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The Heating Value of a Different Location of Human Body Lipids

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Abstract - *Background:* Distribution character of fats can influence to emergence of different severe life-threatens diseases.Body lipids morphology is enough well investigated, but there is little data on the calorific properties of various lipids, including atherosclerotic plaque (AP).Aim of the study was to investigate the calorific properties of a human body lipids of various anatomical sites.

Methods : Trial design is a prospective randomized pilot physical experimental trial.

Adipose tissue in the amount of 252 samples from 36 individuals (17 female sex) at autopsy. The subjects were dying from various injuries and were between 36-54 years old.

Interventions: Differential scanning calorimetry («Mettler Toledo», USA) was used with an increments temperature of 10.37 °C per minute. In an experimental set up specimens were heated up from 26.0 °C to 700.0 °C for 70.0 minutes.

Keywords : *atherosclerotic plaques,lipids, calorific value, specific heat capacity, different localization.*

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Results: The heat capacity of the studied lipids decreases from AP (dense) to AP (loose), VF (omentum fat), SF (umbilical area), SF (shoulder area), SF (buttock area) and VF (pararenal fat). The dense AP (-3, 97±0,16°C) has higher a heat capacity (p=0.02) than the loose AP (-3, 44±0,15°C). The lowest thermal capacity has a pararenal fat of VF (-1, 25±0,21°C) in compare with SF (buttock area) (p=0.027).

ConclusionsIn: Conclusion, the fats of a human body have different calorific properties depending on a location. Atherosclerotic plaques carry the highest energy potential in comparison to the other body lipids. The lowest thermal capacity has pararenal fats. The results of the study suggest that an atherosclerotic plaque is not an accidental phenomenon in the body, but it is a logical pathophysiological process in result of fats compaction.

Keywords: atherosclerotic plaques,lipids, calorific value, specific heat capacity, different localization.

I. Introduction

According to numerous studies an atherosclerotic plaque (AP) is the main cause of an atherosclerotic \ diseases, and it is a non-homogeneous structural formations [1, 2]. AP shave layered structure, but they always have atheromatous masses [2, 3]. It is well-known fact that the body lipids are an origin of energy andthey have a different diversity and structure both by location and function [3, 4]. The body fats are distributed in the body throughout, for instance, in subcutaneous area, in submucosa, inside and around of parenchymatous and hollow organs. They are represented in different forms, such as saturated, non-saturated, atheromatous, etc. [5, 6]. Distribution character of fats can influence to emergence of different severe life-threatens diseases [6, 7]. Therefore, it is a scientific interest to study a heat capacity (caloric value) of the different body fat depend on a place of location. Also, there are little data on studies of the calorific properties of various lipids of the body [8, 9].The aim of the study was to investigate the calorific properties of human body lipids of various anatomical sites.

II. Study Design

A prospective randomized pilot physical experimental trial in vitro.

a) Participants

Adipose tissue in the amount of 252 samples was obtained from 36 individuals (19 males, 17 females) at autopsy. The subjects had died from various injuries and were between 36-54 years old. The autopsy material (lipids) was taken for research purposes after forensic medical examinations had been carried out. The criteria used for inclusion of material in the research were:

1. sampling was performed within 2 hours after death(interval of time between death and collection);
2. tissue donors had no chronic somatic diseases (such as cardiovascular, endocrine, cancer pathologies, etc.) prior to death,and cause of death of their was road accident;
3. every Monday (after weekend) the four tissue donors were included in the study during nine weeks ofa summer season of an year (a total of 36 tissue donors).

Removal of autopsy material was performed at the Centre for Forensic Medical Examination of the city of Almaty. Tissue was collected from 7 various locations:

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visceral fat (VF), from the omentum and paranephric regions; subcutaneous fat (SF) from the buttock area, the abdomen (umbilical region), and shoulder area; APs from the descending aorta: homogeneous AP, at the stage of smooth/dense plaque (hereafter referred to as dense), and heterogeneous AP at the stage of destruction (loose plaque).

b) Research methods

Differential scanning calorimeter («Mettler Toledo», USA) was used with an increments temperature of 10.37 °C per minute. In an experimental set up specimens were heated up from 26.0 °C to 700.0 °C for 70.0 minutes. The calorific value of lipids was determined according to the heat capacities of lipids. The greater the temperature difference between the sample (sample) and a standard (reference), the more of the heat generated, thus the higher is heating value [4,8].Heating value was determined indirectly, by measuring heat capacities of organic substances.

The more a temperature difference between the sample (sample) and the standard (reference) the more a substance releases heat [9, 10].

Statistical analysis. Student's two-t-test (with Bonferroni correction,α/2) with confidence interval (CI) were used. The study data are presented in tables as mean standard error of the mean (M± SEM), and P values of <0.025 were considered significant. Statistical analysis was performed using SPSS for Windows version 17.0 (SPSS: An IBM Company, Armunk, NY) and Microsoft Excel-2010.

III. Results

The results of the study are shown in a Table 1.

Table 1 shows that lipids from various sites have different abilities to store a heat. The heat capacity of the studied different lipids decreases in a rowfrom AP (dense) to AP (loose), VF (omentum fat), SF (umbilical area), SF (shoulder area), SF (buttock area) and VF (pararenal fat). APs have the highest heat capacity among the lipids, at once the dense AP (-3, 97±0,16°C) has higher a heat capacity (p=0.02) than theloose AP (-3, 44±0,15°C). The lowest thermal capacity has a pararenal fatof VF (-1, 25±0,21°C) in compare with SF (buttock area) (p=0.027).

For a more in depth analysis of the properties of these lipids, theheat capacity values are presented in correlation with temperature dynamics. Figure 1 shows how the properties of the heat capacity of the analyzed lipids change during of the combustion process. Thecombustion process indicates the difference between the sample t°C and the reference t°C.Figure 1 clearly shows that the atherosclerotic plaques, both dense and loose are almost below zero in the scale of t °C difference between the sample and the standard. Thisunderlies an intense absorption of the heat in the calorimeter. Thatcan indicate that the APs have a relatively higher heat capacityin comparison to other lipids. For example, in contrast to APs other lipids have relatively similar combustion characteristics: they absorbs the heat actively at approximately 200 °C, and they actively releasesthe heat starting from 300 °C to 500 °C and completely burns after 600°C.

It is interesting to note that the lipids from the omentum areahave an intermediate position between the atherosclerotic plaques and the rest of the lipids from other locations. This can suggest that the omentumfat, at least according to physical parameters of the heat capacity, are close to atherosclerotic fats, and they have a high thermal capacity as the APs.

According to the Table 1 and the Figure 1 we can conclude firstly, that all lipids have the ability to store a heat. Secondly, the lipids of various locations of the body have different abilities to store a heat. Third, atherosclerotic plaques carry ahigher energy potential in compare with the rest of the body lipids. So,thedense and loose APs have the highest heat capacity. It is known that a heat capacity of substances depends on its chemical composition, structure, and biological nature [11, 12].

IV. Discussion

The fact, that different body fats have different biophysical and biochemical properties, has also been confirmed by others [13]. The study of the mRNA expression of proteins secreted by adipocytes in the subcutaneous and visceral adipose tissue in humans have shown that visceral and subcutaneous adipocytes have different properties with regard to the synthesis of bioactive molecules [14].

Fats are energy accumulators, but not all fats are the same between themselves [15]. Triglycerides containing saturated fatty acids are main energy source in the body. The harder the fat, the greater is the content of saturated fatty acids [16, 17].

Heating value of lipids according to the chemistry rules depends on the content of saturated and branched hydrocarbon chains [18].

Appearance of APs in the body precedes transient, sometimes permanent hyperlipidemia [19]. Because of a reserve capacity of the body accumulation of APs takes some years [20, 21]. Could we guessthat genesis of APsis the result of the transformation of body fats which were not used? Despite the small volume APs intrinsically possess a high heating value. Therefore, over time a certain amount of excess fat within the body is transformed into a more compact, but energy consuming lipid. Perhaps this process of increasing density of fats is adeliberate and intentional process which is required for saving body space without loss of energy resources?

The research result revealed that the lipids of a human body have different heating capacities

depending on their location where APs have had the greatest heating capacityamong of the studied lipids. Our findings can allow to look at the nature of anatherosclerosis occurrence and development is not just from the standpoint of pathology, but itis possible to tell from the position of "physiological" changes of body fats. The results of the study suggest that an atherosclerotic plaque is not an accidental phenomenon in the body, but it is a logical pathophysiological process in result of fats compaction.This point may allow to develop new treatment methods of atherosclerotic diseasesin the future.

V. Conclusion

The fats of a human body have different calorific properties depending on a location.

The lipidsof various locations of the body (dense AP, loose AP, VF from omentum fat, VF from pararenal fat, SF from umbilical area, SF from shoulder area, SF from buttock area) have different abilities to store a heat. Atherosclerotic plaques carry the highest energy potential in comparison to the other body lipids, especially the dense APs havethe highest a heat capacity. The lipids from omentum area have an intermediate position between lipids of atherosclerotic plaque and the rest lipids from other locations.The lowest thermal capacity has pararenal fats.

Competing interests: Conflicts of interest werenotdeclared by any author.

VI. Endnotes

Study limitation. Several limitations of the study deserve comment. First, the design of the present study was experimental-based, which is susceptible to selection bias. Second, the sample size was small, limiting its ability to detect significant results. Third, the physical investigations indicated only some of organic substances, and calorific value was estimated by specific heat capacity. Fourth, the heterogeneous content of organic substances in the human fats was not analyzed in the present study. Finally, it is important to mention that our study was performed on Kazakhstan citizens, and our findings may not be relevant to people of other countries.

Trial national registration: State registration # 0109RK000079, code O.0475 at the National Center for Scientific and Technical Information, the Republic of Kazakhstan.

Trial International registration ClinicalTrials.gov NCT01700075.

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VII. Abbreviations

atherosclerotic plaque (AP)
visceral fat (VF)
subcutaneous fat (SF)
confidence interval (CI)
mean□standard error of the mean (M± SEM)

Table 1 : Values of overall heating capacities of lipids from various sites (the temperature difference between the sample and thereference)

	AP (dense)	AP (loose)	VF (omentum fat)	SF (in umbilical area)	SF (in shoulder area)	SF(in buttock area)	VF (pararenalfat)
Difference between sample and reference* (t °C)	-3,97 ±0,16	-3,44 ±0,15	-3,35 ±0,23	-2,87 ±0,44	-1,97 ±0,23	-1,81 ±0,19	-1,25 ±0,21
CI max	-3,65	-3,15	-2,91	-2,00	-1,23	-0,99	-0,49
CI min	-4,282	-3,73	-3,79	-3,73	-2,69	-2,63	-2,01

Abbreviations:
*,mean±standard error of the mean
AP, atherosclerotic plaque
VF, visceral fat
SF, subcutaneous fat
CI, confidence interval
toC, temperature measure in Celsius

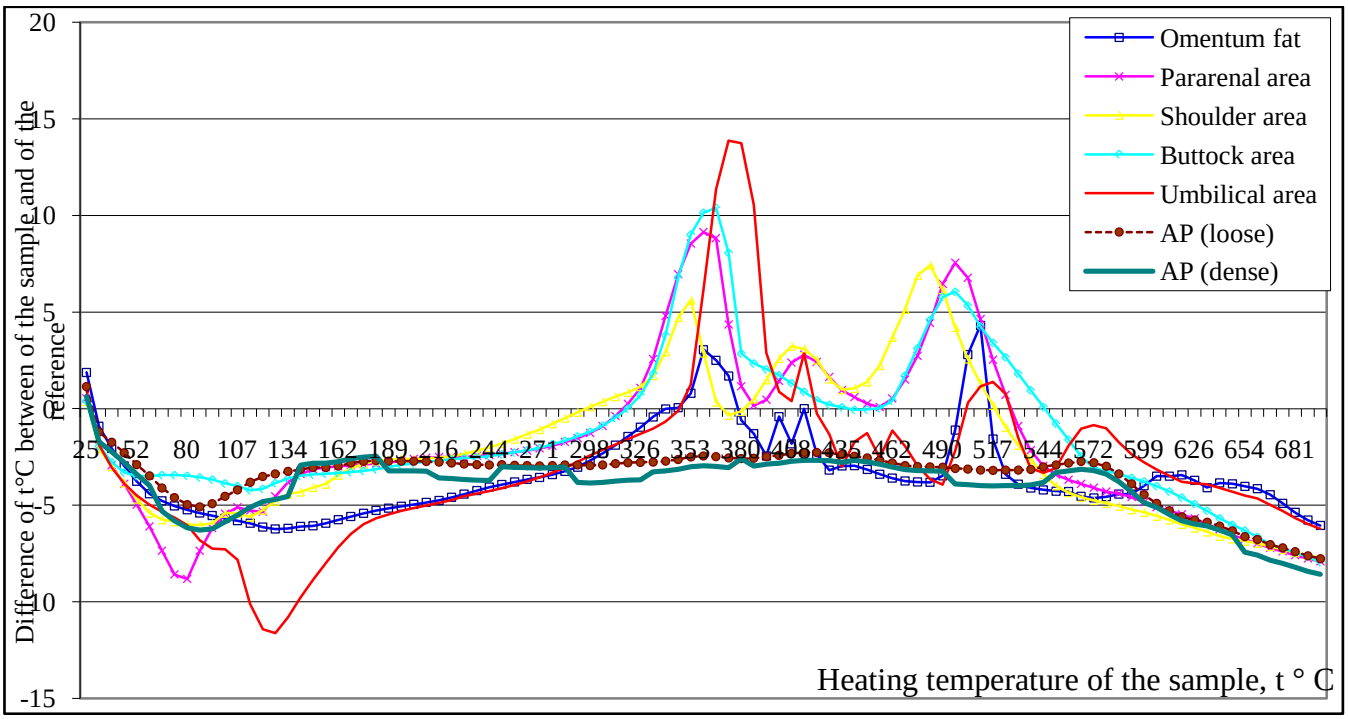

Figure 1 : Comparative values of heating capacities of the lipids with temperature dynamics between of the sample and of the reference

Abbreviations:
AP, atherosclerotic plaque
toC, temperature measure in Celsius

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