INTRODUCTION

Burn injuries to the female breasts are very common, either isolated or non-isolated injuries, mostly due to scald burns ***(Burvin et al., 1996)***.

In toddlers, scald burns are more common than flame burns, but in older age groups, flame burns which cause full-thickness burns are more likely to happen ***(Foley et al., 2007)***.

In prepubescent females, since most burns are scald burns, it is believed that subcutaneous tissue is quite viable. This is significant as in children the mammary gland lies 4-8 mm in subcutaneous tissue ***(Kunert et al., 1988)***.

Patients with injuries to the underlying breast tissues may not develop breasts with subsequent psychological troubles ***(Hsiao et al., 2009)***.

Thermal injuries cause many deformities due to contractures and scars formed underneath which the breast parenchyma continues to develop resulting in flattened and disfigured breast, loss of NAC either partially or completely and loss of breast mound with loss of the inframammary fold ***(Grishkivech et al., 2009)***.

Most cases require follow up to plan surgical correction taking in consideration measures to assist maturity of the scar during this period ***(McCauly et al., 2005)***.

Severe breast contactures are one of the most troubling problems facing surgeons ***(Grishkivich et al., 2009)***.

Asymmetry of burned breasts is another troubling issue that requires addressing skin contractures, nipple dystopia, volumetric and geometric equality ***(Payne et al., 2003)***.

Choosing the best option for breast reconstruction is dependent upon the age at which the injury occured, the type of injury and the extent of the surgical management during the acute phase of treatment ***(Kalendar et al., 2000)***.

No single procedure is suitable for all cases and the options must be individualized according to the patient putting in mind the burn pattern and the patient expectations ***(Loss et al., 2002)***.

Repititive surgeries may be needed to obtain a satisfactory result for the patient ***(Hsiao et al., 2009)***. Yet, it remains important for good reconstruction to select the patient and to have good preoperative planning ***(Hsiao et al., 2009)***.

The aim of surgery must be dedicated to restore acceptable shape, contour and symmetry as possible for the patient self-esteem and good appearance to overcome the psychological effects of the injury ***(McLennan et al., 2000)***.

AIM OF THE WORK

To review different and updated modalities of breast reconstruction after burn injuries to the female breast.

ANATOMY OF THE BREAST

The mammary gland is situated on the anterior thorax and is by definition bilateral and symmetrical. Its form, volume and contents vary with age, making precise characterization possible. Glorified by the artists throughout the ages, the breast occupies an important place in the image of women in our culture, and in its beauty rests a fundamental element of feminity ***(Fitoussi et al., 2009)***.

The base of the breast has the following extensions:

From 2nd rib (above) to the 6th or 7th rib (below) . From the sternal border (medial) to the midaxillary line (lateral) ***(Skandalakis et al., 2009)***.

The nipple-areola complex is located between fourth and fifth ribs. Natural lines of skin tension, known as Langer lines, extend outwards circumferentially from the nipple areola complex ***(Ismail et al., 2006)***.

On average, the breast is 10 to 12cm in diameter and 5 to 7 cm thick at its center. The contour of the breast is typically cone like with breast tissue projecting into the axilla as the axillary tail of Spence. The volume of the breast can range from 21 to 2000 ml, with an average of 400 ml. The volume fluctuates with menstrual cycle. The breast is more conical in nulliparous women and more pendulous in women who have had children. The contour and volume of the breast, however, vary greatly among individuals, and may vary from left to right. More than half of women have volume differences of greater than 10% and more than one fourth of women have volume differences greater than 20%. These differences are typically not appreciated by most women ***(Sabel et al., 2009)***.

- **<u>Emberiogenesis:</u>**

The breast undergoes multiple changes throughout life, from intrauterine life to senescence.The development of the breast has several implications that impact the breast surgeon ***(Sabel et al., 2009)***.

The epithelial\mesenchymal interactions that will give rise to the glandular tissue of the breast, in both sexes, can first be seen at about the fifth or sixth week, when two ventral bands of thickened ectoderm, the mammary ridges or milk lines, extend from the axilla to the inguinal region. Usually, invagination of the thoracic mammary bud occurs by day 49, and the remaining mammary line involutes. The thoracic ectodermal ingrowths branch into 15-20 solid buds of ectoderm which will become lactiferous ducts and their assiciated lobes of alveoli in the fully formed gland. They are surrounded by somatopleuric mesenchyme which forms the connective tissue, fat and vasculature which is invaded by the mammary nerves. Continued cell proliferation, elongation and further branching produces the alveoli and defines the duct system. Nipple formation begins at day 56, primitive ducts (mammary sprouts) develop at 84 days and canalization occurs about 150^{th} day. During the last 2 months of gestation the ducts become canalized; the epidermis at the point of original development of the gland forms a small mammary pit, into which the lactiferous tubules open. Perinatally the nipple is formed by mesenchymal proliferation. At birth, the combination of fetal prolactin and maternal oestrogen may give rise to transient hyperplasia and secretion of 'whitch's milk'. In males, the breasts usually remain rudimentary, whereas in females at puberty, in late pregnancy and during the period of lactation, they undergo further hormone-depdndent developmental changes. The female breast is a unique organ in that it remains in a rudimentary (i.e. fetal) form until puberty, at which time its development continues under the influence of sex hormones ***(Suzan et al., 2008)***.

The breast bud located at the fourth intercostal spaces eventually develops on each side into mature breast ***(Hammond et al., 2009)***. The adult form is reached in late adolescence ***(Suzan et al., 2008)***.

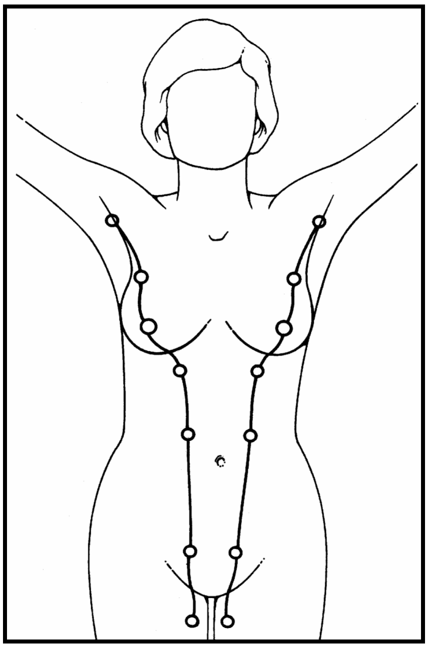

Figure (1): The milk line. Mammary glands usually develop in humans from the pectoral portion of the line. Supernumerary mammary structures may develop from other positions along the line ***(Skandalakis et al., 2009)***

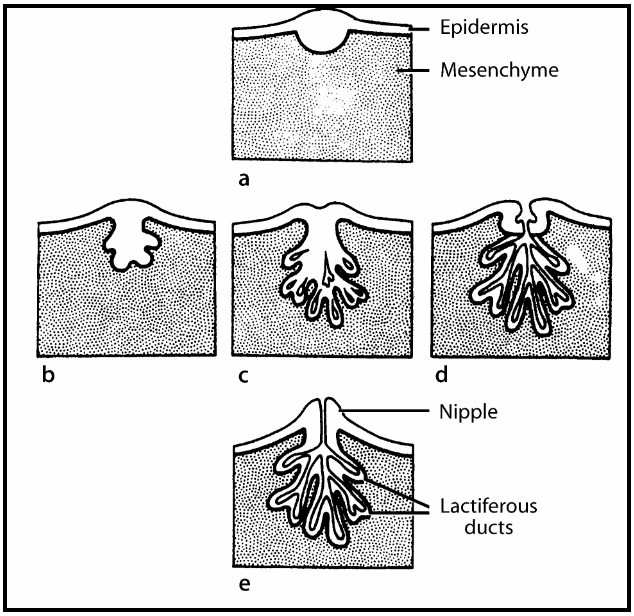

Figure (2): Developmental changes of the breast:a-d Stages in the formation of the duct system and potential glandular tissue from the epidermis.Connective tissue septa are derived from mesenchyme of the dermis.e-eversion of the nipple near birth ***(Skandalakis et al., 2009)***.

- **Age related changes:**

1- Prepuberty:

The mammary gland in children is believed to be located 4-8mm in the subcutis.It is believed to be attached to the underlying nipple by the epithelium of the pars infundibularis of the milk duct ***(Kunert et al., 1988)***.

The breast contains lactiferous ducts but no alveoli. Untill puberty, little branching of the ducts occurs, and any slight mammary enlargement reflects the growth of fibrous stroma and fat ***(Suzan et al., 2008).***

Table (1): Timeline of breast development ***(Skandalakis et al., 2009).***

4th-6th fetal week	Development of milk lines or mammary (ectodermal) ridges
10th fetal week	Atrophy of the proximal and distal part of the milk lines; the middle (pectoral) part is responsible for the genesis of the breast
5th fetal month	Development of the areola and 15-20 solid cords
Later	Lactiferous ducts; mammary glands develop from the milk lines
After birth	Nipple is visible
Puberty	Ducts develop acini at their ends

2- Puberty:

As puberty begins, the circulating estrogen causes the ductal epithelium and surrounding stroma to grow. These ducts begin to extend into the superficial pectoral fascia and arborize within the supporting stroma to form collecting ducts and terminal duct lobular units. These ultimately form buds that precede further breast lobules. Surrounding the ducts, vascularity increases and connective tissues increase in volume and elasticity, replacing adipose tissue and providing support for the developing ducts ***(Ismail et al., 2006)***.

Estrogens also promote adipocyte differentiation from mesenchymal cells in the interlobular stroma: breast enlargement at puberty is largely a consequence of lipid accumulation by these adipocytes. From puberty onwards, externally recognizable breast development (thelarche) can be divided into five separate phases ***(Suzan et al., 2008)***.

Table (2): Tanner stages (based on the external appearance of the breast) ***(Sabel et al., 2009)***.

stage	Approximate age	Description
Stage 1	Puberty	Preadolescent,with slight elevation of the papilla.
Stage 2	11.1+\- 1.1 yr	Elevation of the breast and papilla as a small mound. Increase in size of the areola
Stage 3	12.2 +\- 1.1 yr	Further enlargement of the breast.
Stage 4	13.1 +\- 1.2 yr	The areola and papilla form a secondary mound above the breast.
Stage 5	15.3 +\- 1.7 yr	Areola recedes into the general contour of the breast

- **<u>Structure of the breast:</u>**

A) <u>SOFT TISSUE:</u>

The breasts are composed of lobes which contain a network of glandular tissue consisting of branching ducts and terminal secretory lobules in a connective tissue stroma. The connective tissue stroma that surrounds the lobules is dense and fibrocollagenous, whereas intralobular connective tissue has a loose texture that allows the rapid expansion of secretory tissue during pregnancy. Fibrous strands or sheets consisting of condensations of connective tissue extend between the layer of deep fascia that covers the muscles of the anterior chest wall and the dermis. These suspensory ligaments (of Astley Cooper) are often well developed in the upper part of the breast and support the breast tissue, helping to maintain its non-ptotic form ***(Suzan et al., 2008)***.

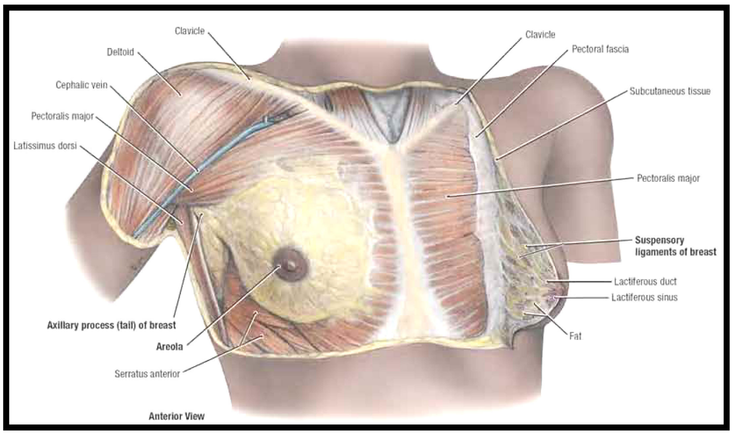

Figure (3): Superficial dissection of the female pectoral region ***(Agur et al., 2009)***.

B) Skin:

As in youth, the skin of the breast often has a compact consistency, exhibits excellent rebound when stress is applied to it and, generally, provides firm support to the underlying parenchyma and fat, which contributes greatly to uplifted appearance of the youthful breast. Then, as a result of many influences including genetic factors, advancing age, weight gain and pregnancy, the dynamics of the skin of the breast change. With increasing size, stretch marks can develop and the breast becomes variably ptotic with loss of shape. Either due to an inferior location initially or due to fluctuations in the filling out of the skin envelope, the location of NAC can appear low in relation to the breast mound. Perhaps more importantly, after surgical alteration of the breast, the tendency for the breast skin to stretch seems to increase in many patients ***(Hammond et al., 2009)***.

C) Superficial Fascia:

The superficial fascia enveloping the breast is continuous with the superficial abdominal fascia (of Camper) below, and the superficial cervical fascia above. Anteriorly, it merges with the dermis of the skin ***(Skandalakis et al., 2009)***.

The fascia completely envelopes the lobes of this organ; each breast is formed of 15-20 lobes of glandular tissue. The lobes and lobules are separated by connective tissue septa ***(Sabel et al., 2009)***.

The gland of the breast lies within the superficial fascia between (anterior & posterior) lamella, connecting these two fascial layers are fibrous bands (Cooper suspensory ligaments). Cooper's ligaments help giving the breast its shape and anchor the gland to the skin ***(Hammond et al., 2009)***.

The breast maintains mobility on the chest wall because of the retromammary bursa; which is a cleft between the posterior layer of the superficial pectoral fascia and pectoralis major muscle fascia ***(Sabel et al., 2009)***.

D) <u>Deep Fascia:</u>

The deep pectoral fascia envelops the pectoralis major muscle and is continuous with the deep abdominal fascia below. It attaches to the sternum medially and to the clavicle and axillary fascia above and laterally. Along the lateral border of the pectoralis major muscle, the anterior lamina of the deep pectoral fascia unites with the fascia of the pectoralis minor muscle and, more inferiorly, with the fascia of the serratus anterior. A posterior extension of this fascia is continuous with the fascia of the latissimus dorsi and forms the so-called suspensory ligament of the axilla ***(Skandalakis et al., 2009)***.

Deep to the pectoralis major muscle, the clavipectoral fascia envelops the pectoralis minor muscle and part of the subclavius muscle and attaches to the inferior aspect of the clavicle, dividing into two laminae, anterior and posterior to the subclavius. Between the clavicle and the upper edge of the pectoralis minor muscle, this part of the clavipectoral fascia is pierced by the cephalic vein, the thoracoacromial artery and vein, lymphatic vessels and a branch of the lateral pectoral nerve which innervates the clavicular head of the pectoralis major muscle. The axillary fascia lying across the base of the axillary pyramidal space is an extension of the pectoralis major fascia and continues as the fascia of the latissimus dorsi. It forms the dome of the axilla ***(Skandalakis et al., 2009)***.

A small amount of breast tissue travels toward the axilla in the majority of women. The surgeon in the operating room should remember there is a part of breast tissue which is the only part beneath the deep fascia. It is well known as the tail of Spence, and it enters the axilla through an opening of the deep fascia of the medial axillary wall. This opening is the well-known hiatus of Langer ***(Skandalakis et al., 2009)***.

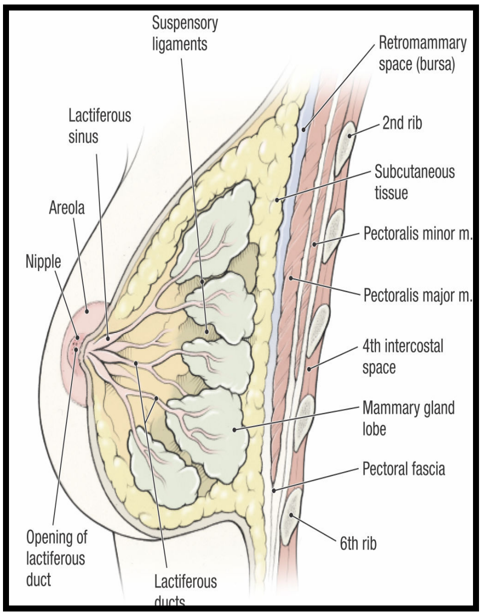

Figure (4): Sagittal section of the breast showing retro mammary space ***(Agur et al., 2009)***.

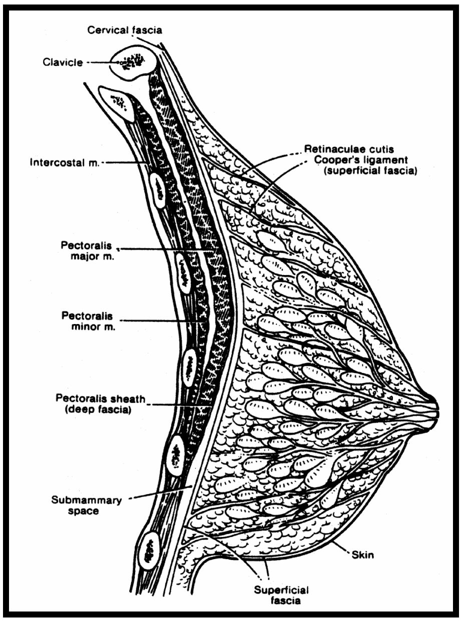

Figure (5): Sagittal section of the breast showing superficial and deep fascia ***(Skandalakis et al., 2009)***.

E) Inframammary fold anatomy:

The inframammary fold is the defining shelf for the inferior pole of the female breast. Emberyologically, it is known as the specific formation of the connective tissue in the region of the inframammary fold. Once puberty begins with proliferation of glandular and adipose tissue, the breast becomes a pendent structure with its inferior border defined by the inframammary fold ***(Riggio et al., 2000)***.

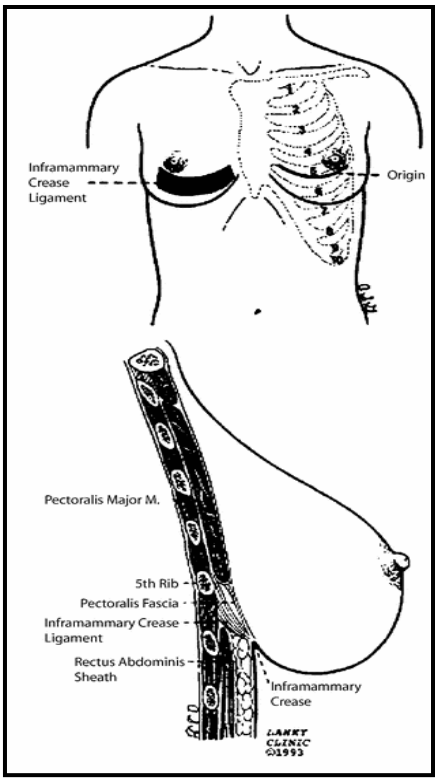

Figure (6): The horizontal position of the inframammary ligament originating from the 5th rib periosteum medially and extending to the 5th-6th intercostal space laterally (above). The inframammary ligament originates from the 5th rib and inserts into the deep dermis of the skin (below) ***(Bayati et al., 1995)***.

The most careful study of the inframammary fold was found, in the majority of cases, to correspond to the anterior arch of the 6th rib. Their histologic examination showed fibers passing from the pre-pectoral (deep) fascia, but they didn't find a connection between the superficial fascia and the dermis of the fold ***(Mutan et al., 2000)***.