DOI 10.1007/s10517-018-3997-x

Comparison of Morphology of Adipose Body of the Orbit and Subcutaneous Fat in Humans

D. S. Afanas'eva[1], M. B. Gushchina[1], and S. A. Borzenok[1,2]

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 164, No. 9, pp.381-384, September, 2017
Original article submitted April 21, 2017

We compared histological structure of the orbital and subcutaneous adipose tissue. Quantitative morphometry showed that the mean diameter of adipocytes and their volume density in the orbital adipose tissue were significantly lower than in the subcutaneous fat, while volume density of vessels and elements of the connective tissue in the orbital adipose tissue was higher. Previously known and revealed here differences in the structure of orbital and subcutaneous adipose tissue do not answer the question, whether subcutaneous adipose tissue can be used for replacement of the orbital tissue deficit.

Key Words: *subcutaneous fat; lipofilling; enophthalmos; orbital fat*

The space between the eye bulb, extraocular muscles, vessels, and nerves is filled with adipose tissue, so called orbital adipose body (OAB) [3]. This structure is of specific interest due to some features [2]. OAB belongs to white adipose tissue, but differs from the adipose tissue of the body by embryonic origin [7], functions, and structure [8]. It is known that OAB significantly differs from the subcutaneous fat (SF) by the size of adipocytes, relative volume of collagen, content of endothelial cells, and quantitative density of mast cells [10,12].

Deficit of OAB leading to enophthalmos, *i.e.* displacement of the eye bulb into the orbital space, is observed during various inherited and acquired physiological and pathological states of the eye, such as senile atrophy of the adipose tissue, inherited enophthalmos, trauma or radiation injury, and anophthalmic syndrome. Autotransplantation of SF is often used in these cases for compensation of lost volume [5,9]. Thus, the histological structures of OAB and SF should be studied in accordance to the main principle of plastic surgery — like substitutes like [11].

[1]S. N. S.N. Fyodorov Eye Microsurgery Complex, Ministry of Health of the Russian Federation; [2]A. I. Evdokimov Moscow State University of Medicine and Dentistry, Ministry of Health of the Russian Federation, Moscow, Russia. ***Address for correspondence:*** ada-tomsk@yandex.ru. D. S. Afanas'eva

Here we compared the histological structures of OAB and SF.

MATERIALS AND METHODS

Specimens of OAB (n=24) from 5 male and 17 female patients aging 3-89 years were obtained during surgical repair and plastic surgery of the ocular and periocular area. OAB samples (main group) were taken from the following areas containing adipose tissue: upper internal (2 samples), upper middle and upper external (14 samples), lower (5 samples), and retrobulbar part of OAB surrounding the optic nerve (3 samples). Samples of OAB from the upper internal and upper external fatty tissue were obtained from 2 patients during cosmetic blepharoplasty.

The reference group consisted of 6 samples of SF obtained from 5 men and 1 woman aging 27-58 years. One sample was resected from the lateral surface of the hip, 5 other samples were taken from the paraumbilical area.

The samples were fixed in formalin and histological sections were prepared by the standard methods; the sections were stained with hematoxylin and eosin (Biovitrum). Computer morphometry was conducted for quantitative estimation of tissue structures. The histological sections were photographed (10 random fields of view per sample) using a XC-10 digital ca-

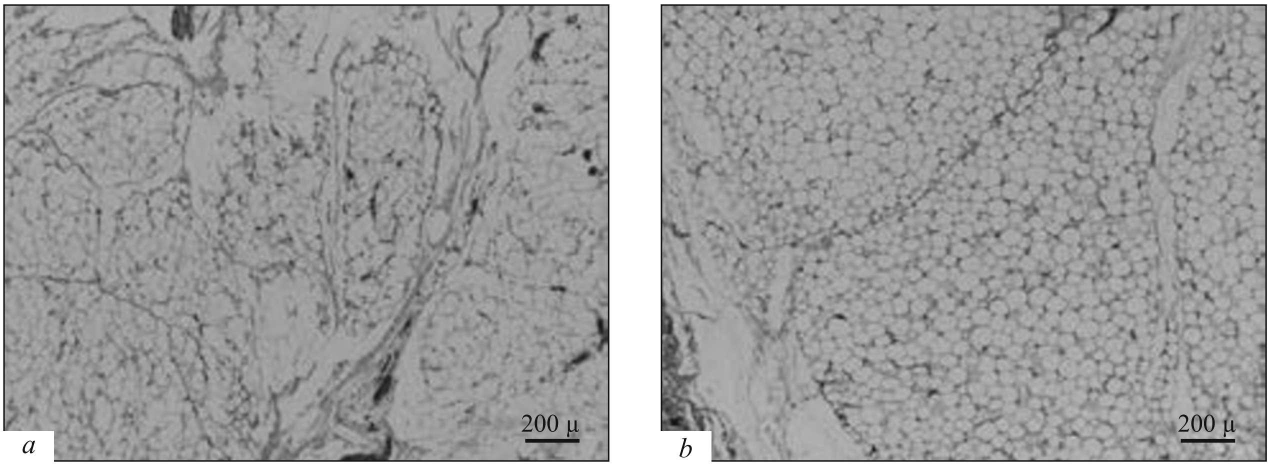

Fig. 1. Standard OAB (*a*) and SF (*b*) pictures. Light microscopy, hematoxylin and eosin staining, ×100.

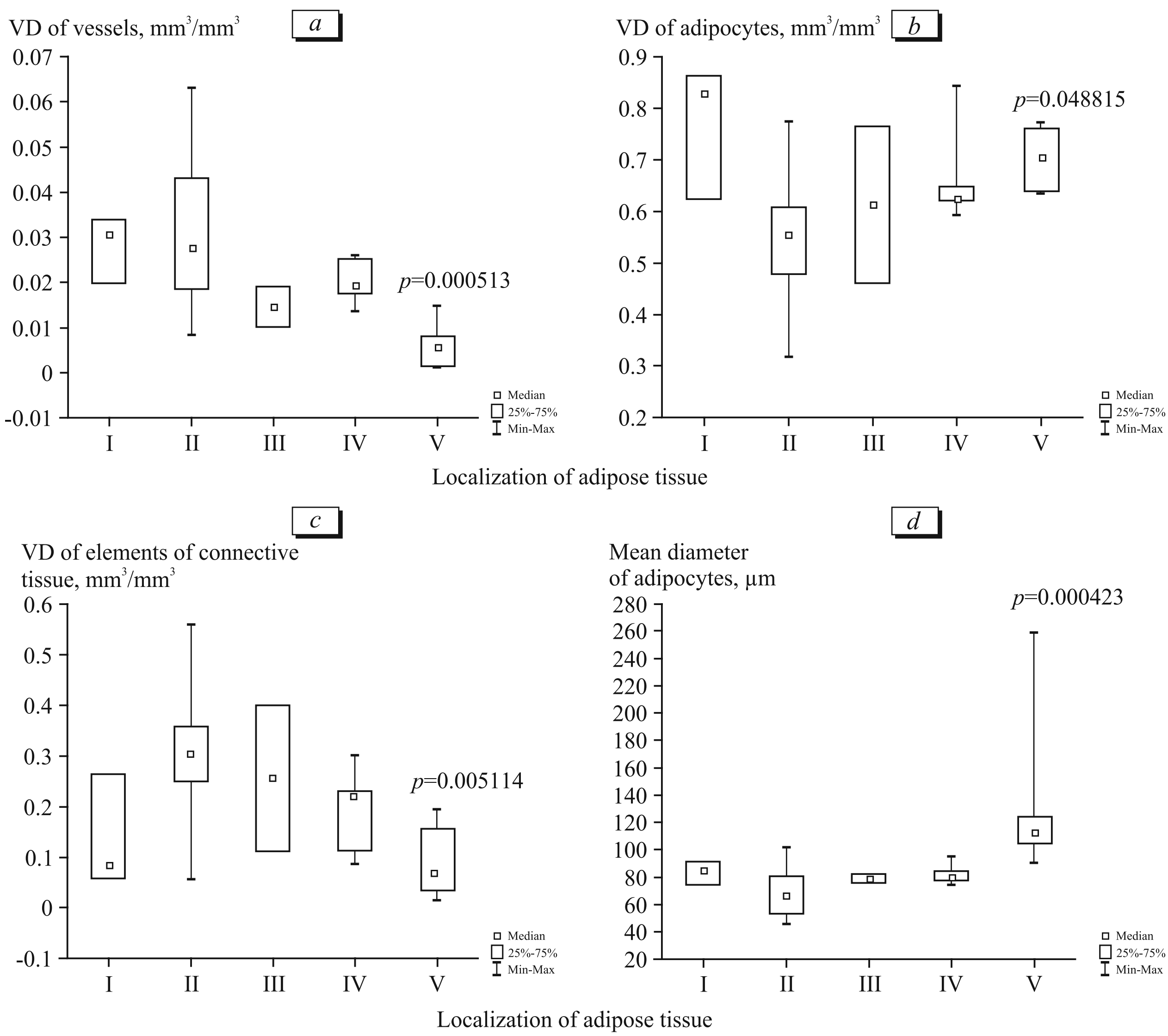

Fig. 2. VD of vessels (*a*), adipocytes (*b*), and stroma (*c*), and mean diameter of adipocytes (*d*) in OAB samples taken from the retrobulbar area (I), upper medium and external (II), upper internal (III), and lower (IV) areas of the adipose tissue and SF (V). Statistically significant differences between SF and OAB samples are presented (Mann—Whitney test).

mera integrated to IX-81 inverted microscope (Olympus). The obtained digital pictures were further morphometrically analyzed. For this purpose, the greatest diameter of 100 random adipocytes was measured in each sample using CellSens Dimension software (Olympus). Volume density (VD) of blood vessels, adipocytes, and connective tissue elements was calculated using the point estimation method [1] and Grid and Cell Counter plugins for ImageJ 1.46 software.

The data were processed using Statistica 7.0 software (StatSoft). Mann—Whitney test was used for comparison of quantitative parameters in the two groups (OAB and SF). Comparison of quantitative parameters in several groups was performed using Kruskal—Wallis test. Median and lower and upper quartiles were used for description of sample not fitting normal distribution.

RESULTS

Macro- and microscopic investigation of histological samples of the adipose tissue of various localizations showed several features of these tissues.

Fragments of SF did not significantly differ from OAB samples resected from the medium and upper lateral, lower, and perineural retrobulbar areas of the adipose tissue. All samples were described by an independent histologist as yellow or bright yellow fragments of the soft or dense elastic tissue. Only macroscopic structure of OAB samples isolated from the upper internal area of the adipose tissue differed from other samples. They had light yellow or whitish color, which is in line with published reports [4,13]. All OAB samples included in this investigation consisted of smaller lobes than SF at both macro- and microscopic levels (Fig. 1).

Morphometry was conducted during microscopy in order to estimate quantitatively the structural differences of the samples. The mean diameter of adipocytes and their VD in the OAB were significantly lower than in SF. However, VD of vessels and elements of the connective tissue in OAB was significantly higher than in SF. In turn, no significant differences in study parameters were observed between OAB samples taken from different areas (Fig. 2). Morphological differences in the samples of the adipose tissue related to gender or age of patients were also not found.

Analysis of macro- and microscopic structure of OAB and SF revealed additional differences in VD of blood vessels, adipocytes, and elements of the connective tissue. The obtained results are in line with published reports on structural differences of OAB and SF [10,12]. Due to the presence of small lobes and high content of connective tissue elements, OAB provides mobility of the eye bulb and oculomotor system. Higher VD of vessels in OAB found in our study agrees with previous data [6] demonstrating dense net of branching vessels in the forming OAB of human embryos.

Taking into account the known and revealed in our study specific features of OAB structure, we can conclude that SF significantly differs from OAB. Further investigations of the possibility of using SF for substitution of volume deficit of OAB are needed.

REFERENCES

1. Avtandilov GG. Medical Morphometry (Manual). Moscow, 1990. Russian.
2. Borzenok SA, Afanasyeva DS, Gushchina MB. Orbital Adipose Tissue: Just a Fat Pad or Terra Incognita in Ophthalmology. Vestn. Ropss. Aka. Med. Nauk. 2015;70(4):464-467. Russian.
3. Vit V. Structure of the Human Visual System. Odessa, 2010. Russian.
4. Grishchenko SV. Esthetic Surgery of Age-Related Changes of the Eyelids. Moscow, 2007. Russian.
5. Ryzhevsky DV, Pashtaev NP, Pozdeyeva NA, Trubin VV. The use of lipofilling in the treatment of post-traumatic enophthalmos. Prakt. Med. 2016;(2-1):43-45. Russian.
6. Shilkin GA, Gemonov VV, Andreitsev AN, Ivanova ZG, Kalinnikov YuYu, Shilkin AG. Embryogenesis and functions of the retrobulbar tissue and its relationship with clinical ophthalmology. Topical Issues in Pediatric Ophthalmology. Moscow, 1990. P. 154-160. Russian.
7. Ahmadi AJ, Saari JC, Mozaffarian D, Garwin GG, Tarbet KJ, Orcutt JC, Hargiss JL, Sires BS. Decreased carotenoid content in preaponeurotic orbital fat of patients with involutional ptosis. Ophthal. Plast. Reconstr. Surg. 2005;21(1):46-51.
8. Bremond-Gignac D, Copin H, Cussenot O, Lassau JP, Henin D. Anatomical histological and mesoscopic study of the adipose tissue of the orbit. Surg. Radiol. Anat. 2004;26(4):297-302.
9. Hardy TG, Joshi N, Kelly MH. Orbital volume augmentation with autologous micro-fat grafts. Ophthal. Plast. Reconstr. Surg. 2007;23(6):445-449.
10. Ilankovan V, Soames JV. Morphometric analysis of orbital, buccal and subcutaneous fats: their potential in the treatment of enophthalmos. Br. J. Oral Maxillofac. Surg. 1995;33(1):40-42.
11. Moseley TA, Zhu M, Hedrick MH. Adipose-derived stem and progenitor cells as fillers in plastic and reconstructive surgery. Plast. Reconstr. Surg. 2006;118(3, Suppl):121S-128S.
12. Onyimba C, Bujalska I, Durrani O, Abbott J, Khosla P, Moosavi A, Reuser T, Stewart P, Tomlinson J, Walker E, Rauz S. Glucocorticoid metabolic pathways in human orbital adipose tissue: a comparison with subcutaneous and omental depots. Endocr. Abstracts. 2007;13:115.
13. Sires BS, Saari JC, Garwin GG, Hurst JS, van Kuijk FJ. The color difference in orbital fat. Arch. Ophthalmol. 2001;119(6):868-871.