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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

PROPHYLAXIS AND CORRECTION OF SOFT TISSUE DEFECTS AFTER LIPOSUCTION BY AUTOLOGOUS MESENCHIMAL STEM CELL TRANSPLANTATION

Speciality: 3213.01 - Surgery

Science: Medicine

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GENERAL CHARACTERISTICS OF THE WORK

The actuality of the subject. The appeal of the population of the world countries to aesthetic surgery is constantly increasing. Among the aesthetic surgeries used in recent years, body contour plastic, which is performed by removing subcutaneous fat tissue from various anatomical regions, is distinguished by its popularity. Liposuction is the surgical aspiration of subcutaneous fat.

The popularity of this surgical method is due to the less traumatic operation, less bleeding during the intervention, shorter rehabilitation period compared to other methods, and long lasting results[1]. In recent years, information about new technical options that increase the indications for liposuction, optimize the process of fat disintegration, prevent massive damage to blood and lymphatic vessels, and increase the effectiveness of liposuction are mentioned[2].

Ultrasonic wave liposuction began to be used to complement the shortcomings of vacuum liposuction. In this method, an ultrasound wave creates cavitation in the subcutaneous fat tissue, breaking the tissue into small sizes, and the liquefied fat is removed from the body with a low-pressure vacuum suction[3].

Ultrasound waves affect only adipose tissue and do not damage blood vessels, nerves and connective tissue elements. As a result, blood loss decreases, the frequency of complications decreases and the rehabilitation period is shortened[4].

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1 Wu S, Coombs DM, Gurunian R., Liposuction: Concepts, safety, and techniques in body-contouring surgery. Cleve Clin J Med. 2020;87(6)/367-75.

2 Alan Matarasso, Current Concepts in Liposuction, in Plastic and Reconstructive Surgery, 2018, p. 686-696

3 Al-Shamari et al., Comparative Study of Liposuction Techniques: Tumescent, Laser and Ultrasound-Assisted, 2022, p. 1-9.

4 İ.Genç, K.Findıkçıoğlu, A.Sadıoğlu, A.Erdal et al. The Effect of Ultrasonic Liposuction Enegy Levels on Fat Graft Viability, Aesthetic Plastic Surgery 46, p. 2509-2016, 2022.

According to literature data, the results of ultrasound liposuction surgery are satisfactory in 80-82% of cases[5].

After the liposuction operation, as in any operation, various complications can appear. In the early postoperative period, it is possible to encounter complications such as swelling, infection, seroma, hematoma, edema, skin necrosis, skin sensitivity[6].

What bothers patients more is the appearance of deformation, asymmetry, hyperpigmentation, skin sagging, skin wrinkling, and tissue defects that disturb body image in the long term. The occurrence of this type of permanent complications in soft tissue lowers the results of the performed ultrasound liposuction surgery and in many cases leads to corrective surgery[7].

Various treatment measures are used for the prevention and correction of deformations and tissue defects formed after liposuction surgery. Since patient satisfaction is unsatisfactory, scientific research in this field is continued. In recent years, mesenchymal stem cells (MSCs) have been widely used to restore the function of organs and tissues. They have high regenerative properties[8].

These cells have high adipogenic differentiation and can be widely used in subcutaneous adipose tissue defects.

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5 Shridharani et al. , The role of ultrasound-assisted liposuction in body contouring, 2016, Plastic and Reconstructive Surgery, vol. 138, no. 1S, p. 135S-143S.

6 Jeffrey E. Janis et al., A Systematic Review of Liposuction Complications, 2019, p. 30-35

7 Halk AB, Habbema L, Genders RE, Hanke CW. Safety Studies in the Field of Liposuction: A Systematic Review. Dermatologic Surg. 2019;45(2)/171-182.

8 Maria Concetta Fazzari and Daniele Reverberi, Mesenchymal Stem Cells: Biology, Phenotypic Heterogeneity, and Therapeutic Potency, p. 1-16. Published in Stem Cells International, 2018.

MSCs-enriched lipoaspirate improves angiogenesis through the secretion of the mentioned growth factors, and also increases the proliferation of adipocytes due to the activation of the collagenase type gene, resulting in long-term survival of the graft[9].

Thus, MSCs stimulates the revascularization of the autofat graft exposed to ischemia, synthesizes proangiogenic paracrine growth factor, vascular endothelial growth factor (VEGF), fibroblast growth factor, hepatocyte growth factor, and insulin-like growth factor.

MSCs can be obtained from many sources. The most commonly used source is red bone marrow and adipose tissue. Considering that it is possible to obtain and separate a large amount of adipose tissue through liposuction, the tissue we separate can then be widely used as a source of MSCs. As a result of mechanical crushing and centrifugation stages, adipose tissue is separated into 2 fractions: adipocytes and stromal vascular fraction (SVF). Stromal vascular fraction is heterogeneous, its composition consists of blood cells, fibroblasts, pericytes, endothelial cells, periadipocytes, etc. Also SVF is a depot of MSCs that can differentiate in different directions[10].

The purpose of the research. To evaluate the results of prevention and correction of deformity and soft tissue defects after abdominal ultrasound liposuction with autologous mesenchymal stem cell transplantation.

10. Fulvio Laurenti et al., Adipose Tissue-Derived Stromal Cells and Platelet-Rich Plasma: Stem Cell Transplantation in Aesthetic Surgery/ Stem Cells International, 2019. p. 1-12.
11. Gentile P., Calabrese C., De Angelis B. et al. Impact of the different preparation methods to obtain human adipose-derived stromal vascular fraction cells (AD-SVFs) and human adipose-derived mesenchymal stem cells (AD-MSCs): enzymatic digestion versus mechanical centrifugation. Int J Mol Sci. 2019;20(21):5471.

Tasks of research:

1. Performing abdominal liposuction with computer modeling, examining short-term and long-term results;
2. To study the histological changes in the subcutaneous fat tissue before and after liposuction and study the course of the rehabilitation process;
3. To evaluate the efficiency of autopial transplantation for the prevention of deformation and tissue defects after liposuction surgery;
4. To investigate the effect of prophylactic MSCs-enriched autopye transplantation on the results of ultrasound liposuction surgery;
5. To study the results of correction of deformity and tissue defects after ultrasound liposuction with MSCs-enriched autopial transplantation.

The object and subject of the research. In the thesis work, liposuction was performed in the abdominal area in 110 patients and the results were evaluated in a comparative manner by groups. VASER (USA) device was used as an ultrasound

device. The age range of patients varied from 18 to 63 (average age 37.31.17). Patients were divided into 3 groups. In the 1st group, the results of 40 patients who underwent ultrasound liposuction were studied, in the 2nd group, 30 patients underwent autopsy transfer to the operative field for the purpose of prevention of soft tissue defects. In the 3rd group, the results of autologous mesenchymal stem cells-enriched autologous stem cells were evaluated in 40 patients.

The main provisions defended:

- Abdominal ultrasound liposuction surgery can be widely applied as an effective aesthetic intervention method, and better body beautification can be achieved after computer modeling.
- The results of histological and immunohistochemical studies conducted after ultrasound liposuction showed an increase in collagen and elastin fibers, an increase in proliferative activity in small-diameter vessels, an increase in tissue immunity and regenerative activity of connective tissue components.

- For the prevention of post-liposuction deformation and tissue defects, 50-100 ml autopial transfer was effective and reduced the number of complications.
- Autopial transplantation enriched with stem cells for the purpose of prevention minimized the number of complications that disturb the body contour after liposuction, good and sufficient results were achieved in 93.9±2.28% of patients.
- Deformation and tissue defects after ultrasound liposuction can be eliminated by autologous stem cell-enriched autologous transplantation in 88.2±3.07% of cases, and it has become an effective treatment method.

Scientific innovation. Ultrasound liposuction on the front wall of the abdomen was carried out by computer modeling, the causes of postoperative complications, frequency of occurrence, correction methods and rehabilitation issues were widely investigated. For the first time, autopial tissue transplantation enriched with mesenchymal stem cells was applied in the prevention and correction of tissue defects after liposuction. At the end of the liposuction operation, the injection of MSCs -added autopia tissue into the donor area reduced the number of complications, especially tissue defects, and improved the results. In correction of complications such as deformity and asymmetry, autopial transplantation enriched with MSCs has been an effective treatment method. This method has shown a positive result, and it has been revealed that in the future it can be widely used as a new direction to eliminate the negative consequences of liposuction, reduce the number of complications, and obtain more beautiful aesthetic results.

The practical significance of the research. In the study, the effect of the subtleties of the surgical technique of ultrasound liposuction on the aesthetic effect, occurrence of complications, and the rehabilitation period was studied. In order to achieve better aesthetic results, computer modeling was performed before the operation, and liposuction was performed according to the obtained orientations. In order to determine the volume of intraoperative blood transfusion, hemoglobin according to a special formula was

determined in the aspirate, which ensured timely hemotransfusion. Autopial transplantation enriched with MSCs has been an effective method for the prevention and correction of deformations and asymmetries that disturb the body contours after ultrasound liposuction and improved the aesthetic results. The principles and rules of using wire scalpels and autologous MSCs-enriched autopial tissue for correction in unsatisfactory patients have been developed.

Approval of research. The main provisions of the dissertation were presented at 5 scientific-practical conferences.

The initial defense of the dissertation was held at the extended meeting of the staff of the I Department of Surgical Diseases of the Azerbaijan Medical University (04.07.2023, protocol No. 11) and at the meeting of the Discussion Council of the Azerbaijan Medical University, which held scientific seminars on the specialty 3213.01- "Surgery" (28.12.23- year, protocol No. 3) was discussed.

Application of research results to practice. The results of the research are applied in clinical practice at the I Department of Surgical Diseases of Azerbaijan Medical University and the surgery department of Medera Hospital.

Publications on dissertation material. 13 scientific articles and theses were published on the subject of the dissertation (7 articles, 6 theses), including 5 speeches. Among them, 5 articles and 4 theses were published in local press, 2 articles and 2 theses were published in foreign press.

Size and structure of the dissertation. The dissertation is presented in the form of computer-compiled text on 175 pages (209765 c.) and consists of introduction (7618 c.), chapter I - literature review (63085 c.), chapter II - research materials and methods (26560 c.), chapter III (33297 c.), chapter IV (36334 c.), chapter V (12808 c.), conclusions (26845 c.), results (1220 c.), and practical recommendations (1998 c.). 213 sources are included in the bibliography list.

MATERIALS AND METHODS OF RESEARCH

The research was conducted based on the results of examination and treatment of 110 patients who underwent ultrasound liposuction. The patients underwent inpatient treatment at Medera Hospital during 2018-2022, and all of them underwent liposuction surgery on the front wall of the abdomen. Depending on the goal, patients were divided into 3 groups.

Group I - the results of the treatment of 40 patients who underwent liposuction were studied.

Group II - autopial tissue injection was used for the prevention of soft tissue defects at the end of liposuction surgery in 30 patients.

Group III - the results of prophylactic autologous mesenchymal stem cell transplantation after liposuction were evaluated in 40 patients.

The average age of women was 35.0±0.663, and that of men was 38.0±0.85 ($t=2.98$; $P<0.01$). Interventions were performed intravenously and under general anesthesia. First, subcutaneous adipose tissue was infiltrated with Klein's solution (0.9% NaCl 1 liter, 1% lidocaine 50 ml, 1 ml 1:1000 epinephrine, 10 ml 8.4% NaHCO3) through an injector cannula at 100-300 ml per minute. Disintegration of adipose tissue was performed with a titanium probe with a diameter of 3-5 mm. A piezoelectric ultrasound generator - a handpiece - was attached to the support of the probe, through which the ultrasound was transmitted to the titanium probe. After 5-10 minutes of ultrasonic treatment of fat tissue, vacuum suction devices with a pressure not higher than 0.5 atm were used to remove the fat emulsion formed and to perform the final correction of body contours. In this case, it was appropriate to use a thin (3 mm) cannula. At the end of the operation, the incision lines were drained, sutured with 4\0 polypropylene monofilament sutures. The skin is fixed with a special hypoallergenic patch. For 4 weeks after the intervention, patients wore a special compression garment all day.

Preoperative examination, intraoperative monitoring and postoperative observation were performed in all patients included in the study. Examinations were carried out in the pre-operative period to clarify the diagnosis and determine the indication for ultrasound liposuction. Due to the relatively long duration of the operation, all risk factors were taken into account due to the type of anesthesia performed. The results of clinical-laboratory and sometimes specific examinations were evaluated.

Examinations such as collection of anamnesis, examination, laboratory analyzes of blood and urine (general analysis of blood, extended biochemical analysis of blood, coagulogram, determination of electrolytes in blood, determination of hepatitis markers, HIV, Treponema Pallidium, blood group, general analysis of urine), ECG, R-scopy of the chest were carried out in the pre-operative period. If any somatic pathology is suspected, the examination plan is expanded, and a consultation with a specialist in the appropriate field is conducted. USM of ten abdominal walls and lower peripheral veins was performed in all patients. Since venous pathology is common in patients with a high body mass index, thromboembolism prophylaxis was applied.

The conversation with the patients in the pre-operative period plays a big role in conducting the selected operation. The main issue was the preliminary discussion of the outcome of the operation. The use of computer modeling of the results during the planning of the preoperative intervention is of great importance. At the same time, the patients were informed about the general and local surgical complications that may occur after the operation, as well as the treatment of these complications. All patients were introduced to the informed consent and their signatures were obtained. One of the other important points is taking photos of patients in different periods before and after the operation, objectifying the results obtained.

Intraoperative monitoring was carried out as part of anesthesiology measures.

Postoperative control was carried out by monitoring the general somatic condition of the patients and the progress of the

wound process. Histological examination of skin-fat flaps was performed to evaluate the morphological changes in the subcutaneous adipose tissue. The material was removed immediately after the liposuction surgery, and 1 month after the surgery by dermolipectomy with local anesthesia.Ultrasəs liposaksiyasında baş verən qanitirməyə qiymət vermək üçün əməliyyat zamanı alınmış aspiratda hemaqlobinin miqdarı təyin olunmuşdur:

$$V= (CHb_1 \times V_{aspirat}) / (CHb - CHb1)$$

Here V – volume of blood loss; $V_{aspirat}$ – aspirate volume; CHb – concentration of Hb in peripheral blood; CHb_1 – hemoglobin in aspirate.

This method is reliable for determining the volume of blood lost during liposuction surgery and ensures timely replacement hemotransfusion.

The volume of aspirate removed during liposuction surgery varied. The table below shows the amount of fat excreted by group (Table 1).

Table 1.

Volume of aspirate removed by groups.

Aspirate volume	I group	I group	II group	II group	III group	III group
	Mandatory	%±m	Mandatory	%±m	Mandatory	%±m
100-2000	8	20.0±3,81	9	30.0±4,37	10	25.0±4,13
2000-4000	22	55.0±4,74	14	46,7±4,76	20	50.0±4,76
4000-6000	7	17,5±3,62	6	20.0±3,81	6	15.0±3,40
6000-8000	2	5,0±3,44	1	3.3±1,70	3	7,5±2,51
>8000	1	2,5±1,49	-	-	1	2,5±1,49
Total	40	100,0±0,0	30	100,0±0,0	40	100,0±0,0

As shown in the table, the volume of extracted aspirate varied from 100 ml to 8200 ml. In the vast majority of patients - 56 patients (50.9±4.77%) from 2 to 4 liters of fat were removed. Up to 2 liters of

aspirate in 27 patients (24.5±4.15%), 4 to 6 liters of aspirate in 19 patients (17.3±3.61%; t=5.62; P<0.001), and more than 6 liters of adipose tissue in 8 patients (7.3±2.48 %; t=8.12; P<0.001) were aspirated. Such a lot of fat removal is due to the fact that the patients are overweight on the one hand, and on the other hand, surgery is performed in the abdominal region, where excess fat accumulation is more than in other regions.

Before and after the operation, ultrasound examination was used to study the state of the tissues of the operation area. The structure, thickness, asymmetries of the subcutaneous fat tissue, distribution of autopyo and autopyo transplant enriched with stem cells, development of connective tissues, seroma, hematoma, skin condition were studied. USM was performed before surgery, 1, 3, 6, 9 and 12 months after surgery.

The results of the treatment applied to the groups were evaluated in the early and long postoperative periods. The following criteria were used for evaluation: symmetry of the operation area, palpable scar changes of the subcutaneous fat tissue, contours of the operation area, sagging and quality of the skin (color, texture, thickness - "pinch" test). Symmetry and contours of the operative region were determined based on the analysis of external view, USM and photographs taken in different situations. By palpation, soft tissue hardening, skin elasticity and mobility were checked in the intervention area. Detection of light sliding movements during palpation was accepted as a successful indicator of autotransplantation.

Subjective evaluation of the results of the treatment depended on the level of patients' satisfaction. The degree of satisfaction with the operation was studied based on the questionnaires given to them. In the questionnaire, the results of the treatment were evaluated as sufficient, good and insufficient. The results of the questionnaires collected from patients in groups were collected and the effectiveness of the performed liposuction was evaluated.

Computer modeling was used to determine the exact indications for ultrasound liposuction and to discuss the results of

surgical treatment with the patient and make the final decision. Usually, liposuction was performed taking into account the acquired knowledge and skills, the concept of beauty, and the patient's wishes. However, body contours were not processed in the same order, each patient was treated individually. Dissatisfaction with the contours of the patient's body was revealed mostly during the analysis of computer images and photographs. In this regard, the final decision agreed with the patient was made by making changes in the photographs or conducting computer modeling of the appearance. The application of computer modeling during ultrasound liposuction is a modern method that allows predicting the postoperative results of body contours. This method clearly shows patients the results that liposuction can give, and allows them to make the final decision correctly. And the surgeon gains an orientation to fulfill the patient's wish.

The statistical processing of the research was carried out using the "SPSS STATIC 20" program. In all cases $p<0.05$, the difference between groups was considered statistically significant.

RESEARCH RESULTS AND THEIR DISCUSSION

Only ultrasound liposuction of the abdomen was performed in 40 patients included in group I. Group I constituted the control group and the results of the treatment were compared with this group. The age of the patients under control was between 18-63 (37.3±1.17). The majority of patients were in the period of working capacity, and patients in all groups were mostly between 31-40 years old (45.5±4.75%). At the same time, the number of patients in the 21-30 age group was not small, it was 35 people (31.8±4.44%). The number of patients over 50 years old was noticeable, 6 people (5.5±2.17%) happened. In each group, 1 patient was male (2.7±1.54%), and the rest were female.

As with other aesthetic operations, the evaluation of results after ultrasound liposuction was carried out as follows: early postoperative and long-term postoperative results. Early postoperative outcomes were studied according to the progress of the healing process

and the presence of postoperative complications. The final aesthetic results were evaluated as distant postoperative results. Early postoperative complication was observed in 26 out of 40 patients (65.0±7.54).

In 4 (10.0±4.74%) patients, suppuration of the surgical wound occurred. In 2 patients, the subcutaneous area was drained, washed with antiseptics, and massive antibacterial treatment was performed. Seroma was noted in 11 patients (27.5±7.06%). The treatment of these complications was very difficult and was canceled after several punctures. In order to assess external satisfaction in 20 patients of group I, the amount of hemoglobin in the aspirate separated during ultrasound liposuction was studied by the method proposed by us. During ultrasonic disintegration of adipose tissue, the amount of hemoglobin in the aspirate did not exceed 3.3 g/l, on average it was 2.24±0.208 g/l ($p<0.01$).

A number of aesthetic changes were detected in 18 (45%) of group I patients 1 month after ultrasound liposuction (Table 2).

Table 2.

Complications in the long postoperative period in group I patients.

Criteria indicating the postoperative course	Number of patients	
	Mandatory	%(P±m)
More or less removal of fat	1	2,5 ±1,47%
Skin sagging	4	10,0±4,74%
Hyperpigmentation	4	10,0±4,74%
Subcutaneous fibrosis	9	22.5±3.98%
There was no aggravation	22	55,0±7,87%
Total	40	100,0±0,0%

These deviations are grouped as temporary and permanent changes, which are sometimes easily and sometimes difficult to correct. Among the temporary aesthetic changes, skin hyperpigmentation was found in 4 (10.0±4.74%) patients, and subcutaneous fibrosis was found in 9 (22.5±3.98%) patients. Solidifications were formed as an aseptic infiltrate in the places of adipose tissue destruction. Permanent aesthetic changes were found in 9 patients (22.5±3.98%). Of these, 4 (10.0±4.74%) patients had excess skin that expanded and formed folds after liposuction. In two patients with already formed skin, 3-4 months after liposuction, skin-subcutaneous fat folds were cut and removed. Two patients refused the proposed operation.

Another aesthetic defect that required additional surgery was asymmetric removal of excess subcutaneous fat on the anterior abdominal wall. Such a case was found in 1 patient (2.5 ±1.47%). 6 months after liposuction, excess adipose tissue duplicates were removed by liposuction, and tissue defects were eliminated by autologous mesenchymal stem cell-enriched autologous transplantation.

Long-term results after ultrasound liposuction were evaluated at 1 month to 3 years. At this time, the aesthetic effect achieved over time has been focused on. Out of 40 patients included in group I, 36 had long-term results, and 4 patients refused further examination and photography and did not come to examinations.

When objectively evaluating the results of the operation, the results of USM and histological examination of the state of the subcutaneous fat tissue 1, 3, 6, 9, 12 months after the operation were taken into account. Results from liposuction were rated as good, sufficient, and insufficient (Figure 1).

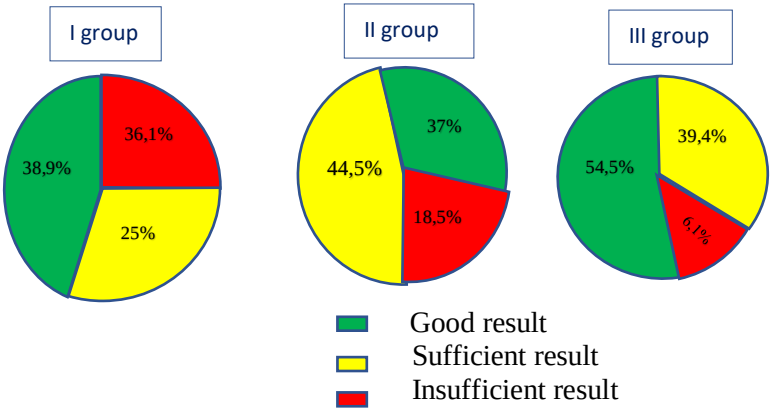

Figure 1. *Comparative assessment of long-term outcomes in patients by group.*

Thus, there were no postoperative complications in patients with good results. The obtained aesthetic results coincided with the expected results during computer modeling. The liposuction area became symmetrical, smooth contoured, the subcutaneous fat tissue was noticeably reduced, the skin was fully plumped, there was no bumpiness, no skin relief was disturbed, no skin discoloration was noted, and body contours were improved. At the same time, postoperative scars were less noticeable, light-colored, without pigmentation, without hypertrophy, without keloids, and there was no tension in that area. Patients were completely satisfied with the result.

Patients who achieved a sufficient result were satisfied with the operation, minor changes were not a problem. Although serious complications were not noted, secondary deformations of body contours were found, which required additional correction to obtain an optimal aesthetic effect. Some patients agreed to the correction, while others ignored these complications and refused the correction. In patients with satisfactory results, the elasticity and turgor of the skin in the liposuction zone were not complete, there were skin wrinkles in some areas, excess skin remained, and some skin color changes were noted. In some patients, the post-operative scar was somewhat firm on

palpation, tended to hypertrophy, and local signs of stretching were noted.

In patients with insufficient results, there was no improvement in the body contour, unevenness and deformations were observed in some areas. Bad results after liposuction on the anterior abdominal wall were mostly due to the operation not being performed according to the instructions. Patients strongly objected to abdominoplasty and preferred liposuction. As a reason, some stated that they did not want the scar left after abdominoplasty, while others stated that they were afraid of the difficult rehabilitation of abdominoplasty surgery. At the same time, the hematoma and seroma formed after the operation also caused aesthetic complications. Both the patient and the doctor confirmed the same opinion and noted the need for additional corrective intervention. Some patients underwent correction once and some patients twice to correct the complication.

In order to prevent complications after ultrasound liposuction, 30 patients in group II underwent autopial transplantation at the end of the operation. So, before starting liposuction, 100-200 ml of adipose tissue is taken dry from the patient's abdomen and cleaned by centrifugation at 3000 rpm for 3 minutes with the help of a laboratory technician. After centrifugation, 3 fractional masses are obtained. The upper layer is "fatty" and consists of fat released from disintegrated adipocytes. Cleaned adipose tissue is collected in the middle layer. This is the layer we need for autotransplantation. The lower layer consisted of erythrocyte mass, tumescent solution and other mixed elements. In this method, 50-100 ml of pure adipose tissue was obtained for autotransplantation from 100-200 ml of aspirated lipoaspirate. After liposuction, the obtained autograft was injected into the surgical area and evenly distributed, trying to spread the adipose tissue to the entire recipient area in order to increase the contact area. The skin of the recipient area was manually palpated to ensure equal distribution and non-aggregation of adipose tissue, preventing deformation (Figure 2).

a) b)

Figure 2. *Autofat transplantation.*
a) Autofat tissue injection
b) uniform distribution of autofat tissue by manual palpation

In 27 (90.0%) of 30 patients included in the II group, it was possible to follow the long-term results. 3 patients did not come to the call. When evaluating long-term results, special attention was paid to the condition of the skin in the liposuction area, the degree of reduction of the subcutaneous fat layer, the degree of smoothness of body contours, symmetry of regions, and the condition of postoperative scars.

Good results were noted in 10 patients (37.0%) (Figure 1). The aesthetic results obtained in these patients coincided with the results of computer modeling in the preoperative period. Sufficient results were recorded in 12 patients (44.5%). Although the expected results were not fully obtained, no serious complications were found in the operation area and body contours. The occurrence of insufficient results after aesthetic operations was related to the failure to achieve the results set before the operation. In patients who underwent liposuction, there was no change in the body contour, on the contrary, symmetry was lost and unevenness was observed in some areas. Such distant result was noted in 5 patients (18.5%) included in group II. Here the reasons were different.

The results of patients who underwent prophylactic autofat transfer during ultrasound liposuction showed that injection of pre-prepared autofat into the liposuction area at the end of the operation

helps to improve the final results. Thus, the number of tissue defects after liposuction decreases and the skin in the operation area recovers better. At the right dose and following the correct technical conditions, autofat transfer has improved the results of especially large-volume ultrasound liposuction.

In histological evaluation, proliferative activity increased by 65.0% in small-diameter vessels, 40.0% in medium-diameter vessels, and 20.0% in large-diameter vessels. It was confirmed morphometrically that the level of collagen fibers increased by 26.0% and elastin fibers by 25.0%.

Thus, in order to improve the results of ultrasound liposuction and reduce the number of complications, group II patients underwent prophylactic auto fat transfer at the end of the operation, better results were obtained compared to the control group. Fat transplantation is successfully used in many areas of plastic-aesthetic and reconstructive surgery. The method is simple, universal, easy to adapt biologically, and causes less pathological changes in the transplanted area. Adipose tissue is used to increase soft tissue volume and function after trauma, after thermal and radiation damage, in the correction of congenital and acquired defects, and aging. However, the use of auto fat grafting is somewhat limited due to the fact that the graft does not remain stable for a long time. So, over time, 20-80% of the auto fat graft remains and functions. The addition of autologous mesenchymal stem cells (MSCs) to the autologous tissue used to overcome this deficiency is of great interest and improves graft survival. Thus, MSCs stimulates the revascularization of the autopiyal graft exposed to ischemia, synthesizes proangiogenic paracrine growth factor, vascular endothelial growth factor (VEGF), fibroblast growth factor, hepatocyte growth factor, and insulin-like growth factor. MSCs-enriched lipoaspirate improves angiogenesis through the secretion of the mentioned growth factors, and also increases the proliferation of adipocytes due to the activation of the collagenase type 1 gene, resulting in long-term survival of the graft.

In order to prevent complications after ultrasound liposuction, especially tissue defects that distort body contours, in 40 patients

included in group III, at the end of the operation, MSCs-enriched auto fat was injected into the liposuction area. Auto adipose tissue was obtained in a volume of 200-300 ml from the part below the navel on the anterior abdominal wall before liposuction. During the preparation of MSCs, a mechanical method was used, no enzymes or chemicals were used, the structure of adipose tissue was not changed, and adipocytes were not damaged. Adinizer knife system - Smart Kit Basic with CE mark and ISO 13485 certificate was used in the research work. The stromal vascular fraction (SVF) was obtained mechanically and used as a MSCs cocktail. Approximately 12 ml of SVF cocktail was obtained from 60 ml of lipoaspirate. SVF cells included in the cocktail were counted by nanocytometry. According to the results obtained during nanocytometry, there were 800,000-1,200,000 (on average 1 million) SVF cells in 1 ml of SVF cocktail. The composition of the cocktail is heterogeneous, in addition to MSCs, the SVF cells named in the previous chapters are also included in the cocktail. It is impossible to accurately measure how much MSCs is in a given volume. The concentration of MSCs in the cocktail depends on a number of individual characteristics, such as the patient's age and health. An average of 12 ml of the SVF cocktail we obtained was added to purified auto adipose tissue, which we kept aside under sterile conditions. At the end of the operation, it was distributed to the abdomen as a preventive measure.

In the patients who underwent auto fat transplantation enriched with prophylactic stem cells, both the early and the long term course of the postoperative period were studied, complications were detected in time, and treatment measures were taken. Early postoperative complications were observed in 10 (25.0%)out of 40 patients.

Seroma at the surgical site was found in 4 (10.0%) patients. A hematoma was noted in 1 (2.5%) patient. The volume of seroma and hematoma was monitored with the help of USM, and if it was too large, the content was emptied by puncture. 2 patients needed repeated puncture. A fluid collection and a blood collection were requested in all cases. 2 people (5.0%) had a postoperative wound infection.

28 patients of group III had no complications in the long term (Table 3).

Table 3.

Complications in the long term in group III patients.

Criteria indicating the postoperative course	Number of patients	
	Mandatory	%(P±m)
More or less removal of fat	2	5,0%
Skin sagging	2	5,0%
Hyperpigmentation	3	7,5%
Subcutaneous fibrosis	5	12,5%
There was no aggravation	28	70,0%
Total	40	100,.%

After liposuction, the formation of excess skin and skin folds was observed in 2 (5.0%) patients. Both patients were over 50 years old, and the volume of the performed liposuction was large, so the skin was left over. When group III was compared with groups I and II, excess skin formation was less. This happened due to auto fat transfer enriched with MSCs at the end of ultrasound liposuction. Another change in body contouring after ultrasonic liposuction was asymmetry, skin roughness, which was observed in 2 (5.0%) patients. One of them has excess fat tissue, and the other has a hole in the skin. 33 (82.5%) of 40 patients who underwent prophylactic stem cell-enriched auto fat transplantation were kept under long-term follow-up and complications were assessed.

In addition to clinical evaluation, histological and USM examination of the surgical site was also performed. In the study, histological changes of tissue structures before and after liposuction were compared. For the first time, changes in tissues after auto fat transplantation enriched with stem cells were studied, lymphocyte groups, CD79 (alpha) and CD8 lymphocyte groups were detected by

immunohistochemical method during the rehabilitation period, the components of the microcirculatory network and the percentage of fibrous tissue structure were studied. In morphometric calculation, 68.0% increase in small vessels, 37.0% in medium-diameter vessels, and 20% in large-diameter vessels were observed. Before the operation, the level of collagen was 9.0%, and the level of elastin fibers was 15.0%. 1 month after liposuction in group I patients, collagen was 24.0%, and elastin fibers were at 23.3%, compared to group III patients, it was confirmed morphometrically that the level of collagen fibers increased by 29.8%, and elastin fibers by 27.0%.

In 18 patients (54.5%), the long-term results were evaluated as good (Figure 1). In these patients, deviations in body contours were not noted, excess fat accumulations, asymmetry were not noticeable. The results of the performed examinations, photography, and comparison with computer modeling confirmed the good result, there was no need for correction, and the patients themselves showed that they were satisfied with the operation (Figure 3).

Figure 3. *View of a patient who underwent MSCs-enriched autofat transfer*
a) before surgery
b) 6 months after surgery

There were 13 patients (39.4%) whose long-term results were sufficiently recorded. In most cases, liposuction surgery brings patients to their dreams. However, in some cases undesirable results are noted. In the distant period after the operation, tissue defects that distort the contours of the body appear. Of these, skin unevenness, asymmetry, and scar-related deformations are more common. The basis of these complications is the wound formed after liposuction. Complications that occurred in 4 out of 40 patients (10%) caused a permanent aesthetic change.

Abnormalities in the healing process of this wound defect after liposuction distort body contours and cause tissue defects. As a result, there is a need for additional aesthetic correction in patients with these complications. For this purpose, we used the method of separating subcutaneous fat tissue into layers and lipofilling enriched with autologous mesenchymal stem cells to eliminate tissue defects.

The method of cutting the subcutaneous tissue with a wire scalpel was applied to correct scar deformation and stretch marks formed after liposuction. A wire scalpel is a rigid, non-twisting surgical instrument with a diameter of 0.05-0.5 mm, one end of which is attached to a handle, and the other end of which is attached to a long needle. Currently, scalpels of this type are produced by the "Artos" company (Russia).

Removal of scar stretching and deformations with the help of a wire scalpel is an easy and convenient method. Sometimes it can be done on an outpatient basis. However, complications are possible in rare cases. Bleeding and hematoma formation in the subcutaneous tissue are more common. In order to prevent this complication, the depth of the incision to be performed in the subcutaneous layer should be chosen correctly. At the same time, the anatomical features of the skin and subcutaneous fat tissue, especially the location of the vessels, should be taken into account. The reason for the complications is that the space created after the method is filled with a mixture of a certain amount of blood and fluid injected for infiltration, and over time it is replaced by fibrous tissue. This method was performed in patients with soft tissue defects who did not want MSCs-enriched autopsy

transplantation. The method has been assessed as financially appropriate and sufficiently effective.

Because permanent tissue defects were formed in 17 (15.5%) of 110 patients who underwent ultrasound liposuction, correction was performed by MSCs-enriched auto fat transplantation. In this group of patients, the surgical field was large and the volume of extracted aspirate was more than 3 liters. As a result, contour deformations and tissue defects were formed. MSCs-enriched auto fat transfer allowed to correct the mentioned complications. The difference in the method during correction is that the adipose tissue to be used is taken from the thigh area. Thus, in patients who have undergone abdominal liposuction, fibrous tissue predominates in the umbilical region, so it is unsuitable for use as a source of MSCs. The thigh area ranks second due to its richness in MSCs. It is for this reason that lipoaspirate was obtained using the thigh area as the donor area. Outcomes were evaluated at 1, 3, 6, and 12 months after post-liposuction contour defects were reversed with MSCs-enriched autofat transfer.

In the postoperative period, early (pain, infection, necrosis) and long-term complications (nodulation at the transplant site, remaining contour defects, incomplete recovery) were studied. It was found that 2 out of 17 patients (11.8%) had pain at the transplant site, and 1 patient (5.9%) had infection.

After conservative measures, these complications have passed. In 2 patients (11.8%), contour defects were reduced after MSCs-enriched auto fat transplantation, but it was not possible to completely eliminate them, and the mentioned treatment method - correction with MSCs-enriched auto fat transfer was needed.

Autolipofilling enriched with MSCs is a safe, easy-to-perform and effective treatment method. As can be seen from the obtained results, in 88.2±3.07% of cases, it was possible to eliminate tissue defects revealed after ultrasound liposuction. Addition of MSCs to auto adipose tissue increased the viability of transplanted tissue, reduced adipose tissue resorption, and was effective in correcting areas with soft tissue deficit and asymmetry. Since this method is performed

safely and comfortably, it can be successfully applied in other areas of plastic surgery.

RESULTS

1. Ultrasound liposuction performed after computer modeling on the front wall of the abdomen was chosen for its low trauma, few complications and lasting aesthetic effect, good and sufficient results were obtained in 75.0±4.13% (P<0.01)of cases [4,5,6,8].
2. Histological studies conducted after abdominal ultrasound liposuction showed an increase in hyperkeratosis in the multilayered epithelium, a 60.0±4.67% increase in proliferation in small diameter vessels, an increase in the amount of collagen (24.0±4.07%, t=3.06; P<0.01) and elastin (23.3±3.03%,t=2.24; P<0.05), and confirmed an increase in tissue immunity, microcirculatory network and connective tissue regenerative activity [7,11,14].
3. Prophylactic auto fat transfer during ultrasound liposuction improved the results of the operation (81.5±3.70%, P<0.01), reduced the number of post-liposuction tissue defects by 2.5±1.49% (P<0.01) compared to the control group [1,2].
4. Auto fat transfer enriched with mesenchymal stem cells has been a more effective preventive method to improve post-liposuction results and reduce contour deformations. In 93.9±2.28% of cases, the long-term results were assessed as good and sufficient [3,9,10,12].
5. Mesenchymal stem cell-enriched autofat transfer to correct contour defects after ultrasound liposuction was a safe, easy-to-perform, and effective treatment method, eliminating tissue defects in 88.2±3.07% (P<0.01) of cases [1,8,13].

PRACTİCAL RECOMMENDATİONS

1. Ultrasonic liposuction is widely used as an aesthetic operation that is easy to perform, safe and has few complications. During the

operation, the surgeon should hold the device's support and direct the tip of the cannula to the area where excess fat is collected in the hypodermis and ensure the disintegration and evacuation of the adipose tissue. In this case, liquid infiltration should be carried out sufficiently and the operation should be performed with strict adherence to technical rules.

2. To find out the amount of blood lost during liposuction, it is more appropriate to determine the hemoglobin in the removed aspirate and calculate it using the following formula:

$$V = (CHb_1 \times V_{aspirat}) / (CHb - CHb1)$$

Here V – volume of blood loss; $V_{aspirat}$ – aspirate volume; CHb – concentration of Hb in peripheral blood; CHb_1 – hemoglobin in aspirate.

This method is reliable for determining the volume of blood lost during liposuction surgery and ensures timely replacement hemotransfusion.

3. For the prevention of complications such as post-liposuction deformity and tissue defects, 50-100 ml of pre-prepared adipose tissue is needed at the end of the liposuction operation. After the liposuction in the donor area is complete, the autograft should be injected through the cannula, starting from the most distal part, withdrawing the cannula part by part, and ensuring even distribution with the help of hands.
4. In order to reduce the number of complications after ultrasound liposuction, especially the number of tissue defects that distort the body contours, injection of auto fat enriched with mesenchymal stem cells into the liposuction area at the end of the operation has been an effective prevention method. Auto adipose tissue must be obtained and prepared for transplantation in different amounts before liposuction, depending on the volume of liposuction to be sucked from below the umbilicus and stem cells in the anterior abdominal wall.
5. Elimination of body contour deformations and tissue defects after ultrasound liposuction by lipofilling enriched with mesenchymal

stem cells is an effective treatment method. In the case of large-area tissue defects, the defect is separated using a blunt cannula. In small-sized defects, lipofilling of auto adipose tissue enriched with wire scalpel and MSCs is appropriate.

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CONDITIONAL ABBREVIATIONS

MSCs - mesenchymal stem cells
VEGF - vascular endothelial growth factor
SVF - stromal vascular fraction
HIV - human immunodeficiency virus
EKG - electrocardiogram
Hb - hemoglobin

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