

M.I. Tomskiy, S. Chinti, D.G. Tikhonov, K.S. Loskutova, E.A. Isakov

Brown Adipose Tissue and Extremely Cold Climate

ABSTRACT

In the article a case of verification of brown adipose tissue was described at a patient of 54 years old, a resident of the coldest city in the world Yakutsk. The brown adipose tissue was revealed in adipose tissue samples with para-aortic, perirenal, subclavian and perityroid areas. The abdominal fat was introduced by typical white adipose tissue.

Keywords: brown adipose tissue, white adipose tissue, cold climate, histology.

INTRODUCTION

It has been widely accepted that brown adipose tissue (BAT) can be functioned only in infant organisms. However, in 2009, “The new England journal of medicine” published three articles dedicated to activity of brown adipose tissue in adult humans. The articles clearly demonstrated the existence of BAT by a method of positron emission tomography with determination of ^{18}F - fluorodeoxyglucose assimilation and intravital biopsy with immunohistochemical determination of UCP 1 protein in biopsies [3 - 5].

Brown adipose tissue activates in specific areas of the fat when animals or humans are exposed to the cold [2]. A number of researchers have found indirect evidence of activity of BAT in inhabitants of regions with extremely cold climates [1, 6]. However, despite the many indirect signs of activation of brown adipose tissue in adult residents of regions with extremely cold climates, up to date, the fact was not confirmed by histology and morphology verification of BAT. We also did not find in the Medline and Web of Science histologically confirmed cases of describing the activity of BAT in the circumpolar residents of cold regions of the globe.

In this report, we describe the first case of histologically confirmed existence of a typical brown adipose tissue at a resident of Yakutsk, died of trauma.

Yakutsk is located in the northeast of the Russian Federation. Yakutsk is an absolute record-breaker for the minimum air temperature among the cities of the world. The average annual temperature in the city is about -10°S , and in February 5, 1891 the temperature 64.4°S has been fixed.

The patient R., male, 54 years old, height 168 cm, slim complexion, was born and lived in the city of Yakutsk, had no permanent job, for the last years worked in constructing buildings. Most of time he spent working outdoors and was affected by cold temperatures.

Samples were obtained from adipose tissue in the following areas: from subcutaneous fat of the abdominal wall, from the neck, from para-aortic, and left perirenal, subclavian and around-thyroid areas [7]. From these samples histological preparations were done by a conventional standard method (fixed with formaldehyde and embedded in paraffin) (Fig. 1-3). Staining with hematoxylin-eosin.

At microscopic examination typical brown adipose tissue clusters were observed histologically in the preparations of the para-aortic and both perirenal, and subclavian regions and around-thyroid regions. In preparations of subcutaneous fat and abdominal fat only typical unilocular fat white adipocytes were found. On Fig. 2 and 3 characteristic for brown adipose tissue, compared to the white adipose tissue, histological signs are observed. Thus, on Fig. 2 adipocytes are of smaller size, and at x200 magnification it is shown that they consist of many small vacuoles, while white adipose cell consists of one large fat vacuoles (Fig. 1). On Fig. 1 histological examination shows the presence of a typical white adipose tissue, where the adipocytes have in their cytoplasmic lipid droplets in one large vacuole, and Fig. 2 and 3 show the typical histological picture of brown adipose tissue with the presence of fat in the cytoplasm of cells in the plurality of lipid droplets as small vacuoles.

CONCLUSION

It should be noted that this message is the first evidence for the presence of the brown adipose tissue in the adults living in a very cold region.

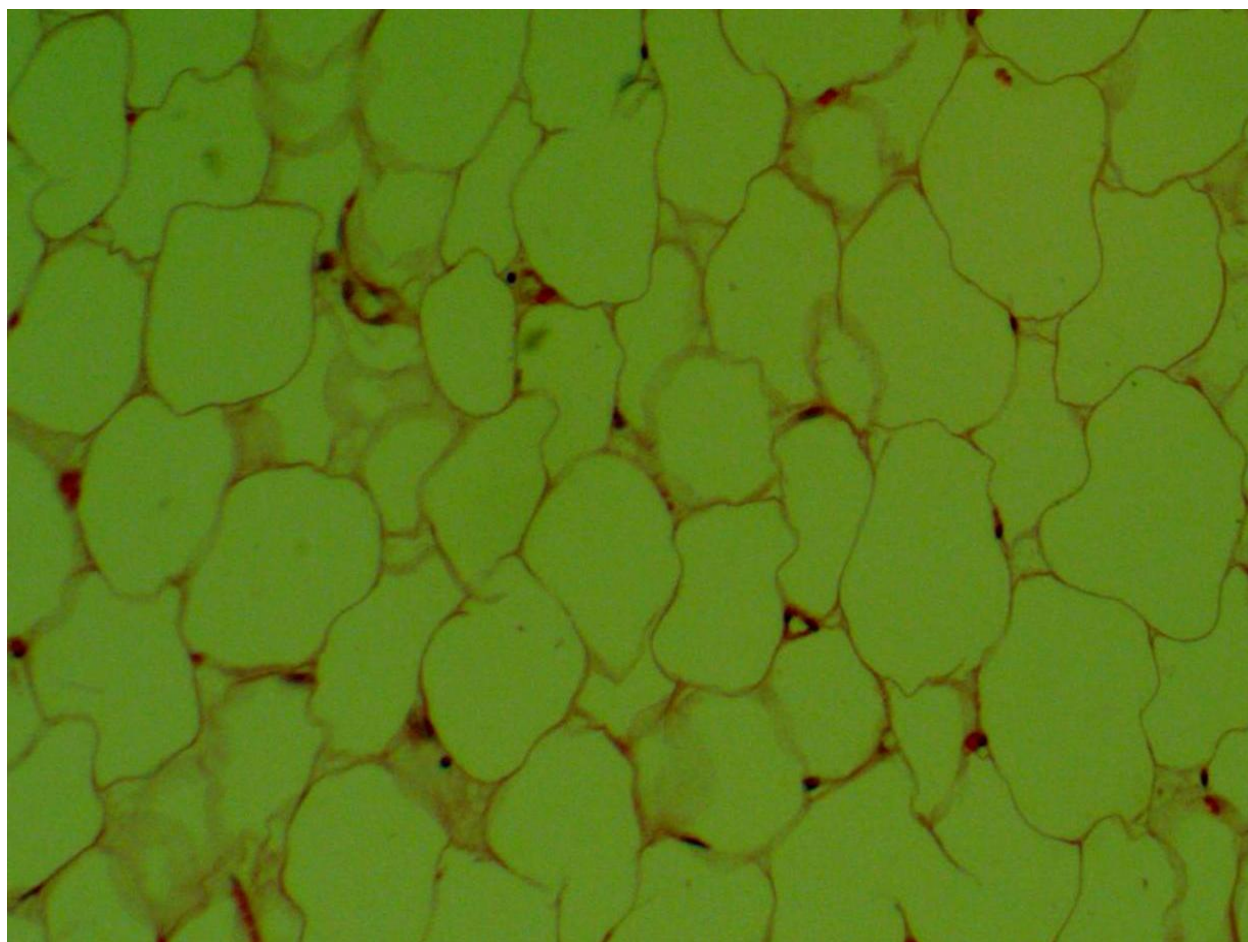


Fig. 1. Patient R., 54, a resident of Yakutsk. White adipose tissue of subcutaneous tissue. Staining with hematoxylin-eosin. Incr. x 100

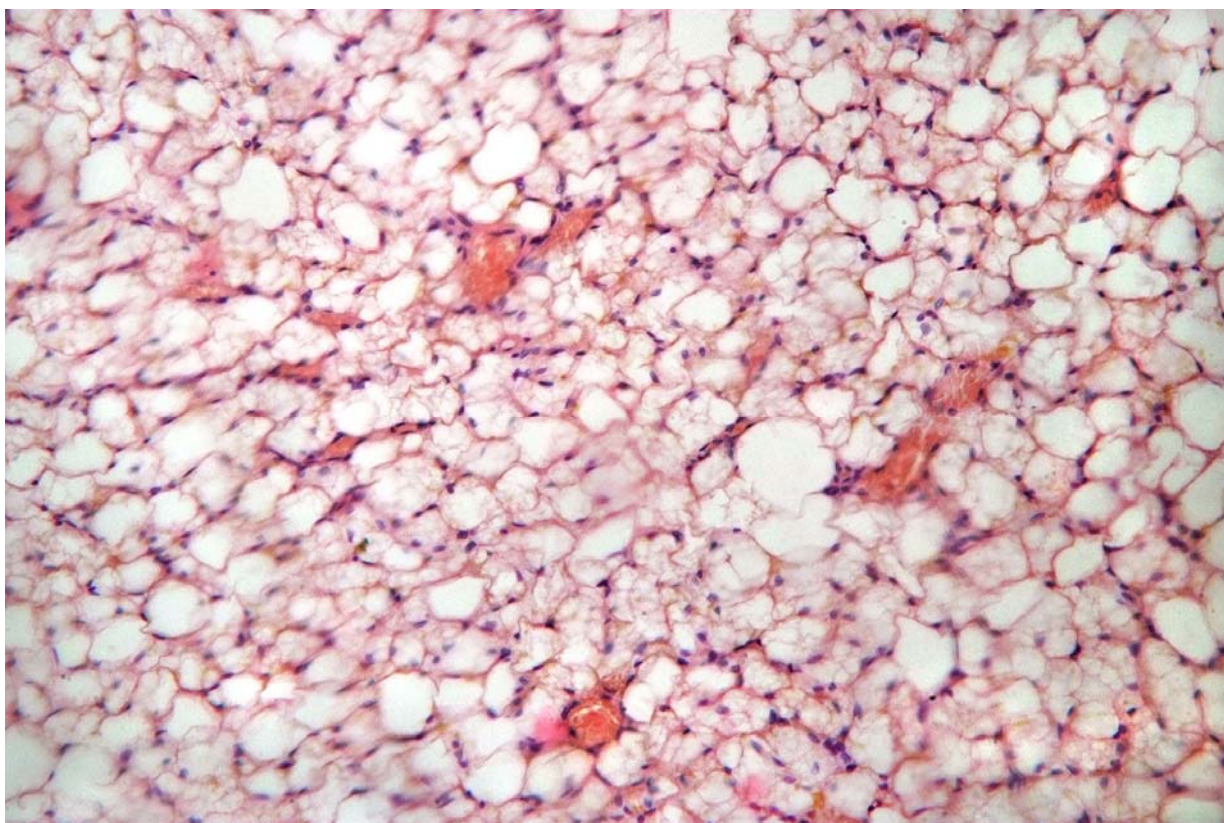


Fig. 2. Patient R., 54, a resident of Yakutsk. Brown adipose tissue of perirenal fat. Staining with hematoxylin-eosin. Incr. x 100

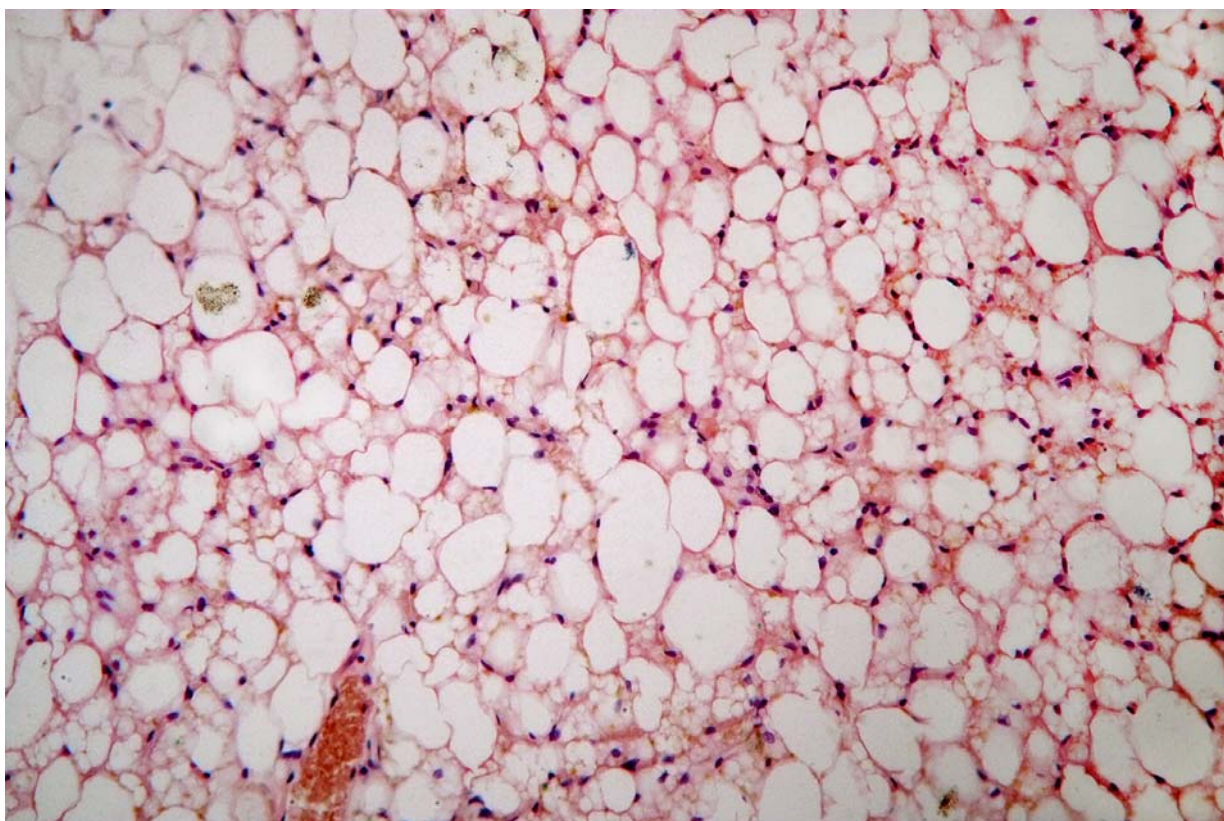


Fig. 3. Patient R., 54, a resident of Yakutsk. Brown adipose tissue from para-aortic tissue. Staining with hematoxylin-eosin. Incr. x 200

REFERENCES

1. Andersen S. Thyroid hyperactivity with high thyroglobulin in serum despite sufficient iodine intake in chronic cold adaptation in an Arctic Inuit hunter population / Andersen S., Kleinschmidt K., Hvingel B., Laurberg P. // Eur. J. Endocrinol. -2012. - 166 (3). — P. 433-440.
2. Cinti S. Distribution and development of brown adipocytes in the murine and human adipose organ / Frontini A., Cinti S. // Cell Metab.- 2010. -11 (4). — P. 253-256.
3. Cold-activated brown adipose tissue in healthy men / van Marken Lichtenbelt WD, Vanhommerig JW, Smulders NM [Et al.] // N. Engl. J. Med. - 2009. - 360 (15). — P. 1500-1508.
4. Functional brown adipose tissue in healthy adults / Virtanen KA, Lidell ME, Orava J. [et al.] // N. Engl. J. Med. - 2009 - 360 (15). — P. 1518-1525.
5. Identification and importance of brown adipose tissue in adult humans / Cypess AM, Lehman S., Williams G. [et al.] // N. Engl. J. Med. - 2009 - 360 (15). — P. 1509-1517.
6. Levy S.B. An assessment of infrared thermal imaging as an indirect method for quantifying variation in brown adipose tissue using data from the Indigenous Siberian Health and Adaptation Project / Levy SB, Leonard WR, Tarskaia LA [et al.] // American Journal of Human Biology. - 2014 . 26). — P. 270 -270.
7. The presence of UCP1 demonstrates that metabolically active adipose tissue in the neck of adult humans truly represents brown adipose tissue / Cinti S., Cannon B., Nedergaard J. [et al.] // FASEB J ..- 2009. - 23 (9). — P. 3113-3120.

Authors:

Tomskiy Mikhail Innokentievich - MD, professor, director, FGBNU "YSC CMP", Yakutsk, Russia;

Saverio Cinti - Ph.D., MD, professor of anatomy, director of the Center for the Study of Obesity, University of Ancona, Italy;

Tikhonov Dmitry Gavrilovich - MD, professor of Health Research Institute of NEFU named after M.K. Ammosov, Yakutsk; Russia

Loskutova Kyunnyay Savvichna - PhD, Head. Department of Pathomorphology RB № 1- NCM MH Sakha (Yakutia), Yakutsk, Russia

Isakov Evgeniy Andreevich. - doctor pathologist RB№1 - National Center of Medicine, HM of Sakha (Yakutia), Yakutsk, Russia.