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Original article

Classification of Postburn Deformities of the Breast

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SUMMARY

Introduction/Aim. An increased survival of patients with extensive and critical burns has increased the number of scar deformities in various parts of the human body. Breast lesions particularly affect the physical and mental health of girls and women. Scar deformities manifest in the form of individual scars or large scar fields of the breast and chest. All of this causes a wide variety of possible types of damage and the complexity of their classification. The aim of the work was to develop a classification of postburn scar deformities of the breast based on the definition of key areas of deformity and severity of the lesion to determine the reconstruction plan with optimal use of available healthy tissues of the surrounding areas.
Material and methods. The classification of cicatricial deformities of the breast was based on a retrospective study, which was conducted involving 68 patients with lesions of 96 glands (40 unilateral and 28 bilateral). Clinical assessment of the lesion was used, taking into account the segmentation of the breast and adjacent areas, determination of parenchymal deficiency, and the degree of lesion of the mammary-areolar complex. The surface of the breast and adjacent areas of the chest and anterior abdominal wall are divided into 10 segments. The segmentation of areas allowed us to clarify the development of deformities with the selection of their key areas due to scars and to determine the most suitable areas for obtaining the donor tissue for reconstruction.
Results. Four types of breast deformities are proposed based on determining the location of scar tissue transformations, the severity of the lesion of the nipple-areolar complex, parenchymal deficiency, and the nature of the deformity.
Conclusions. The presented classification of postburn scar deformities of the breast reflects the main features of structural and functional disorders, makes it easy to determine the severity of the deformity, and helps to differentiate and objectively approach the choice of treatment tactics.

Keywords: **postburn deformities, breast, classification of deformities**

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INTRODUCTION

An increased survival of patients with extensive and critical burns has increased the number of scar deformities in various parts of the human body. Breast lesions particularly affect the physical and mental health of girls and women.

Breast in different periods of a woman's life reacts differently to the influence of a thermal agent. When the lesion occurs in childhood, violation disorders of gland development, kypho-scoliotic deformities of the spine, limited external respiratory functions and others appear. In older age, complaints of a cosmetic nature add and develop inferiority complexes (1 - 3). Scar deformities manifest in the form of individual scars or large scar fields of the breast and chest. All of this causes a wide variety of possible types of damage and the complexity of their classification (4).

For practical purposes, a certain classification determines the possibility of developing a single concept of diagnosis and treatment, adequate analysis of clinical material, prognosis of treatment results, complications, and outcomes (5). Therefore, the classification is the scientific and methodological basis for the diagnosis and treatment.

Several classifications of postburn breast deformations are offered by the authors, in which age, type, anatomical and functional characteristics are appointed as the dominant evaluation criteria (6 - 9).

This approach allows us to consider functional disorders and facilitates the practical implementation of classifications; however, it is not always sufficient, as it does not consider the nature of the tissue damage to determine the key areas of deformation, the severity of an injury and the possibility of using healthy tissues for maximum breast skin recovery.

This is essential in choosing surgical tactics, prognosis, and treatment results.

The aim of the paper was to develop the classification of postburn scar deformities of the breast based on the determination of the key deformity areas and severity of the lesion to determine the reconstruction plan with optimal use of available healthy tissues of the surrounding areas.

MATERIALS AND METHODS

During the period from October 2001 to June 2020, a retrospective study was conducted involving 68 patients with cicatricial deformities of 96 breasts (28 bilateral and 40 unilateral injuries).

The age of the patients ranged from 5 to 38 years (mean age - 15.6 ± 0.96 years) (Table 1).

Table 1. *Number of patients by age (n = 68)*

Range of years	< 7	8 - 13	14 - 18	> 18
Number of patients	10	23	16	19

Inclusion criteria: female, reconstruction performed 10 or more months after suffering burns.

Exclusion criteria: male, pregnancy, patients with associated injuries or comorbidities.

Clinically, depending on the severity of lesions, breast asymmetry, limited scars or scar fields that spread to the chest and abdominal wall, scar constrictions with the formation of hernias of the parenchyma, mound flattening, displaced nipple–areola complex (NAC), and infra-mammary fold (IMF) obliteration were observed. In addition to local manifestations, signs of kypho-scoliotic spinal deformities were determined.

The method of determining the deficiency of the parenchyma of the breast is based on a study by Vandeput J. J. and Nelissen M. (10). The authors established a statistical correlation between the volume of the breast and the anthropometric indicator of the distance between the nipple and the submammary fold (nipple to infra-mammary fold distance (NI): taken vertically down). To do this, the distance between the nipple and the submammary fold was measured on the affected and unaffected sides. Deficiency of the parenchyma was the ratio of the results of the healthy side to the affected side, expressed as percentage. At bilateral injury, the initial data were average age parameters from 3 to 6 cm (11 - 14).

Determination of parenchymal deficiency (volume) of the breast was calculated using the previously published methods by the formula:

$$\text{volume deficiency \%} = 100\% - | \text{NAC'-IMF'} | \times 100\% / | \text{NAC-IMF} |$$

where NAC-IMF is the distance in cm between the nipple-areolar complex and the inframammary folds on a healthy breast, which corresponds to 6 - 8 cm in bilateral lesions; NAC-IMF is the distance in cm

between the nipple-areolar complex and the inframammary folds of the affected breast (10, 15).

For example: NAC'-IMF' = 3 cm, the deficit is 100% - 3 × 100/6 = 50%.

The degree of NAC damage was divided into mild, moderate, and severe. A mild degree of damage – 1/2 of the areolar part suffers, moderate damage degree – the whole areola is affected, however, with the preservation of the nipple and severe damage degree, the whole NAC is affected or its absence is noted.

Internal contracture is caused by cicatricial-fibrous changes that occur in the deep layers of the integumentary tissues of the breast and the glandular tissue, which can reach the deep fascia, due to reactive inflammation of the affected dermis in the acute period of injury.

External contracture is caused directly by scars and scar tissue of the skin. In the absence of subcutaneous damage, glandular tissues develop normally, and deformities are caused only by external scars (3).

RESULTS

To determine the anatomical location of the scars, the breast and chest were divided into segments.

Segmentation of breast and adjacent areas was based on the anatomical guidelines of Acea Nebril, B. (16). Breast and adjacent areas of the chest and upper anterior abdominal wall were divided into 10 segments (Figure 1).

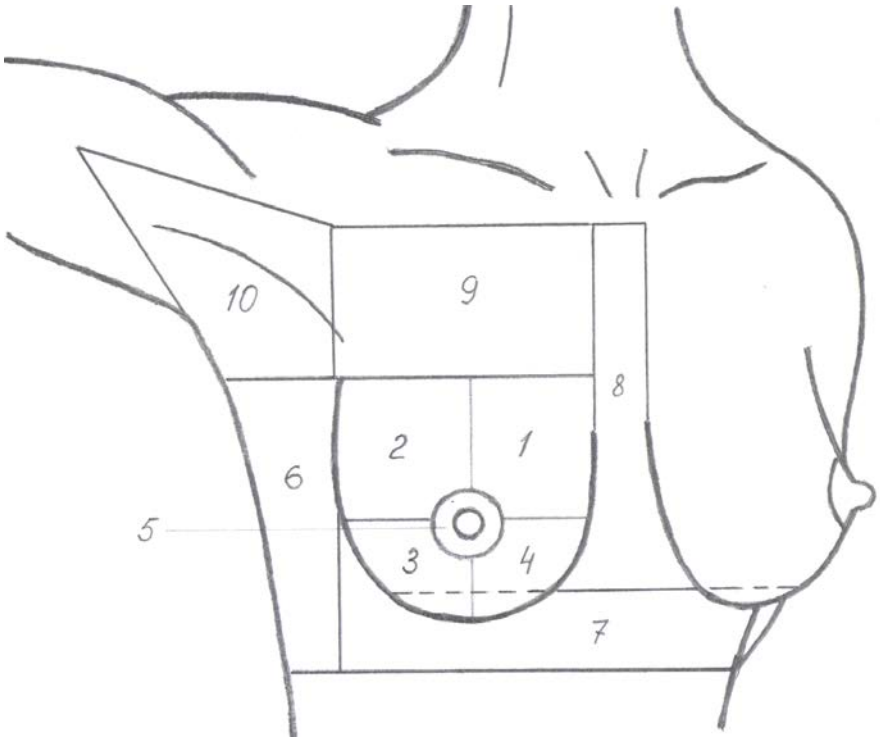

Figure 1. *Segments of the breast and chest*

The breast consists of 5 segments: upper internal (1st segment), upper external (2nd segment), lower external (3rd segment), lower internal (4th segment), and NAC (5th segment). The chest and abdominal wall were divided into sections that included the following segments: upper part (subclavian (9th segment) and upper parts of the intermammary segment (8th segment)), lateral - (axillary (10th segment) and lateral thoracic segments (6th segment)), lower - upper abdominal (7th segment) and inner - intermammary (8th segment).

Segments in adult women are defined better than in girls. Thus, in prepubertal patients, the distribution of segments of the breast was determined by anatomical guidelines: the upper limit – at the level of the 3rd rib, lower - at the level of the 6th rib, medial – edge of the sternum and lateral - anterior axillary line. The position of the NAC was deter-

mined at the intersection of the midclavicular line and the 5th rib.

Classification of postburn deformities of the breast

The classification has four types of breast deformities, which include five main features: localization of scar tissue transformations in certain segments, severity of NAC damage, breast parenchyma deficiency and nature of the deformity (Table 2). In the classification construction, the injury of one gland is considered as one separate case. At bilateral injury, two cases are considered separately.

Table 2. *Classification of postburn deformities of the breast*

Signs	Type 1	Type 2	Type 3	Type 4
Localization (chest segments)	1 - 2 segments	missing	≤ 3 segments	> 3 segments
Localization (breast segments)	missing	1 - 2 segments	≤ 3 segments	> 3 segments
NAC damage	missing	light	average	severe
Deficiency of parenchyma	missing	up to 20%	20 - 50%	more than 50%
Nature of deformity	external	internal	internal-external	internal-external

Type 1. Skin lesions adjacent to the breast of one or more segments without scar deformity of the gland tissues. Deformities of type 1 occur due to cicatricial traction of the areas that surround the breast and belong to external deformities.

With the injury to the 6th segment of the thorax, dislocation of the 2nd and 3rd segments outside the thorax arises with smoothing of the lateral contour of the gland. The outer segments of the gland are mobilized medially with fixation to the outer edge of the pectoralis major muscle to eliminate deformity. Reconstruction of the defect is performed by using skin-fascial flaps of the posterior part of the 6th segment.

Damage to the 7th segment leads to a shift of the lower contour of the gland down and smoothing of the IMF. Mobilization of the 3rd and 4th segments of the gland is performed from the inframammary incision to the top and fixed to the pectoralis major muscle. For the reconstruction of defects, skin-fascial rags are used from the site of the 6th segment, with the formation of a submammary fold.

The skin of the 8th and 9th segments has high mobility and is part of the décolleté. Scars deform the breast by shifting it up and inward, smooth the intermammary space and increase the convergence of the breast. When eliminating the deformity, excision of scars of these segments with mobilization of the gland downward is performed, and subsequent reconstruction with skin-fascial flaps from the upper parts of the 8th and 9th segment or the 7th segments is performed (Figure 2 A, B, C, D).

The scars of the 10th segment led to the deviation of the upper-outer contour toward the axillary area. After mobilization of the gland, scars are revised (Z or V-Y- plastic) or excised by using skin-fascial flaps of the 6th segment.

Type 2. Scar transformation of breast segment integumentary tissues without damage to attached areas causes internal deformity.

The upper 1st and 2nd segment of the breast have a small amount of glandular tissue; they form the upper and lateral contours and are part of the décolleté. The skin of segments has high mobility. Scar alterations of the skin of the 1st segment lead to a shift of the contour up and inward, upper-middle deviation of the NAC and narrowing of the IMF. To obtain a good aesthetic appearance, the scars of the 1st segment are excised, and upper-medial mobilization of the NAC is performed with defect replacement by skin-fascial flaps of the 8th or 9th segments. The revision of scars (Z or V-Y plastic) at small, narrow scars was performed.

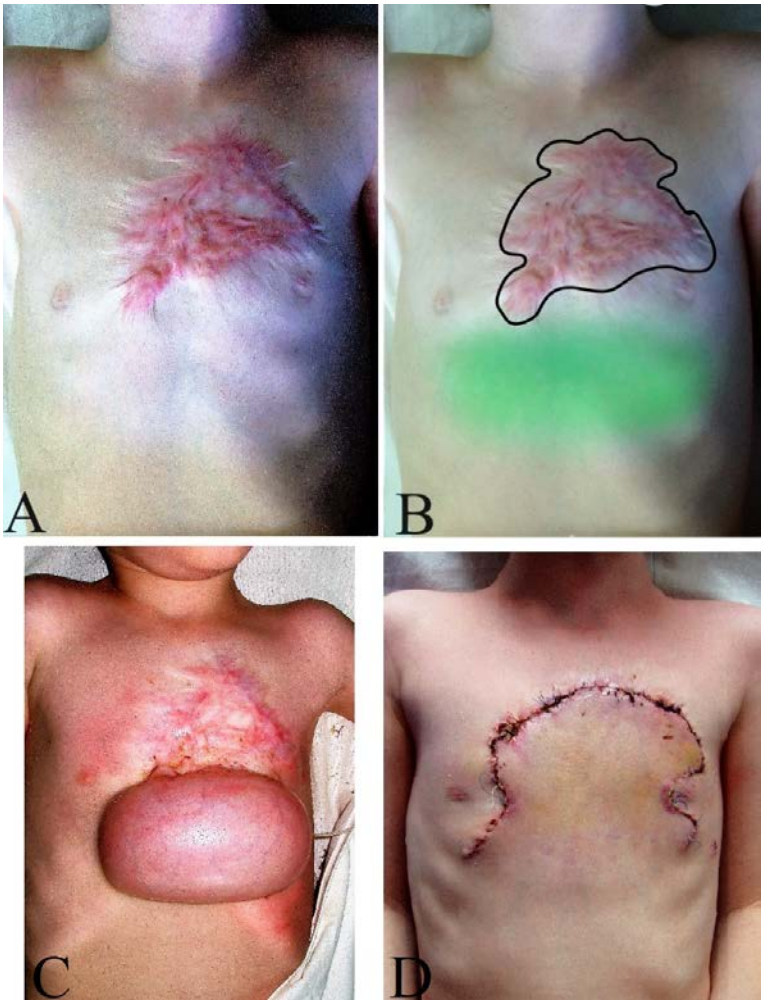

Figure 2. *(A, B, C, D) (A). Scar deformity type I with lesions of the 8th and 9th segment of the chest (key area); (B) Planning: boundaries of scar excision and potential donor area for stretching; (C) Stretching the flap of the 7th segment; (D) Scar defect reconstruction with stretched flap of the 7th segment*

Scars of the 2nd segment of the gland shift the contours up and out with the upper-external deviation of the NAC. Additionally, at the deformity of the 1st segment, excision of scars with top-lateral mobilization of NAC and reconstruction by skin-fascial flaps of the 6th, 9th or 10th segment is carried out. In some cases, it is possible to revise scars with Z- or V-Y-plastic.

To preserve the cosmetic effect of the 1st and 2nd segment reconstruction, the flaps are moved by direct advancement.

The lower 3rd and 4th segment of the breast are most often exposed to scar transformations. The lower segments contain a large amount of glandular tissue and are involved in the formation of the lateral, inner and lower contours of the gland and IMF, which gives the gland a certain shape and aesthetic look. Lesions of these segments determine the deficiency of the parenchyma of the gland from 20% to 50% in the 3rd type of deformity. Scar tissue transformation of the 3rd and 4th segment shifts the lower contour of the MG downward and to the sides.

Restoration of the 3rd and 4th segment has great importance in reconstructive surgery of the breast. During deformity elimination, the scars are excised with simultaneous reconstruction by skin-fascial flaps of the 6th or 7th segment.

The degree of the 5th segment damage – NAC in the 2nd type of deformities – may be mild with damage to ½ of the areal part or medium with damage to the areola, however, with preservation of the nipple. Scar deformity of the NAC is combined with damage to any other segment of the gland, and its displacement depends on the predominant scar traction of the affected segment. When the deformity

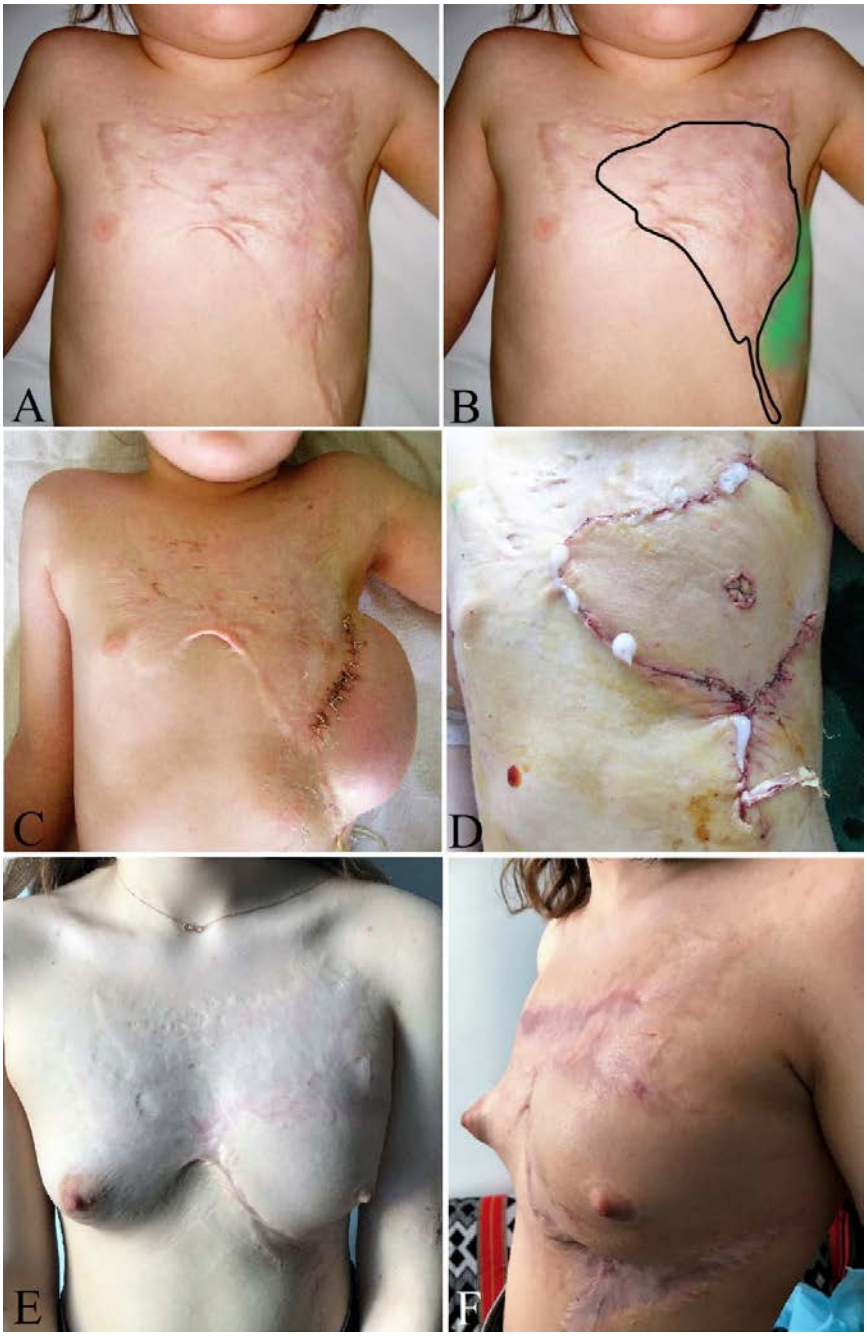

Figure 3. *(A, B, C, D). (A) Scar deformity type 2 with lesions of segments 1 - 5 of the right gland; (B) Planning: boundaries of scar excision and potential donor area for stretching the 6th segment; (C) stretching the flap of the 6th segment; (D) reconstruction of the defect area with a stretched flap from the 6th segment and circular plastic of the NAC; (E, F) 15 years after surgery. Normal development of the breast with a slight downward displacement of the IMF. Correction is needed.*

tion of the NAC is eliminated, NAC is mobilized by scar traction or by performing circular mobilization, with its next displacement to the natural level (Figure 3 A, B, C, D).

Type 3. Tissue scar damage to the breast segments and adjacent segments, NAC damage, defect of the parenchyma. Deformities of type 3 have a mixed external and internal character.

At the 3rd type of deformity of the 1st and 2nd segment of the breast, cicatricial changes of the 8th and 9th segment cover arise, and the external-internal contracture of breast with steady shift of the affected

segments of the gland upward is being formed. In such cases, the key zones of deformity are scars of the 8th and especially of the 9th segment, which require elongation of the scar traction transition area of segment 9 into the 1st or 2nd by using Z or V-Y plastic or replacement of the scar with healthy tissues from the upper parts of the chest by stretching them.

Cicatricial transformation of the 3rd and 4th segments of breast may be accompanied by scar damage to the 6th, 7th and 8th segment, which causes underdevelopment of glandular tissue, impaired physiological growth of the gland with a deficiency of parenchymal tissue more than 50%, stratification of the gland along the anterior surfaces of the thoracic and abdominal walls, and IMF obliteration.

To replace scar defects of the 3rd, 4th, 5th and 7th segment, it is appropriate to use flaps of the 6th segment from the lateral surface of the chest based on the thoracodorsal artery flap (TDAF) and lateral thoracic artery flap (LTAF). These flaps allow the formation of external contours of the breast and IMF. In the case of an insufficient amount of flap material, autotransplantation of adipose tissue is used to enlarge the breast.

Gentle selection of NAC from scars is performed while remodeling the 5th segment and next transposition to physiological position through an aperture in the moved flap (Figure 4 A, B, C).

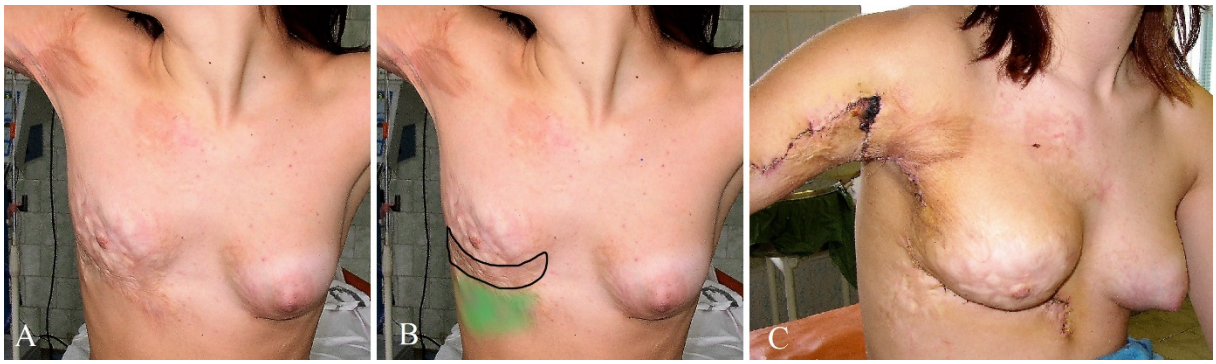

Figure 4. *(A, B, C). (A) Scar deformity type 3 with lesions of the 1 - 5th and 10th breast segments, moderate severity deformity of NAC, parenchymal deficiency up to 50%. Key areas - scar traction of the 10th segment and IMF; (B) Planning: boundaries of scar excision and potential donor area for tissue use from the 6th segment; (C) scar revision of the 10th segment, augmentation of the breast with the skin-fat flap, formation of IMF*

Type 4. Total or subtotal damage of the breast and adjacent segments, severe deformity of the NAC or its absence, and deficiency of breast parenchyma more than 50% cause severe external and internal deformity.

The 4th type of deformity is the most severe tissue damage of both the breast and the surrounding areas (≥ 75%).

Scar fields of integumentary tissues in patients with the 4th type of damage are hypertrophic scars with alternation of scar-altered free grafts, which tightly cover the chest. Breast spreads on the surface of the chest with loss of its shape.

Removal of the 4th type deformity requires the use of several flaps from different areas, which do not have scar defects. To remove deformities of the upper 1st, 2nd, 8th, 9th, and 10th segment, expanded flaps from the upper departments of the chest were used. Additionally, in the case of damage to the 2nd, 3rd, and 10th lateral segment, as well as the 5th segment and 4th, 7th, and 8th lower segment, expanded flaps from the lateral surface of the thorax are used. Such flaps allow the restoration of the poor capacity of the parenchyma of the gland lower segments by including the latissimus dorsi muscle (LDM) in them (Figure 5 A, B, C).

Figure 5. *(A, B, C). (A) Deformity of the 4th type with total damage of all segments of the right breast and all segments of the chest, severe NAC damage, absence of IMF and parenchymal deficiency more than 50%. The main key areas were the lateral and lower parts of the breast, NAC, IMF; (B) Planning: boundaries of scar excision and potential donor area for stretching; (C). Reconstruction by skin-muscle flap of the 6th segment for breast augmentation, NAC, and IMF formation*

To eliminate the deformity through the inframammary incision, the lower segments are mobilized to the top, with the next fixation to the pectoralis major muscle. At the same time, circular mobilization of the NAC, while moving to the natural level, is being performed. Skin and fascial flaps of the 6th and 7th segments are used for the reconstruction of the defects, and skin and muscle flaps of the 6th segment (including the widest back muscle) are used to increase the volume of the gland. When the defect is closed, the IMF is formed. Breast augmentation can also be achieved by using implants. Severe NAC damage requires local remodeling or total reconstruction.

DISCUSSION

Postburn deformities of the breast are one of the most complicated pathologies of the gland. Deformations are characterized by scar transformation of integumentary tissues, displacement and flattening of the gland, local hernias and parenchymal deficiency, and NAC damage (5, 6).

There are various degrees of severity of breast deformities detected, and classification is important for planning and comparing treatment outcomes. Several classifications are being currently proposed.

In their classification, Comparin JP et al. (3) carried out the distribution of persons with postburn deformities of the breast by clinical manifestations into a group of prepubertal girls and a group of adult women. In these two categories of victims, there are three main types, which include victims without damage to the gland itself, with the transformation of the integumentary tissues of the breast, and patients with scarring of the breast and NAC. The distribution into groups, according to the authors, has an impact on treatment tactics in both groups; however, the types of damage are identical in groups, their separation clutters the classification structure, and the indistinctness of scarring makes it difficult to determine reconstruction.

Dziewulski P. et al. (4) classified postburn deformities of the breast by localization, volume, anatomical location of scars, type of deformity and symmetry of the damage. The authors consider certain clinical signs when formulating a treatment plan. However, the disadvantage of this classification is the general characteristics of the deformation, and its key elements are not taken into account. This complicates the practical usage of classification to assess baseline, clear reconstruction plan, and treatment outcome.

Grishkevich VM (5) identifies three components of deformity: shape distortion, scar displacement of the NAC, gland parenchyma and scar deformity of the breast covering tissues. However, this approach does not allow us to determine the features of breast scarring and justifies the plan and methods of reconstruction.

Additionally, these authors do not consider the damage of certain anatomical segments of the breast itself and the chest, which plays a significant role in the formation of the key areas when deformity occurs.

Ebrahiem AA, Manas RK. (6) distinguish three degrees of severity of deformities of the lower pole of the breast depending on the asymmetry, displacement of the NAC, obliteration of the IMF and reduction of growth. The proposed classification is limited to a specific localization and does not take into account the lesions of other areas.

Breast deformity can occur not only due to scar tissue transformations of soft gland tissues but also due to scarring of adjacent areas by secondary traction, which must be taken into account when assessing breast deformity. Therefore, the choice of breast reconstruction method depends on the localization of such scar formations and the availability of healthy intact tissues, which are located near the defect. Elimination of key area deformities is especially important in patients of prepubertal age to allow physiological growth of the breast. This approach allows us to consider functional disorders and facilitates the practical application of classifications.

In our work, the distribution of the breast surface and adjacent areas of the chest and anterior abdominal wall into 10 segments was determined, 5 of which relate directly to the breast and others to individual areas. Segmentation of the areas allowed us to clarify the development of deformities with the selection of their key areas due to scars or scar fields and identify the most suitable areas for obtaining plastic material. This approach provided the basis for the development of postburn breast deformity classification.

Four types of breast deformities are offered based on the determination of scar tissue transformation localization, severity of NAC damage, deficiency of breast parenchyma and nature of the deformity.

Offered classification allows us to define the basic typical pathogenetic mechanisms of breast deformities in different areas, correctly choose a technique of reconstruction, and define the forecast and results of the treatment.

CONCLUSION

The presented classification of breast scar deformities after thermal injury reflects the main features of structural and functional disorders, helps easily determine the severity of deformity, and helps choose treatment tactics with differentiated and objective approaches.

In most cases, when the breast is deformed by scars, tissues of the lateral and top surfaces of the thorax and an abdominal wall, which is similar to breast textural qualities, remain intact, which can be used for the correction of deformities.

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Klasifikacija deformiteta dojki nakon zadobijanja opekotina

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SAŽETAK

Uvod/Cilj. Povećana stopa preživljavanja bolesnika sa velikim i kritičnim opekotinama povećala je broj deformiteta različitih delova tela. Lezije na dojkama naročito utiču na fizičko i mentalno zdravlje devojaka i žena. Deformiteti u vidu ožiljaka manifestuju se u obliku individualnih ožiljaka ili velikih polja ožiljaka na dojkama i grudnom košu. Sve ovo dovodi do velikog broja mogućih tipova deformiteta i kompleksnosti njihove klasifikacije. Cilj ovog rada bio je utvrditi klasifikaciju deformiteta dojki u obliku ožiljaka nakon zadobijanja opekotina, i to na osnovu definicije ključnih oblasti deformiteta i ozbiljnosti lezija, kako bi se odredio plan rekonstrukcije sa optimalnom upotrebom dostupnih zdravih tkiva okolnih područja.
Materijali i metode. Klasifikacija cikatricijalnih deformiteta dojki bazirana na retrospektivnoj studiji uključila je 68 bolesnika sa lezijama 96 žlezda (40 jednostrano i 28 obostrano). Urađena je klinička procena lezija, prilikom koje su u obzir uzeti segmentacija dojki i okolnih područja, određivanje deficita parenhima, te stepen lezija areolarno-mamilarnog kompleksa dojki. Površina dojki, okolnih područja grudnog koša i prednjeg abdominalnog zida podeljeni su u deset segmenata. Segmentacija ovih područja omogućila je razjašnjenje razvoja deformiteta, uz selekciju ključnih područja usled nastanka ožiljaka, kao i određivanje područja najpogodnijih za dobijanje tkiva donora za potrebe rekonstrukcije.
Rezultati. Predložena su četiri tipa deformiteta na osnovu određivanja mesta transformacije ožiljnog tkiva, ozbiljnosti lezije areolarno-mamilarnog kompleksa, deficijencije parenhima, kao i prirode deformiteta.
Zaključak. Predstavljena klasifikacija deformiteta ožiljaka zadobijenih nakon opekotina odražava glavne karakteristike strukturnih i funkcionalnih poremećaja, olakšava određivanje ozbiljnosti deformiteta i pomaže u razlikovanju i objektivnom pristupu izboru strategije tretmana.

Ključne reči: deformiteti zadobijeni nakon opekotina, dojke, klasifikacija deformiteta