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Original Contribution

INVESTIGATION OF THE DEPENDENCE BETWEEN THE ECCENTRICITY OF THE SECTION WITH THE EQUAL TORQUE OF THE UPPER AND LOWER PART OF THE BODY AND THE BODY PARAMETERS

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ABSTRACT
Aim: To investigate the relationship between the eccentricity of the body as a function of mass, height, circumference and body mass index of the body in the section of equal torques of the upper and lower part of body. **Results:** 62 people between the age of 18 and 28 were examined. Very good correlations between the eccentricity of the equal torques of the upper and lower parts of the body and body mass, height, BMI and circumference of the body in the section were derived. We were hypothesized that the cross section of equal torques is an area in which all body movements are focused. We are considering this area as "kinetic center" of the body. As proof of the reality of this center it was point out the infrared photos of the human body. The position of the 'kinetic center' on infrared body image appears point on spinal cord with highest temperature. **Conclusions:** The obtained results can find applications in solving various scientific problems.

Key words: method, equal torques, eccentricity, body-mass index.

INTRODUCTION

In the previous study Atanasov [1] developed a method for measuring the center of gravity of the human body. It was found that the ratio between the length of upper and down parts of the body in the cross-section of the equal torques appears as an anatomical constant. Exactly, the ratio in the cross section of the equal torques of the upper (H_{up}) and down (H_{down}) bodily parts is equals to: H_{up} /H_{down}= 8/10 [2, 3]. On **Figure 1** (**left**) is given position of the center of equal torques on the anterior abdominal wall (inside). The superficial point corresponding to the center of equal torque is located just above the arcuate line of the fascia of the anterior abdominal wall muscles, on the tendon intersection of the rectus abdominis, and on the median umbilical cord, which attaches the umbilicus to the symphysis pubica. It is surrounded on both sides by the medial umbilical ligaments, on the upper side by the navel and the round ligament that attaches it to the liver. The parietal sheet of the peritoneum lies on the inside of the anterior abdominal wall, and the omentum major is the next layer. The visceral peritoneum covers the internal organs that lay there- the small intestines, with the folds of the jejunum remaining to the left and the folds of the ilium to the right, and the mesenterium in the middle, as the lower group of mesenteric lymph nodes are located around the study area. The navel is at the level of the vertebral disc between L3 and L4, between the bifurcation of the aorta, which falls slightly to the left of it and the bifurcation of the abdominal inferior vena cava (slightly to the right). The projection of the center of equal torques is located below the navel,

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and the bifurcations, between the two femoral veins and arteries, that are behind the posterior peritineal sheet. In this part of the retroperitoneum, to the left, is the beginning of the left thoracic duct. Behind them is the anterior sheet of fascia thoracolumbalis and intervertebral disk between L4-L5, the ligaments between the vertebral bodies (anterior and posterior longitudinal ligament), the meningitis and the bundle of spinal nerves at the end of the spinal cord ends - cauda equina. It can be hypothesized that the cross section of equal torques is an area of the body in which all body movements are focused. This area acts as the "kinetic center" of the body. On **Figure 1 (right)** is given the position of the kinetic center on spinal cord.

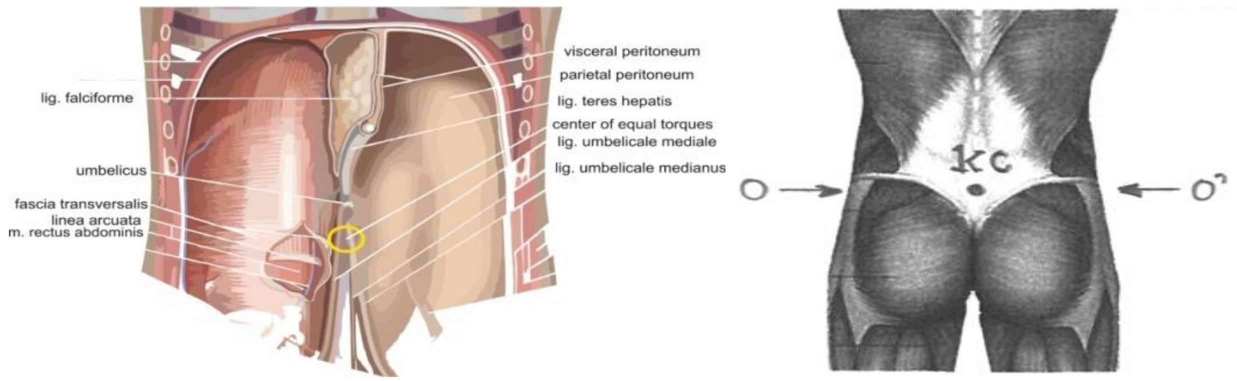

Figure 1 (left). Position of the center of equal torques on the anterior abdominal wall (inside) (**right**): Section O-O´ of equal torques and position of kinetic center 'kc' on Spinal Cord. (Figures are taken from the image in Encyclopedia Britannica 2008, Inc.).

AIM OF THE STUDY

Investigate the relationship between the eccentricity **b/a** of the body as a function of mass **M**, height **H**, circumference **L** and body mass index **BMI** in the section O-O 'of equal torques of the upper and lower parts of the body – **Figure 2.**

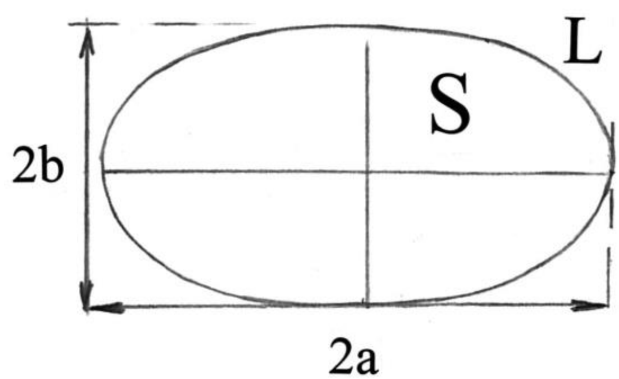

Figure 2. The elliptical section O-O 'of the equal torques of the upper and lower body with area S and circumference L.

MATERIALS AND METHODS

64 people aged between 18 and 28 of both sexes were studied. The area S of the ellipse section was calculated by the geometric formula:

$$S = \pi (ab) \qquad (1),$$

where a and b are the two radii of the ellipse and $\pi = 3.14$ **(Figure 2).**

The STATISTICS statistical package was used in all calculations.

Main tasks of the study

1. To calculate the statistical relationship between the eccentricity b/a of the section, which is an ellipse, and the circumference of the body L in the section of equal torques.

2. To calculate the statistical relationship between the eccentricity b/a of the ellipse and the body mass index BMI of the body.

3. To calculate the statistical relationship between the area S of the ellipse and the body mass index BMI.

4. To calculate the statistical relationship between the eccentricity b/a of the ellipse and the mass M of the body.

5. To calculate the statistical relationship between the eccentricity b/a of the ellipse and the height H of the body.

RESULTS

The measured parameters - mass (M, kg), body height (H, m), cross-sectional circumference (L, m), cross-sectional area S (cm^2) with circumference L, eccentricity b/a of the elliptical cross-section and BMI (kg/m^2) are given in **Table 1**.

Table 1. *Mass, height, circumference, area, eccentricity, body BMI and cross-sectional area with circumference L and eccentricity b/a.*

N	Body Mass M, kg (Surface S of the cross-sectional area S, cm^2)	Eccentricity b/a of the section (2 b/2a , cm/cm)	Height of the body H, m (Body Mass Index) BMI , kg/m^2)	Circumference of the body L in the cross section of equal torques L, m
1	75 (2311.04)	23/32 (0.7187)	1.87 (21.44)	0.87
2	44 (1884)	20/30 (0.6666)	1.60 (17.1875)	0. 77
3	102 (3020.68)	26/37 (0.7027)	1.84 (30.1275)	1.09
4	97 (2712.96)	24/36 (0.6666)	1.83 (28.9647)	1.01
5	57.9(2411.52)	24/32 (0.7500)	1.57 (23.4897)	0.96
6	54.4 (2449.2)	24/32.5 (0.7384)	1.55 (22.64)	0.95
7	70 (2143.05)	21/32.5 (0.6461)	1.74 (23.12)	0. 85
8	59.3(2110.08)	21/32 (0.6562)	1.75 (19.36)	0.98
9	64.8 (2286.9)	33/22 (0.6666)	1.74 (21.40)	0. 96.5
10	69.7 (2642.31)	25.5/33 (0.7727)	1.64 (25.91)	1.07
11	56 (2009.6)	20/32 (0.6250)	1.65 (20.57)	0. 96
12	64 (1912.26)	21/29 (0.7241)	1.83 (19.11)	0.78
13	52.1(1959.36)	19.5/32 (0.6093)	1.66 (18.906)	0.91
14	63.9(2166.6)	23/30 (0.7666)	1.66 (23.189)	0.90
15	103(4396)	35/40 (0.8750)	1.7 (35.64)	1.26
16	66.6(2449.2)	24/32.5 (0.7384)	1.7 (23)	0.96
17	73.5(2455.48)	23/34 (0.6764)	1.8 (22.685)	0.96
18	51(1554.3)	18/27.5 (0.6545)	1.69 (17.857)	0. 81
19	43.8(1866.73)	20.5/29 (0.7069)	1.56 (17.998)	0. 86
20	67.3(2238.82)	23/31 (0.7419)	1.73 (22.485)	0. 95
21	63(2166.6)	23/30 (0.7666)	1.78 (19.88)	0.89
22	63.5(2590.5)	25/33 (0.7575)	1.65 (23.32)	0.96
23	86.5(2669)	25/34 (0.7353)	1.88 (24.47)	1,05
24	81(2307.9)	21/35 (0.6000)	1.83 (24.187)	0. 96
25	82(5124.48)	34/48 (0.7083)	1.77 (26.17)	1.01
26	95(2967.3)	27/35 (0.7714)	1.9 (26.315)	1.06
27	81(2694.12)	26/33 (0.7878)	1.78 (25.564)	1.05
28	93(1877.72)	23/26 (0.8846)	1.75 (30.367)	0. 93

29	86(2599.92)	23/36 (0.6388)	1.85 (25.128)	0. 97
30	73(1884)	20/30 (0.666)	1.83 (21.798)	0.90
31	55(1909.12)	19/32 (0.5937)	1.73 (18.377)	0. 88
32	76(2694.12)	26/33 (0.7878)	1.88 (21.50)	0.99
33	90(3052.08)	27/36 (0.7500)	1.88 (25.46)	0.100
34	50.7(1516.62)	21/23 (0.9130)	1.59 (20.05)	0.87
35	74(2590.5)	25/33 (0.7575)	1.6 (28.906)	1.09
36	58(1758.4)	20/28 (0.7143)	1.55 (24.14)	0. 84
37	88(2094.38)	23/29 (0.7931)	1.74 (29.065)	0. 98
38	60(2166.6)	23/30 (0.7666)	1.64 (22.30)	0.95
39	110(3136.86)	27/37 (0.7297)	1.81 (33.57)	1.15
40	56(2072.4)	22/30 (0.7333)	1.54 (23.61)	0.95
41	95(3052.08)	27/36 (0.7500)	1.79 (29.65)	1.02
42	55(2003.32)	22/29 (0.7586)	1.56 (22.6)	0.90
43	54(1884)	20/30 (0.6666)	1.7 (18.685)	0. 95
44	54(1946.8)	20/31 (0.6451)	1.7 (18.685)	0. 87
45	54(1934.24	22/28 (0.7857)	1.59 (21.36)	0.91
46	55(2260.8)	20/36 (0.5555)	1.60 (21.484)	0.98
47	60(2210.56)	22/32 (0.6875)	1.65 (22.038)	0.93
48	59.5(2486.88)	22/36 (0.6111)	1.63 (22.394)	0. 97
49	104(3253.04)	28/37 (0.7567)	1.8 (32.1)	1.21
50	63(2712.96)	24/36 (0.6666)	1.68 (22.32)	0.96
51	75.5(2967.3)	27/35 (0.7714)	1.84 (22.30)	1.04
52	55(1808.64)	18/32 (0.5625)	1.72 (18.591)	0. 89
53	67(2417.8)	22/35 (0.6285)	1.70 (23.18)	1.01
54	57(1912.26)	21/29 (0.7241)	1.65 (20.936)	0.89
55	83(3315.84)	32/33 (0.9696)	1.60 (32.422)	1.18
56	52(2311.04)	23/32 (0.7187)	1.54 (21.93)	0.94
57	47(1912.26)	21/29 (0.7241)	1.64 (17.475)	0.85
58	54(2311.04)	23/32 (0.7187)	1.63 (20.32)	0.88
59	90(3052.08)	27/36 (0.7500)	1.62 (34.293)	1.18
60	60(2238.82)	23/31 (0.7419)	1.5 (26.66)	1.02
61	59(2135.2)	20/34 (0.5882)	1.65 (21.671)	0.95
62	62(2044.14)	21/31 (0.6774)	1.63 (23.335)	0.98
63	51(1494.64)	17/28 (0.6071)	1.54 (21.5)	0.84
64	47(1978.2)	21/30 (0.7000)	1.58 (18.827)	0.87

Figure 3 shows the relationship between the eccentricity b/a of the of the cross section O-O' and the circumference L of the cross section.

Figure 4 shows the relationship between the eccentricity b/a of the cross section O-O' and the body mass index BMI.

Figure 5 shows the relationship between the cross-sectional area S of the body and the body mass index BMI of the body.

Figure 6 shows the relationship between eccentricity b/a and body mass M on a linear scale.

Figure 7 shows the relationship between eccentricity b/a and body height H on a linear scale.

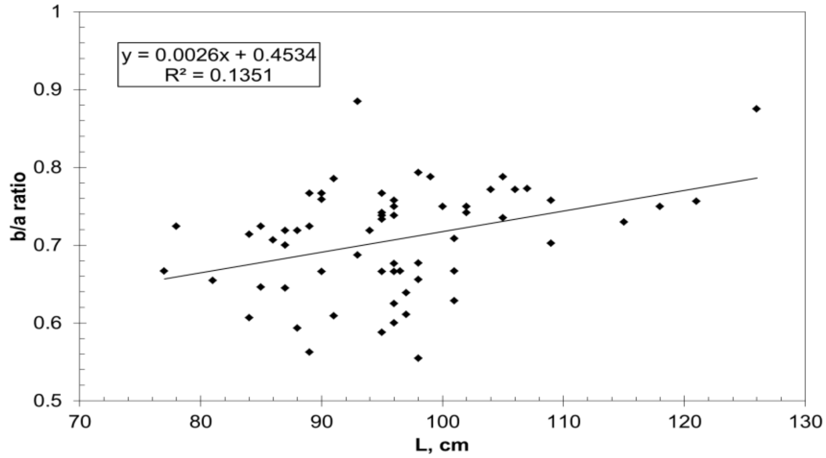

Figure 3. Dependence between the eccentricity b/a and the circumference of the body L in cross section O-O'.

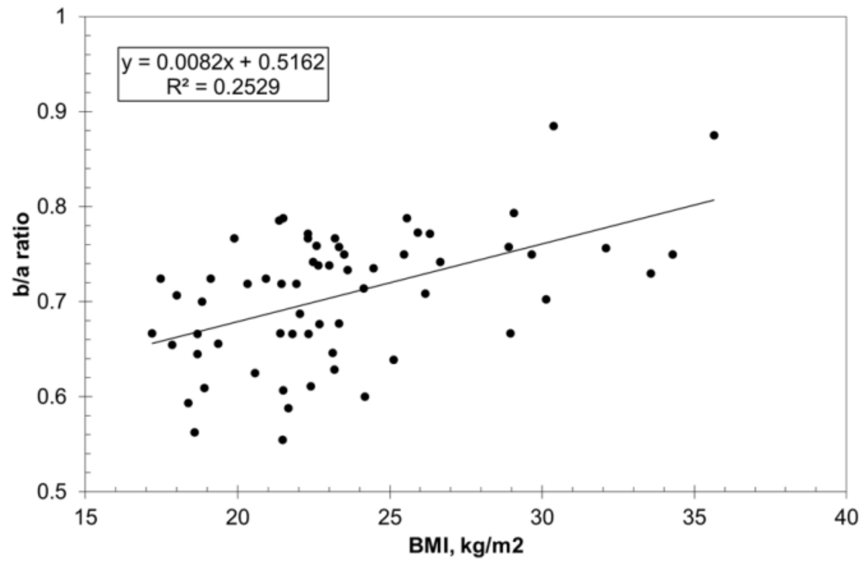

Figure 4. Relationship between body eccentricity b/a and body mass index BMI.

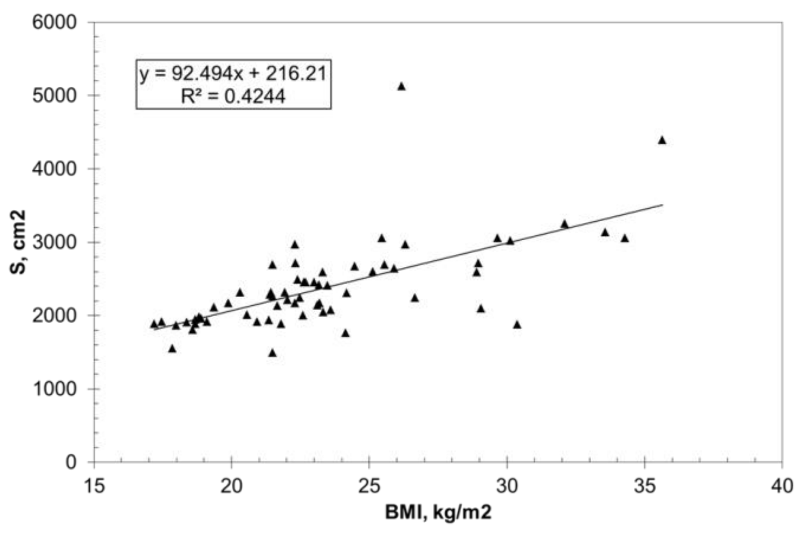

Figure 5. Dependence between the area of the ellipse S and the body mass index BMI.

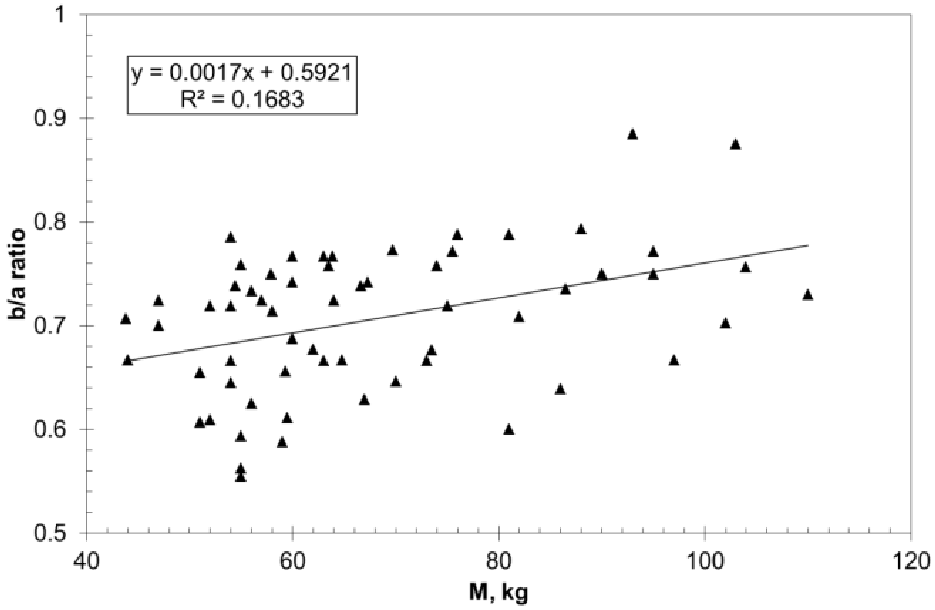

Figure 6. Dependence between eccentricity b/a and the body mass M.

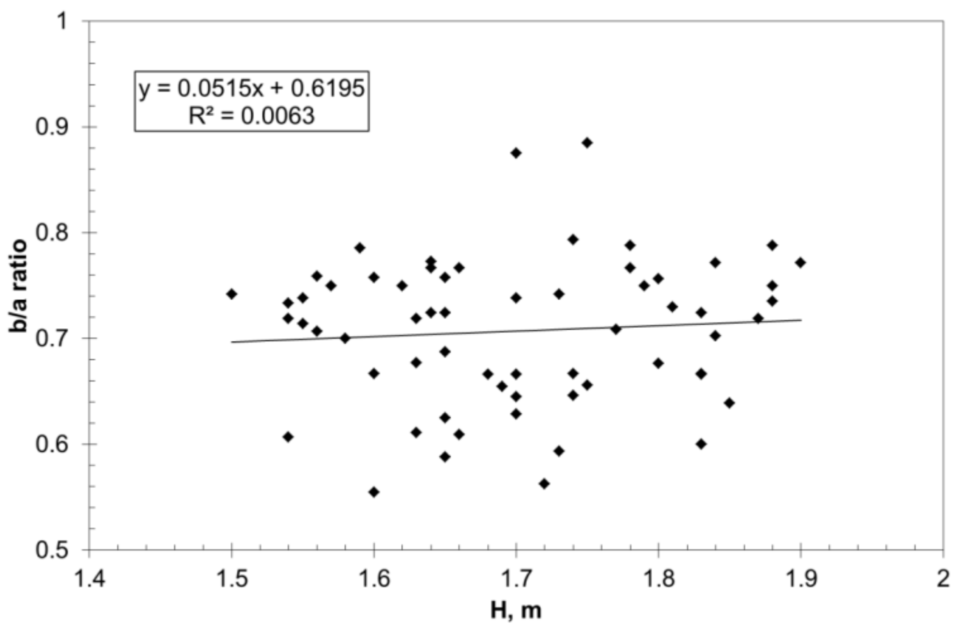

Figure 7. Dependence between the eccentricity b/a and body height H

On **Table 2** is presents the studied dependencies.

Table 2. *The studied dependences and their correlation coefficients*

Researched quantities	Statistical dependence	Correlation coefficient
b/a-L	b/a = 0.0026L + 0.4534	R=0.3675
b/a –BMI	b/a = 0.0082 BMI + 0.5162	R =0.5029
S-BMI	S=92.494BMI + 216.21	R = 0.6514
b/a-M	b/a = 0.0017M + 0.5921	R = 0.4102
b/a-H	b/a = 0.0515H + 0.6195	R = 0.0793

DISCUSSION

A low correlation coefficient (0.3675) is observed between the eccentricity b/a of the ellipse (body cross section O-O ') and the circumference of the ellipse L of the body cross section, which shows a weak dependence between the eccentricity of the elliptical circumference of the body moments. It can be considered that the two parameters are weakly related. At different circumference of the section, close eccentrics of the section can be observed. Such a weak relationship is observed between the eccentricity and the mass M of the body with a slightly higher correlation coefficient equal to 0.4102. A relatively large correlation coefficient (0.502) is observed between the eccentricity b/a of the ellipse (section of the body O-O') and the BMI of the body. This shows a significant relationship between the eccentricity of the elliptical circumference of the body and the BMI of the body. The strongest relationship is observed between the cross-sectional area S and BMI of the body (0.651), i.e. the two parameters are related. The relationship between eccentricity and body height is weak (0.0793), indicating that eccentricity is independent of body height.

In Introduction we hypothesized that the cross section of equal torques is an area of the body in which all body movements are focused. We are considering this area as "kinetic center" of the body. As proof of the reality of this center we will point out the infrared photos of the human body. On infrared images of the back of the body the 'kinetic center' overlaps with point with very high temperature. The position of the 'kinetic center' on spinal cord appears oval area with highest temperature (**Figure 8**), and the ratio between the upper (H_{up}) and down (H_{down}) bodily parts is equals to 8/10. However, the identification of the kinetic center on the spine requires further studies in people of different ages and body configurations.

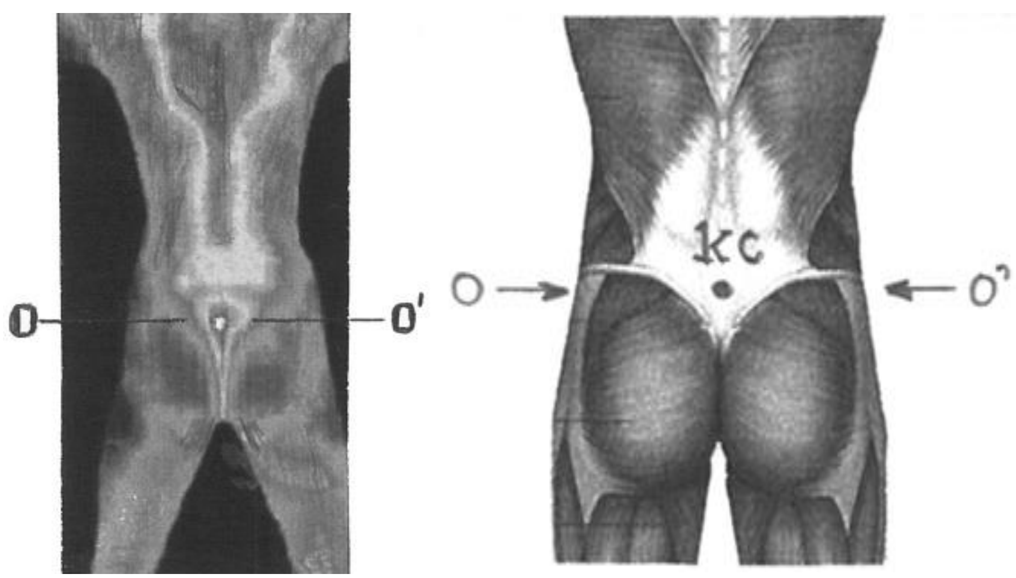

Figure 8 (left). The position of the 'kinetic center' on infrared body image appears oval area (point) on spinal cord with highest temperature (O-O' section); (**right**)-The position of 'kinetic center on spinal cord.(The left figure is taken from: Hearing Health &Technology Matters (hearinghealthmatters.org).

The area of 'kinetic center' is very close to the end point of the spine (brain), which in many mystical Indian teachings and especially in Yoga is considered the place of hidden latent energy of the human body, the so-called. Kundalini Shakti [4]. This latent energy can be awakened both through intense movements of the abdominal muscles (so-called "bandhi") and by willfully holding the breath accompanied by active meditation of Consciousness at the end of the spine (Muladhara chakra) [5].

The obtained results can find applications in solving various scientific problems [6].

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