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Results of Plastic Surgery of Post-Burn Scar Deformity of the Face and Neck with a Free Skin Graft

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Abstract With plastic surgery of post-burn scarring of the face and neck and the inability to use local tissues, it becomes necessary to use plastic surgery with a full-layer free skin graft. In this aspect, the issues of the quality of graft engraftment remain relevant, and in the long term – aesthetic moments, including the formation of hypertrophic scars, keloids, changes in pigmentation of the transplanted skin, as well as the most formidable complication - the retraction of the graft with a recurrence of scar deformation. **The aim of the study:** to improve the results of surgical rehabilitation of patients with post-burn scar deformity of the face and neck by applying a free full-layer skin graft. **Materials and methods:** according to the applied plastic surgery methods, 115 patients were divided into two groups. In the main group – 54 patients, the proposed method of eliminating post–burn scar deformity of the face and neck was performed; in the comparison group - 61 patients, plastic surgery with a free skin graft was performed according to traditional methods. **Results:** an improved method of surgical treatment of post-burn scarring of the face and neck with a free full-layer skin flap, characterized by an improvement in the quality of the graft taken, by reducing the degree of its retraction, as well as stimulation of vascularization, reducing the risk of formation of subcutaneous fluid accumulations, excluding long-term wearing of a pressure bandage, which generally contributes to a more physiological engraftment of transplanted tissues.

Keywords Burns of the face, Plastic surgery, Post-burn scar deformity, Free skin graft

1. Introduction

Post-burn contractures in the face and neck have a multifactorial origin and are difficult to prevent with extensive burns. Burns of the face lead to distortion of anatomical landmarks, causing aesthetic, functional and psychological problems. Each subunit of the face is unique in structure, so the surgeon needs to adjust the operation time and technique depending on the area and severity of the contracture. The contracture of one unit, especially the neck and forehead, can strengthen the contracture of neighboring subunits. The role of these external influences must be taken into account when determining the sequence of surgical procedures. The surgeon must master all methods of reconstructive surgery, from skin grafting to tissue expanders and microsurgery, in order to get the best results [1]. Surgical intervention in post-burn contractures should be avoided during the active phase of healing and scarring (i.e. while the scar is still immature and highly vascularized). It usually takes about 1 year. Before surgery for contracture, the scar should mature, become soft, elastic and less vascularized. A highly vascular scar bleeds more during surgery and makes it difficult to achieve ideal hemostasis, which leads to poor graft engraftment and leads to a recurrence of contracture.

One of the radical methods of plastic surgery for burns in this area is expander dermotension. The extension can be located in direct contact with the reconstructed area to perform a local pre-expanded flap, or in another area to perform a regional pre-expanded flap, followed by a local or distal extension to achieve a pre-expanded complete skin graft [2]. The advantage of using healthy skin next to the affected areas is that it is similar in terms of pigmentation, hairiness, thickness and texture. In light of this, zygomatic, chin or labial skin extensions are considered particularly suitable for the treatment of perioral lesions. However, they can cause certain consequences for the donor site, such as the appearance of stretch marks, loss of skin elasticity or a decrease in hair density both on the scalp and in the beard area in men. Treatment of the consequences of burns or other loss of perioral tissues is difficult due to the place of their occurrence, functional importance, as well as social and aesthetic aspects. This is a mobile area with concave and convex features and a complex muscular structure, the deformation of which can manifest itself during movement or only during relaxation. The functional consequences of burns in this area are skin retraction and lack of skin, which can lead to labial eversion, microstoma, the formation of

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folds and subsequent lip failure, as well as the inability to open the mouth opening, which jeopardizes oral hygiene and intubation procedures. The results of the reconstruction of the upper and lower lips, as well as the eyelids, indicate that this technique is associated with the risk of ectropion [3]. The main problem of expander dermotension with the vastness of a scar defect that occupies almost the entire head or neck area is the lack of a substrate - normal tissue for expander dermotension.

Skin grafts, dermal substitutes with grafts and flaps are available to cover the post-release raw area [4]. Grafts help to show the cervical-chin angle and the contour of the neck. Nevertheless, the grafts are not malleable and shrink. To a large extent, the use of dermal substitutes gives better results and can lead to pinching of the skin, although attention to detail will be required to obtain a complete grip on large areas [5]. Good results can be obtained if the patient can have thin perforant flaps raised. In the presence of microsurgical experience, thin flaps from deep lower epigastric perforation, thin anterolateral femoral flaps or flaps of the radial artery of the forearm can be used [6]. These flaps can also be pre-straightened so that the area of available skin is larger for excellent results. Extensive primary thinning of these flaps can lead to partial necrosis and may require skin grafting. This jeopardizes the result, and the alternative is to strive for the complete survival of the flap and its subsequent thinning.

Thus, the issue of plasty of extensive post-burn defects of the soft tissues of the head and neck is still open. Microsurgical autotransplantation of complex flaps is acceptable and effective for plasty of extensive scar defects of the head (in the absence of conditions for expander dermotension). At the same time, microsurgical autotransplantation of tissues requires special equipment and tools, a trained microsurgical team. Microsurgical flaps cannot be used in cases where there are no recipient vessels for revascularization of the graft [7]. If it is impossible to use local tissues, it becomes necessary to use plastic surgery with a full-layer free skin graft. In this aspect, the issues of the quality of graft engraftment remain relevant, and in the long term – aesthetic moments, including the formation of hypertrophic scars, keloids, changes in pigmentation of the transplanted skin, as well as the most formidable complication - the retraction of the graft with a recurrence of scar deformation. An improved method of free skin grafting has been proposed for plastic surgery, the evaluation of the results of which served as the basis for this study.

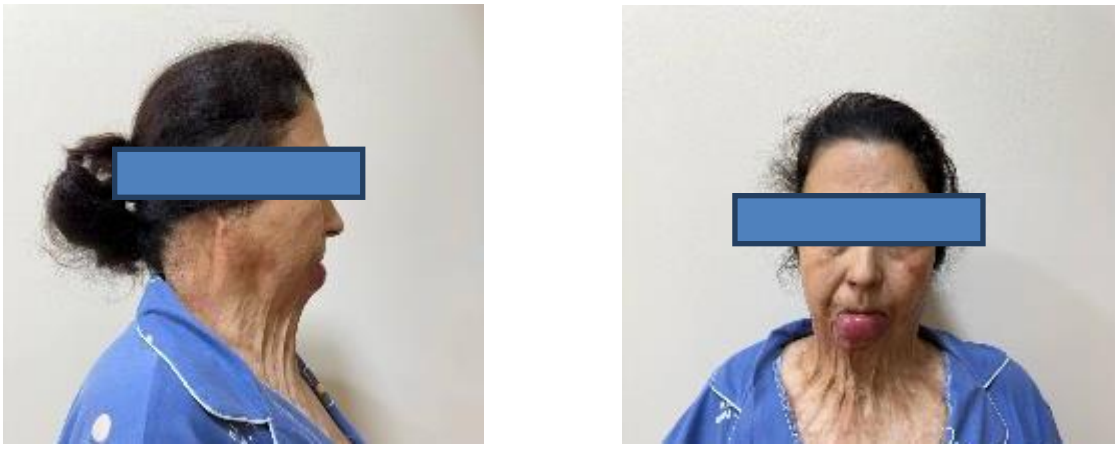
2. Materials and Methods

All patients were divided into two groups according to the applied plastic surgery methods. In the main group – 54 patients, the proposed method of eliminating post–burn scar deformity of the face and neck was performed; in the comparison group - 61 patients, plastic surgery with a free skin graft (FSG) was performed according to traditional methods (Table 1).

FSG plastic surgery was performed in 61 patients in the comparison group, of which 25 in the face area and 36 in the neck area. In the main group, this operation was performed in 54 patients, of which 33 patients in 21 cases in the face and neck area.

Table 1. Distribution of patients into study groups

Type of operation	Comparison Group		Main group		Total	
	abs.	%	abs.	%	abs.	%
Facial defect plastic surgery	25	41,0%	21	55,0%	46	55,2%
Neck defect plastic surgery	36	59,0%	33	45,0%	69	44,8%
Total	61	100,0%	54	100,0%	115	100,0%



Appearance before surgery

Acute expander dermotension

Applying Hemoben powder to the wound surface after excision of scar tissue on the neck

View after plastic surgery

Irradiation of the plastic zone with a laser device "Sogdiana"

Figure 1. Patient Zh. Post-burn mid-lateral bilateral scarring of the neck. Neck contracture III art . Pronounced cosmetic defect. Plastic surgery with a free skin graft

Both groups were dominated by women. About half of the patients were aged from 20 to 44 years, about a third were 45-59 years old. The timing of burns ranged from 1 year to 5 years. In all cases, only finally formed scar deformations without elements of the inflammatory process were subjected to plastic surgery. Taking into account the fact that in this work we consider the results of only one stage of plastic surgery, the sizes of scar defects among patients were

different, while the analysis included only patients with an average defect area that was within 50-120 cm^2, as well as large defects that exceeded an area of 120 cm^2.

In the comparison group, there were 39 patients with average defects (63.9%), of which 8 (13.1%) were in the upper third area, 1 (1.6%) in the middle third area, 6 (9.8%) in the lower third area, defects involving 2 or 3 areas of the face – 5 (8.2%), on the neck – 19 (31.1%). There were 22 (36.1%) patients with large defects in this group: 2 (3.3%) in the area of the upper third face, 2 (3.3%) in the lower third face, 1 (1.6%) defects involving 2 or 3 areas of the face, 17 (27.9%). In the main group of patients with average defects there were 32 (59.3%), of which 6 (11.1%) in the area of upper third persons, 1 (1.9%) in middle third persons, 4 (7.4%) in lower third persons, defects involving 2 or 3 areas of the face – 3 (5.6%), on the neck – 18 (33.3%). There were 22 patients with large defects in this group: upper third persons – 2 (3.7%), middle third persons – 2 (3.7%), defects involving 2 or 3 areas of the face – 3 (5.6%), on the neck - 15 (27.8%).

A method of surgical treatment of post-burn scar deformity of the face or neck with a full-layer skin flap, included a linear horizontal incision with excision of scar tissue, performing head reduction, eliminating tightening scars along the side of the neck with additional incisions, treating the wound surface (recipient zone), excision/ fence of a free skin flap for autodermoplasty, performing autodermoplasty, fixing a freely displaced skin flap to the soft tissues of the recipient zone, standard fixation of the head, the wound surface of the recipient zone is treated by applying a powdered composition "HEMOBEN", in an amount of 60 mg for every 4 cm^2 of the treated surface, and after 5-10 minutes, autoplasm diluted with saline solution in a ratio of 1:1 is applied with a syringe, in an amount of 10 ml per 10 cm^2 of the surface, before taking a free skin flap from the inguinal area, acute dermotension is performed by implanting a latex rectangular expander under the skin, with a base volume of 40.5 cm^2, into which 300-400 ml of sterile saline solution is injected, after that, the potential skin flap is irradiated with a Pulse-100 laser device (Uzbekistan) in the infrared spectrum (with a wavelength of 900 nm) with a frequency of 100 Hz, a pulse power of 80-100 W / pulse, for 10 minutes at a distance of 3 cm from the surface of the skin flap in scanning mode over its entire surface, excision a full-layer skin flap is carried out along the edges of the expander stretching and its perforation is performed with an injection needle, one puncture for each 1 cm^2, autodermoplasty is performed with the imposition of fixing nodular sutures along the edges of the wound at a distance of 1.0 cm from each other with atraumatic monofilament non-absorbable suture material 4/0, after which the freely moved skin flap is additionally fixed to the soft tissues of the neck in a staggered manner without applying a pressure bandage for 1 suture for every 2.0 cm^2, in the early postoperative period, irradiation is carried out through dressing of the plastic zone with a laser device "Sogdiana" (Uzbekistan) in the infrared spectrum (with a wavelength of 890 nm) with a frequency of 1300 Hz, with a pulse power of 5-7 W / pulse, for 2 minutes applied to the bandage in scanning mode (over the entire surface of the flap), 2 times a day for 7-10 days (Fig. 1).

For this method, a patent was obtained for the invention of the Ministry of Justice of the Republic of Uzbekistan No. IAP 07436 dated May 31, 2023 ("A method for surgical treatment of post-burn scarring of the head and neck with a full-layer skin flap").

All patients in both groups underwent a standard complex of preoperative examination. In the postoperative period, all variants of local complications were taken into account, both in the near and long-term period.

3. Results and Discussions

The fundamental point in FSG plastic surgery is the long-term fixation of the pressure bandage, which is applied for 5 or more days. That is, the first dressing is performed no earlier than 5 days later. In this regard, the proposed method of FSG plastic surgery made it possible both to eliminate the need for applying a pressure bandage and to shorten the time of primary isolation of the transplanted skin flap. In particular, after plastic surgery in the facial area in the comparison group, the primary dressing was performed after 5.2±0.5 days, whereas in the main group after 3.3±0.5 days ($t=12.84$; $p<0.05$), after plastic surgery in the neck, these indicators were 5.1± 0.4 days versus 3.1± 0.3 days ($t=22.10$; $p<0.05$). Accordingly, in general, in all patients, the average duration of wearing the bandage was 5.2±0.5 days versus 3.2± 0.4 days ($t=24.30$; $p<0.05$).

The following complications were characteristic of this type of plastic surgery. Partial graft necrosis after facial plastic surgery developed in 2 (8.0%) patients in the comparison group, in these cases, flap necrosis occupied about 20% of the entire surface. There were no such complications in the main group. Divergence of sutures in the flap tension zone in the comparison group was noted in 2 (8.0%) patients, in the main group in 1 (4.8%). Subcutaneous suppuration developed in 1 (4.0%) patient in the comparison group. A typical complication for FSG plastic surgery in the comparison group was the formation of a subcutaneous hematoma, which was verified by ultrasound, the elimination of the latter was carried out using percutaneous puncture. In the main group, due to the use of a hemostatic agent, no such complications were noted. In total, 5 (20.0%) patients had various complications in the comparison group after FSG facial defects plastic surgery, while only 1 (4.8%) in the main group. Accordingly, the postoperative period proceeded without complications in 20 (80%) and 20 (95.2%) patients. According to this criterion, due to the small number of groups, no significant difference was obtained ($\chi2=2,337$; $df=1$; $p=0.127$).

After plastic surgery in the neck area, there were 7 (19.4%) patients with various complications in the comparison group, 2 (6.1%) in the main group ($\chi2=2.719$; $df=1$; $p=0.100$).

The analysis of the frequency of the development of immediate complications in general by groups showed that in the comparison group there were 12 (19.7%) with various complications, of which 5 (8.2%) had partial necrosis of the graft, in the main group complications developed in 3 (5.6%) ($\chi2$=5.033; df=1; p=0.025) (fig. 2).

All cases of suture divergence required secondary sutures, which was performed in 5 (8.2%) patients in the comparison group and in 2 (3.7%) in the main group. Excision of necrotic tissues was performed in 5 (8.2%) and 1 (1.9%) patients, respectively. Percutaneous hematoma puncture under ultrasound control was performed in 5 (8.2%) patients in the comparison group. In total, 15 (24.6%) additional interventions were performed in 12 patients in the comparison group, and only 3 (5.6%) in the main group ($\chi2$=7,861; df=1; p=0.006).

The development of various complications also affected the average duration of the hospital period after surgery. So, in the comparison group, this indicator for all patients after FSG was 11.6±1.6 days, whereas in the main group - 8.5±1.6 days (t=10.17; p<0.05).

Long-term complications and the actual result of scarring plastic surgery in the face and neck were recorded during control examinations for 3-12 months after surgery. It should be noted that FSG plastic surgery is one of the most vulnerable methods in terms of the quality of graft healing. We took into account all variants of long-term complications, even situations with changes in graft pigmentation, which on the one hand could be due to the difference in skin in the donor and recipient zones, and on the other hand, the quality of reparative processes, microcirculation, etc. In both groups, after FSG in the facial area, the most frequent complication was hypo- or hyperpigmentation of the graft, the frequency of which was 24% in the comparison group (in 6 out of 25 patients) and 14.3% in the main group (in 3 out of 21 patients). Hypertrophic scars, which usually formed in the area of suture divergence, were detected in 4 (16.0%) and 1 (4.8%), respectively. The most serious complication – graft shrinking with recurrence of scar deformation was noted in 2 (8.0%) cases in the comparison group. In total, there were 12 (48%) different complications in the comparison group, and 4 (19.0%) in the main group ($\chi2$=4,217; df=1; p=0.041).

After neck surgery, there were 15 (41.7%) different complications in the comparison group, and 7 (21.2%) in the main group ($\chi2$=3.317; df=1; p=0.069).

In general, among all patients with FSG plastic surgery, there were 27 (44.3%) different complications in the comparison group, and 11 (20.4%) in the main group ($\chi2$=7,390; df=1; p=0.007) (Fig. 3). At the same time, graft shrinkage was observed in 5 (8.2%) and 1 (1.9%) patients, respectively. The development of this particular complication required repeated full-fledged surgical elimination (Fig. 3 and 4).

According to the development of various complications, the methods of their elimination are indicated in Table. 2. In cases of pigmentation changes, hypertrophic scar formation, patients were referred to cosmetologists. Depending on the spots and the time of year, they performed various types of procedures, from bleaching masks and mesotherapy to laser peeling.

Table 2. Treatment options for long-term complications after plastic surgery with a free skin graft

Type of treatment of complications	Comparison Group		Main group	
	abs.	%	abs.	%
Hardware cosmetology	17	27,9%	7	13,0%
Excision of the scar	2	3,3%	3	5,6%
Repeated FSG	5	8,2%	1	1,9%
Secondary corrective surgery using local plastic surgery	3	4,9%	0	0,0%
Total	27	44,3%	11	20,4%

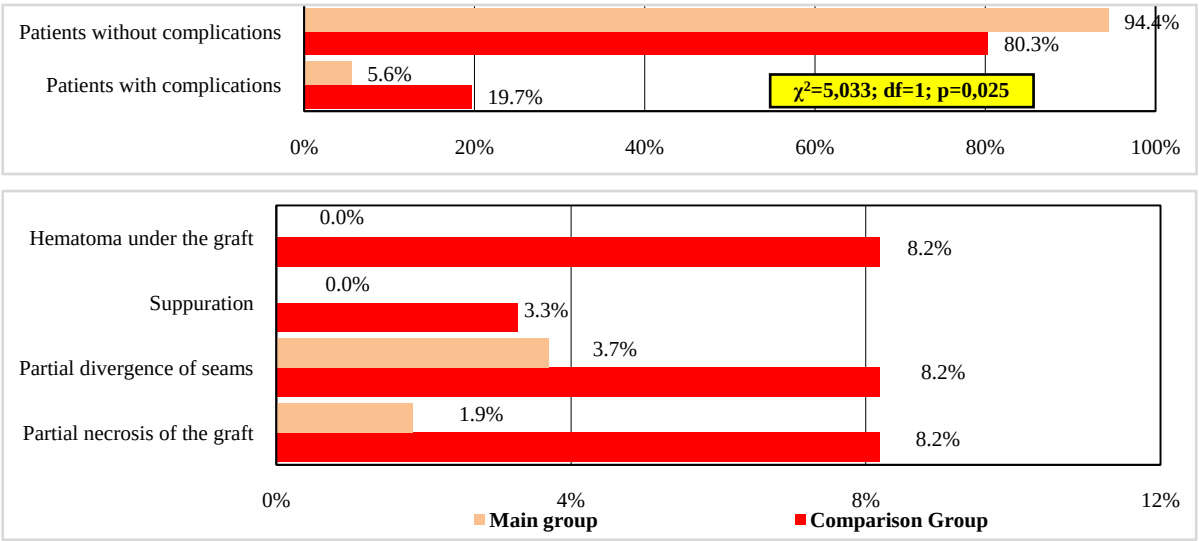


Figure 2. The frequency of immediate complications after plastic surgery of all defects with a free skin graft

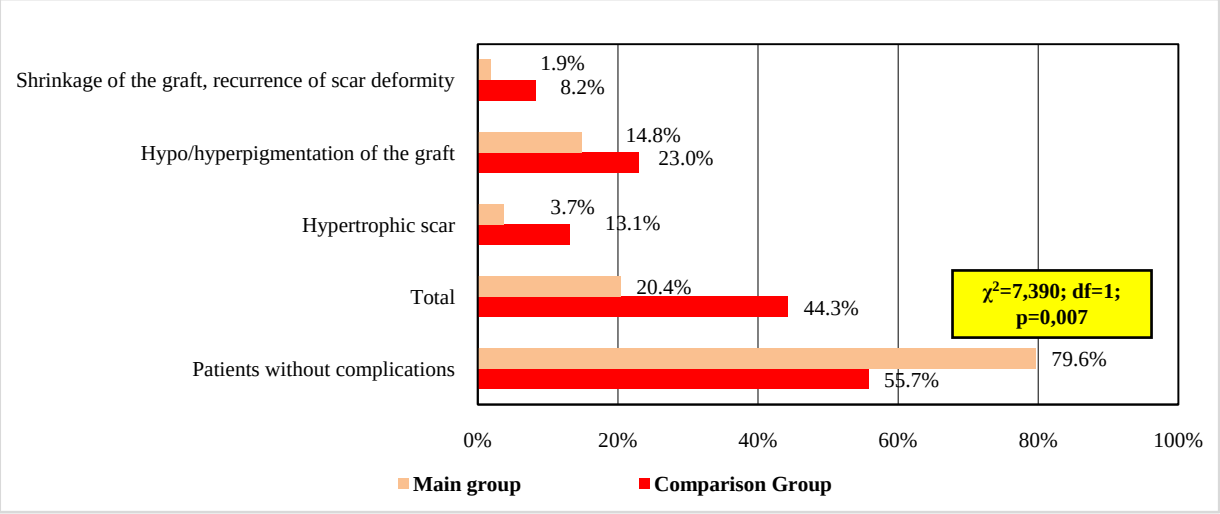


Figure 3. The frequency of long-term complications after plastic surgery of all defects with a free skin graft

View about the operation

View after surgery

Figure 4. Comparison group. Patient A. The consequence of a chemical burn (sulfuric acid). Extensive mid-lateral bilateral scarring of the neck. Contracture of the III degree. Post-burn keloidosis of the face, chest. The result of the first stage of neck plastic surgery with a free full–layer skin graft is a recurrence of scar deformity with the development of grade II contracture

In total, hardware cosmetology was applied in 17 (27.9%) patients in the comparison group and 7 (13.3%) in the main group. In general, 10 (16.4%) patients in the comparison group and 4 (7.4%) in the main group required surgical removal of complications after plastic surgery of scar defects of the face and neck. Accordingly, 34 (55.7%) and 43 (79.6%) patients were without complications ($\chi 2$= 7,391; df=2; p=0,025).

The evaluation of long-term results was carried out according to the following criteria.

An excellent result is all cases of grafting of the flap without the development of immediate (affecting the quality of engraftment) and long–term complications.

A good result is cases when there was a development of aesthetic complications that were subjected to various variants of hardware cosmetological treatment.

A satisfactory result is cases when patients with long–term complications in the form of partial cicatricial deformity required surgical removal in the form of excision of scars or secondary corrective interventions.

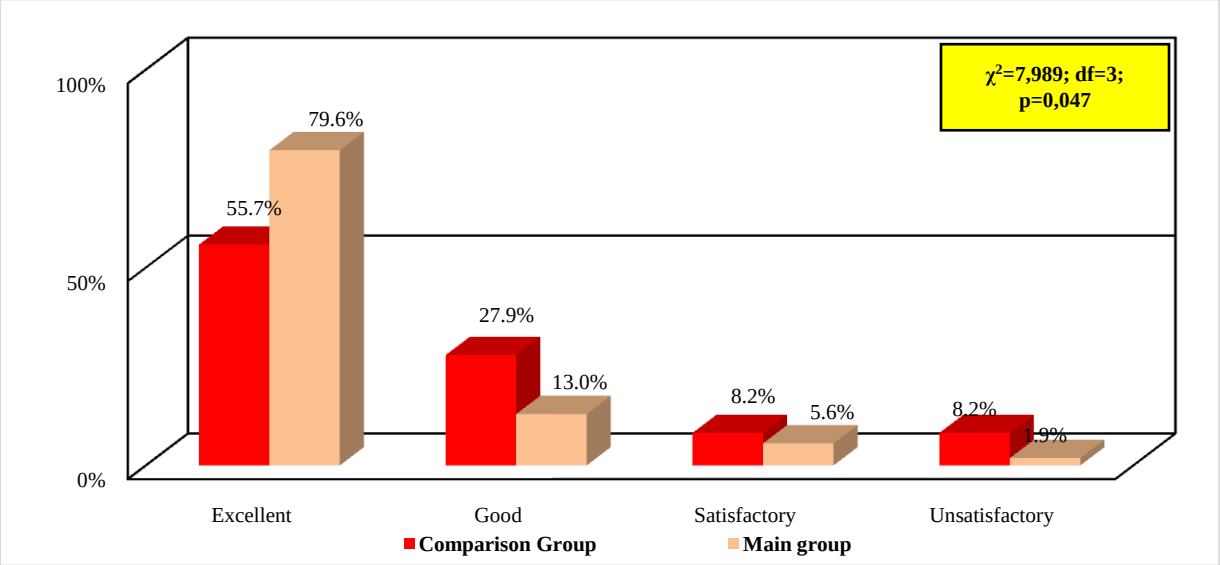


Figure 5. Summary of long-term functional and aesthetic results of plastic surgery of facial and neck defects with a free skin graft

An unsatisfactory result is a situation when, after plastic surgery, a recurrence of scarring has occurred in the face or neck area, requiring a full–fledged repeat operation to eliminate the defect.

After FSG plastic surgery in the facial area, an excellent result was obtained in 13 (52%) patients in the comparison group and 17 (81.0%) patients in the main group. Good results were found in 7 (28.0%) and 3 (14.3%) patients, respectively, satisfactory in 3 (12.0%) and 1 (4.8%) patients. An unsatisfactory result was observed in 2 (8.0%) patients in the comparison group ($\chi 2$= 4,822; df=3; p=0.186).

After FSG surgery in the neck, an excellent result was obtained in 21 (58.3%) patients in the comparison group and 26 (78.8%) patients in the main group. Good results were found in 10 (27.8%) and 4 (12.1%) patients, respectively, satisfactory in 2 (5.6%) and 2 (6.1%) patients. An unsatisfactory result was observed in 3 (8.3%) patients in the comparison group and 1 (3.0%) in the main group ($\chi 2$=3.980; df=3; p=0.264).

In general, among all patients after FSG plastic surgery in the face and neck, an excellent result was obtained in 34 (55.7%) patients in the comparison group and 43 (79.6%) patients in the main group. Good results were found in 17 (27.9%) and 7 (13.0%) patients, respectively, satisfactory in 5 (8.2%) and 3 (5.6%) patients. An unsatisfactory result requiring repeated full-fledged plastic surgery was noted in 5 (8.2%) patients in the comparison group and 1 (1.9%) in the main group ($\chi 2$=7,989; df=3; p=0.047) (Fig. 5).

It should be noted that in this study, due to the initial clinical introduction of new methods of plastic surgery of post-burn scar deformities in the face and neck, we evaluated only one stage in the comprehensive program of surgical rehabilitation of this severe group of patients. About 35% of patients, due to the prevalence of the process, generally underwent from 2 to 5 stages of plastic surgery, including the elimination of scar deformities in other areas (limbs, chest, etc.).

Thus, the introduction of an improved method of taking a full-layer skin graft and plastic surgery of post-burn scar deformity in the face and neck allowed to improve the aesthetic effect of operations.

4. Conclusions

An improved method of surgical treatment of post-burn scarring of the face and neck with a free full-layer skin flap is characterized by an improvement in the quality of the graft taken, by reducing the degree of its retraction, as well as stimulation of vascularization, reducing the risk of formation of subcutaneous fluid accumulations, excluding long-term wearing of a pressure bandage, which generally contributes to a more physiological engraftment of transplanted tissues.

The use of the proposed method of taking a full-layer skin graft and plasty of post-burn scar deformity in the face and neck due to the strengthening of local reparative processes, reducing the risk of flap tension with partial suture divergence or necrosis allowed to reduce the frequency of immediate postoperative complications from 19.7% to 5.6% ($\chi 2$=5.033; df=1; p=0.025) and long-term complications from 44.3% to 20.4% ($\chi 2$=7,390; df=1; p=0.007), respectively, reduce the need for the use of hardware cosmetology from 27.9% to 13.0% and repeated surgical intervention from 16.4% to 7.4% ($\chi 2$=7.391; df=2; p=0,025).

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