lateral branch is usually the dominant branch and contains most of the perforator vessels ***(Mahadevan, 2012).***

The anastomosis between the superior and deep inferior epigastric arteries provides important collateral circulation to the lower part of the abdominal area ***(Méndez et al., 2014).***

The musculo-cutaneous perforators are the main blood supply to the anterior abdominal wall. These vessels were further categorized into large (direct) or small (indirect) perforators ***(Rozen et al., 2009).***

Huger classified the vascular blood supply to the abdominal wall into three zones. **Figure (4)** shows the zones of blood supply to the abdominal wall ***(Huger, 1979).***

Zone I

It was defined by ***Huger*** as the mid-abdomen and is supplied primarily by the deep epigastric arcade. As the internal thoracic artery passes behind the costal cartilages to enter the abdominal wall, it gives rise to the superior epigastric artery. This vessel then enters the abdomen and travels underneath the surface of the posterior rectus sheath. The superior epigastric artery joins the deep inferior epigastric artery through a series of choke vessels within the rectus above the umbilicus ***(Huger, 1979).***

Zone II

It occupies the lower abdomen and is supplied by branches of epigastric arcade and the external iliac artery. Blood supply superficial to the Scarpa's fascia is provided by superficial inferior epigastric and superficial pudendal arteries ***(Huger, 1979).***

Both of these arteries originate from the femoral artery ***(Grevious et al., 2006).***

Ian Taylor mentioned that the deep iliac circumflex artery originates from the external iliac artery and runs parallel to the inguinal ligament and deep to all abdominal muscles to provide blood supply to the area of anterior superior iliac spine, bilaterally. The main deep iliac circumflex artery pierces all the three muscles of the lateral abdominal wall and provides a sizable musculocutaneous perforator ***(Taylor, 2003).***

Zone III

It conveys the flanks and lateral abdomen. Blood supply to this area comes from the intercostal, subcostal and lumbar arteries. The intercostal vessels leave the rib cage and enter the abdominal wall between the tranversus abdominis and internal oblique muscles, where they anastomose with the lateral branches of deep superior epigastric artery (DSEA) and deep inferior epigastric artery (DIEA). The musculocutaneous branches pass through fixed attachments of the muscles. They emerge as vertical strip of vessels, where the external oblique interdigitates with the serratus anterior and where it interlocks with latissmus dorsi in the lower abdominal wall ***(Grevious et al., 2006).***

b. Venous drainage

The anterior abdominal wall is drained via the superficial epigastric, thoracoepigastric, paraumbilical and the superficial circumflex iliac veins ***(Gray, 1918).***

(i) Superficial epigastric vein

The superficial epigastric vein drains the inferior part of the anterior abdominal wall and is connected to the paraumbilical and thoracoepigastric veins. This vessel drains via the great saphenous vein into the femoral,