INTRODUCTION

Reconstruction of abdominal wall defects is complex and the clinical considerations involved in determining the surgical approaches are challenging to general and plastic surgeons. The anatomical factors, site of the defect, size of the defect and wound bed quality, infection, nutritional status of the patient, diabetes and smoking, also play a key role in how reconstruction plans develop **(*Rohrich et al., 2000*).**

Anterior abdominal wall serves several functions; it protects the abdominal viscera. The muscles of the anterior abdominal wall also assist in respiration, pulling down on the ribs during forced expiration and coughing. These muscles help with defecation, micturation, child birth, fixation of the spine and assist in the rotation of the body ***(Roshini et al., 2006)***.

There are different causes of abdominal wall defects either congenital or acquired. The congenital causes can be divided into either herniation of abdominal contents at the umbilicus as Omphalocele (Exomphalos) with an incidence of 1: 6,000 or full thickness abdominal defects situated always to the right of umbilicus like Gastrschisis with an incidence of 1: 20,000 : 30,000.

Deficiency of the abdominal musculature which may be associated with urinary tract dilatation and cryptorichidism as in Brune-Belly syndrome having an incidence of 1: 50,000 ***(Loadsman, 2004).***

The acquired defects of the abdominal wall are caused primarily by trauma, infection, ablative resection of primary or recurrent tumors, complications of surgical procedures such as incisional hernia, radiation damage, burns and abdominoplasty. These defects can be superficial, involving only some layers of the soft tissue of the anterior abdominal wall, or full thickness, extending into the abdominal cavity ***(Cohen, 2006*).**

The main goals of reconstruction of abdominal wall defects is the restoration of the structural and functional continuity of the musculofascial system with the preservation of the integrity of the abdominal wall and minimizing the complications such as infection, dehiscence and abdominal compartment syndrome as well as the achievement of stable local wound coverage ***(James, 2006)***.

The preoperative evaluation should include complete history, physical and general medical evaluation, basic laboratory work and other diagnostic and radiological studies. The evaluation of the extent of the defect and the associated pathology as presence of local inflammation or bowel adhesion is so important in determining the timing and the option used in reconstruction that is balanced with patient’s general health, tissue requirements and wound bed.

The ideal reconstruction should encompass four requirements; prevent visceral eventration, incorporate the abdominal wall, provide a tension-less repair, and dynamic muscle support ***(Dibello et al., 1996).***

Reconstructive options for the abdominal wall repair are vast starting from skin and fascial grafting for covering extensive wounds after being healthy and granulating well. The staged tissue expansion through placement of the tissue expansion devices in between the different layers of the abdominal wall have role in the staged abdominal wall reconstruction ***(Wihelmi, 1998).***

The Vacuum-assisted closure is considered a safe and effective alternative in treating the complicated cases ***(Kilbride et al., 2006).***

The component separation technique which was considered as a preferred technique for the repair of large defects not amenable to primary repair ***(Broud et al., 2007).***

The use of prosthetics (e.g. Prolene, Mersalin) and bioprosthetics (e.g. AlloDerm) have aided greatly in the management of complex abdominal defects Flaps either local, pedicled, or free transferred play an important role in the reconstruction of abdominal wall defects, being necessary for the contaminated wound fields and coverage of applied mesh.

All these reconstructive techniques, and procedures will be described helping for better outcome, decreasing the hazards of infection, hospital stay (***Grevious, 2006)***.

AIM OF THE WORK

The aim of this study is to provide an overview on the current approaches available for the reconstruction of the anterior abdominal wall defects, delineating the basic guidelines followed when faced with complex defects to achieve utmost results.

STRUCTRAL & FUNCTIONAL ANATOMY OF THE ANTERIOR ABDOMINAL WALL

Knowledge of the anatomy of the anterior abdominal wall has enabled the reconstructive surgeons to achieve one of the goals in managing abdominal wall defects which is restoration of the structural and functional continuity of the musculo-fascial system ***(Grevious, 2006)*****.**

Anterior abdominal wall anatomy

The anatomical layers of the abdominal wall include the following seven layers: skin, subcutaneous tissue, superficial fascia, deep fascia, muscular, extraperitoneal fascia, and peritoneum. This anatomy may vary with respect to the different topographic regions of the abdomen. The major source of structural integrity and strength of the abdominal wall is provided by the musculofascial layer. The main paired abdominal muscles include the external oblique muscles, internal oblique muscles, transversus abdominis muscles, and the rectus abdominis and their respected aponeuroses, which are interdigitate with each other, and provide core strength and protection to the abdominal wall viscera. The integrity of the abdominal wall is essential, not only in protecting the visceral structures, but also stabilizing the trunk, and in aiding trunk movement and posture.

Skeletal system

Early 19th century anatomist August Rauber described the large gap in the skeletal system between the lower edges of the thorax and the upper edge of the pelvis as the lacuna sceleti sterno-pubica. This gap is closed by the muscles and their aponeuroses. The skeletal system, which is relatively fixed, provides attachment points for the soft tissue and muscles of the abdominal wall. The skeletal anatomy of the abdomen consists of the xiphoid process, the costal cartilages of ribs 7 to 10, the floating ribs 11 and 12, L1-L5 vertebrae, iliac crests, anterior superior iliac spine, inguinal ligament, pubic tubercle/pubic crest, and the pubic symphysis ***(Moore, 1999).***

The abdominal wall musculoaponeurotic structure is attached to the ribs superiorly, the bones of the bony pelvis inferiorly, and the vertebral column posteriorly.

The skin

Skin was described as being thin compared with that of the back and relatively mobile over the underlying layers except at the umbilical region, where it is fixed ***(Mahadevan, 2003).***

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 inferiomedial obliquity below the umbilical level.

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

Subcutaneous tissue

Superficial fascia

The superficial fascia of the abdominal wall is divided into a superficial and deep layer. The superficial fascia may be as thin as 0.5 inch or less, or a thickness of greater than 6 inch. Above the umbilicus, the superficial fascia consists of one layer. Below the umbilicus, the fascia divides into two layers: Camper's fascia, a superficial fatty layer, and Scarpa's fascia, a deep membranous layer ***(Markman, 1989).***

The abdominal subcutaneous fat thickness, which is separated by Scarpa's fascia, is highly variable. 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 fasica is prolonged quite distinctly into the scrotum and around the penile shaft where it becomes the Colle's fascia.

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. superficial fascia of trunk splits forming anterior and posterior lamellae at the breast and with extensions forming the heavy fibrous stroma of the breast (***Cooper, 1840).***

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.

- ***Variations with adiposity:***

The superficial fascial system anatomy varies significantly as the level of adiposity changes. Obesity further separates the superficial fascial layers until they become indistinct and hardly recognizable ***(Lockwood, 1991).***

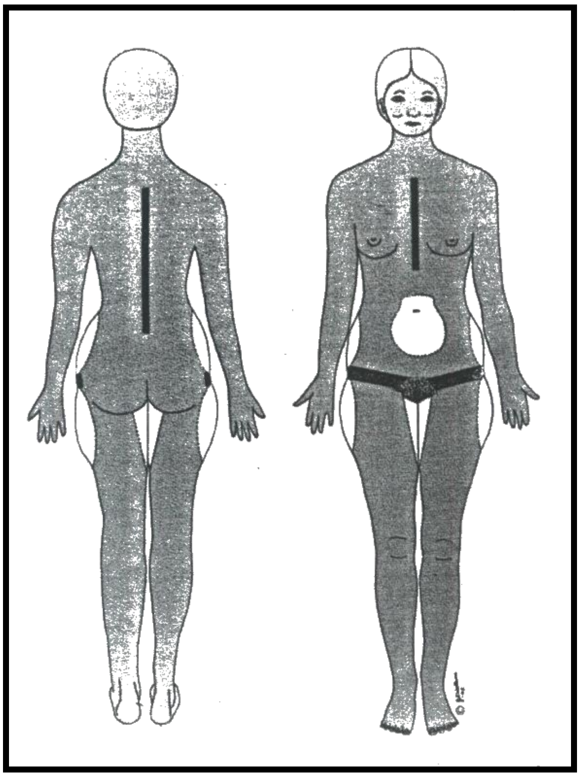

Figure (1): Diagram of superficial fascial system zones of adherence (black bands, most adherent; gray zones, adherent; white zones, least adherent) ***(Lockwood, 1991).***

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.

- ***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. The areas where the superficial fascia is adherent to the underlying muscle fascia are the creases of the skin and plateaus and bulges are formed at areas where the fascia is less adherent to the underlying structure. fig(1),tab(1). ***(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

(Lockwood, 1991)

The primary function of the superficial fascial system as stated by Lockwood, 1991 is to encase, support, and shape the fat of the trunk and extremities and hold the skin to the underlying tissues.

The skin together with the superficial fascial system provides a protective cushion over the musculoskeletal 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.

Deep fascia

The deep fascia is a thin, tough layer that surrounds and is adherent to the underlying abdominal muscles.

Each abdominal muscle has an aponeurotic component that contributes to the deep fascia. The individual abdominal muscles are described in the following section

Extraperitoneal and peritoneal fascia

Extraperitoneal and peritoneal fascias also are known as extraperitoneal fascias and serve to bond the peritoneum to the deep fascia of the abdominal wall. They may receive different names depending on location (ie, transversalis fascia when deep to that muscle, psoas fascia when next to that muscle, iliac fascia, and others). The peritoneum is a thin, one cell thick membrane that lines the abdominal cavity. It is useful in reconstructive efforts, because it provides a layer between the bowel and mesh ***(Niazi, 2001)***.

Musculofascial layer

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. 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. Fig(2).

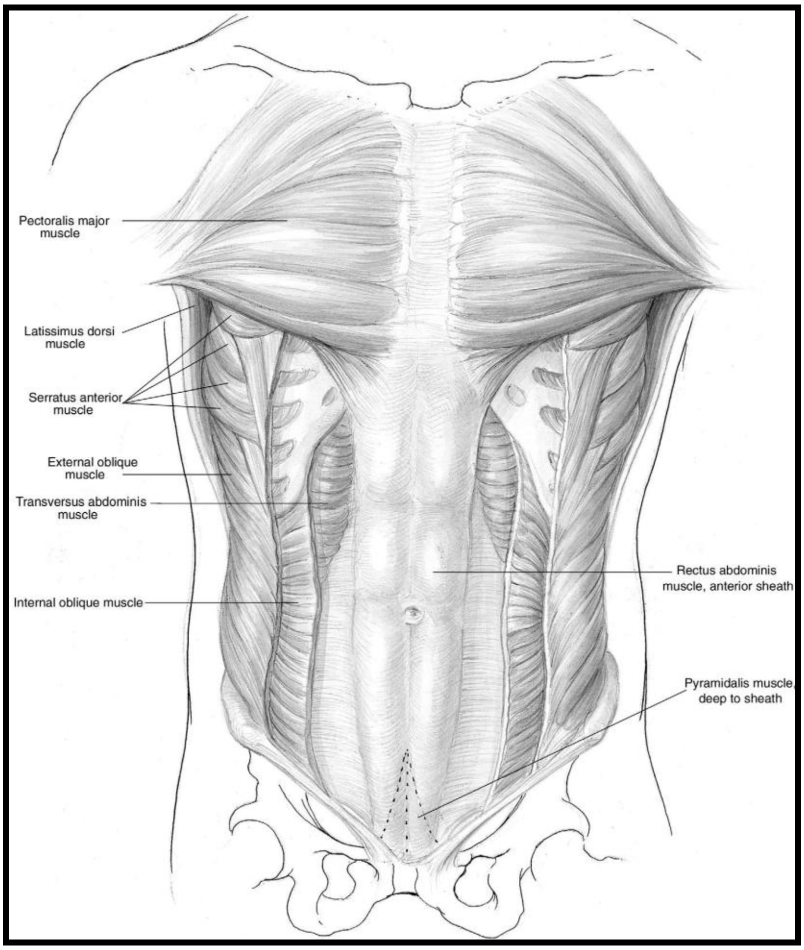

Figure (2): Musculature—anterior abdominal wall.

External oblique

The external oblique muscle is the largest and thickest of the flat abdominal wall muscles. It originates from the lower eight ribs, interlocks with slips of latissimus dorsi and serratus anterior, and courses inferior-medially, attaching by means of its aponeurosis centrally at the linea alba. Inferiorly, the external oblique aponeurosis folds back upon itself and forms the inguinal ligament between the anterior superior iliac spine and the pubic tubercle.

Medial to the pubic tubercle, the external oblique aponeurosis is attached to the pubic crest. Traveling superior to the medial part of the inguinal ligament, there is an opening in the aponeurosis that forms the superficial inguinal ring. The innervation to the external oblique is derived from the lower six thoracic anterior primary rami and the first and second lumbar anterior primary rami. Fig(3). ***(Moore, 1999)***.

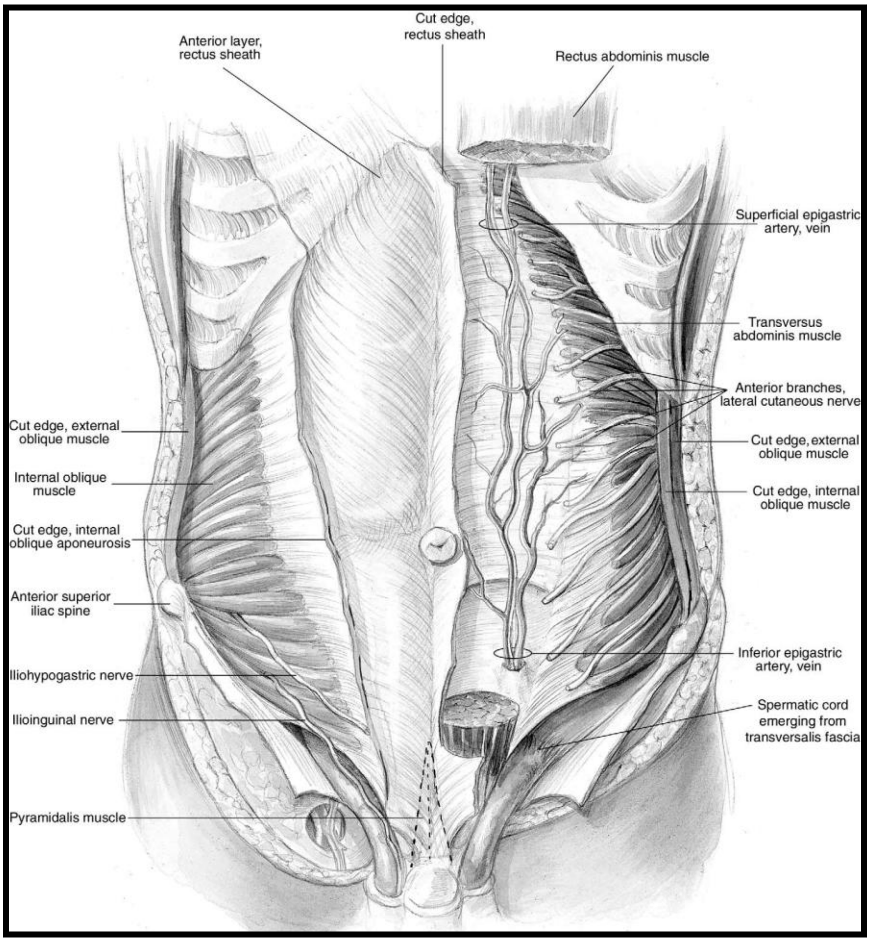

Figure (3): Musculature-anterior abdominal wall.

Internal oblique

The internal oblique muscle originates from the anterior portion of iliac crest, lateral half to two thirds of inguinal ligament, and posterior aponeurosis of the transversus abdominis muscle. The internal oblique fibers run superiorly–anteriorly at right angles to the external oblique and insert on the cartilages of the lower four ribs. The anterior fibers become aponeurotic around the ninth costal cartilage. At the lateral border of the rectus abdominis muscle and above the arcuate line, the aponeurosis splits anteriorly and posteriorly to enclose the rectus muscle to help form the rectus sheath. Beneath the arcuate line, however, the internal oblique aponeurosis does not split and its fibers run only anterior to the rectus muscle. The inferior aponeurotic fibers arch over the spermatic cord, pass through inguinal canal, and then descend posterior to the superficial ring to attach to the pubic crest. The most inferior medial tendinous fibers fuse with the aponeurotic fibers of the transverse abdominis muscle to form the conjoint tendon, which also inserts on the pubic crest. Fig(4). ***(Moore, 1999).***

Transversus abdominis

The transversus abdominis muscle is the innermost of the three flat abdominal muscles. The fibers of the transversus abdominis course predominately in a horizontal orientation. It has two fleshy and one aponeurotic origin. The first fleshy origin is from the anterior three-fourths of the iliac crest and lateral third of the inguinal ligament, while the second origin is from the inner surface of the lower six costal cartilages, where they interdigitate with fibers of the diaphragm. Between the two fleshy origins is the aponeurotic origin from the transverse processes of lumbar vertebrae. These fibers course medially to the lateral border of the rectus muscle. From about 6.6 cm inferior to the xiphoid process