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The Effect of Hypovolemia on the Weights of Human Organs

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Summary. A significant hypovolemia causes a statistically significant decrease in the weights of the liver, spleen and kidneys. This decrease can be on an average of 17% of the theoretical normal weight. Postmortem weights and estimated theoretical values are compared and with respect to the organs mentioned above the difference was marked. The weight of thyroid gland increases significantly. The material consisted of data from of 3468 male and 1422 female corpses.

Zusammenfassung. Hypovolämie bewirkt eine statistisch signifikante Abnahme des Gewichts von Leber, Milz und Nieren. Diese Abnahme kann im Mittel bei 17% des theoretischen Normalgewichts liegen. Die Unterschiede in den Werten, die durch Wiegen und theoretische Berechnung erhalten wurden, sind in Bezug auf die erwähnten Organe markant. Das Gewicht der Schilddrüse steigt signifikant. Das Material setzte sich aus Daten von 3.468 männlichen und 1.422 weiblichen Leichen zusammen.

Key words. Hypovolemia, organ weight – organ weight and hypovolemia

Introduction

Clinics use calculations for the degree of hypovolemia in different types of injuries. [1] The significance of this phenomenon in pathology and forensic medicine has not, as far as I know, heretofore been studied. In this study the effect of severe and moderate hypovolemia on the weights of human organs in men and women has been calculated.

Material

The data were collected from 10.117 corpses performed in 1959–1968 at the Department of Forensic Medicine, University of Helsinki. In 4890 cases significant hypovolemia after violence could be calculated and these cases were analysed. There were 3468 men and 1422 women.

Methods

The regression models for determinating the normal value with suitable measurements such as weight, height, age etc. have been measured before [2]. These models were

used by taking the data from the autopsy record and calculating the theoretical normal weights of different organs. Then the difference between the actual (= weighted) and the estimated weight was measured. Every case was handled separately and only the mean of these differences was measured. The factors (weight, height etc.) which affected organ weight were taken in account in every case. The regression models have been presented [2].

The limits of significance were as follows:

$$z = \frac{\overline{D} * N}{SD * \overline{N+1}}$$

limit of z	p under	significance
1.98	.05	almost significant
2.63	.01	significant
2.87	.005	
3.39	.001	highly significant
3.59	.0005	

Hypovolemic cases were the postmortems in which one or more of the following diagnoses were included in the significant injuries:

Table 1. The cases of hypovolemia

Fractura pelvis
Fracturae multiplices trunci et/seu extremitatis
Fractura diaphyseos femoris
Fracturae multiplices extremitatis et/seu costae et sterni
Haemothorax
Ruptura cordis
" pulmonis complicata
" cordis et pulmonis
" aortae thoracalis
Conquassatio thoracis
Ruptura hepatis
" lienis
" renis

Only such cases were chosen in which the injuried person had lived some time after the trauma and there was therefore enough time for the hypovolemia to develop. Such cases were excluded which had received hospital care. Diagnoses such as Conquassatio capitis were excluded because death is very sudden and it is not possible to identify the hypovolemia definitely and calculate the amount of bleeding.

Results

The differences between the weighted and estimated normal values of the organ weights are presented in table 2 for men and for women in Table 3.

Table 2. The difference between the weighted and estimated organ weights in men

Organ	n	mean (g)	SD (g)	mean difference $W_e - W_W$	SD (g)	p	%
Brain	3259	1472.5	135.4	− 20.8	140.9	.0005	−1.4
Heart	3468	372.5	71.6	− 5.4	57.5	.0005	−1.4
Liver	3397	1639.7	340.5	−145.8	305.4	.0005	−8.9
Spleen	3407	129.0	53.2	− 18.4	50.4	.0005	−14.3
Kidneys	3464	285.9	56.2	− 27.9	52.9	.0005	−9.8
Pancreas	2664	88.7	19.7	− 1.4	18.1	.0005	−1.6
Adrenal gl.	2591	12.0	3.9	− 0.2	3.7	.05	−1.7
Hypophyse (mg)	2599	493.9	86.2	− 2.3	84.6	–	−0.5
Thyroid gl.	2666	32.6	16.5	+ 3.1	16.1	.0005	+9.5
Tonsils	2278	6.0	2.7	+ 0.3	2.5	.0005	+5.0
Prostate	2634	24.8	9.4	+ 0.5	8.2	.005	+2.0

Table 3. The differences between the weighted W_W and estimated W_e organ weights in women

Organ	n	mean (g)	SD (g)	mean difference $W_e - W_W$	SD (g)	p	%
Brain	1276	1305.6	131.6	− 57.1	134.2	.0005	− 4.4
Heart	1399	315.8	76.4	− 9.7	56.2	.0005	− 3.1
Liver	1371	1451.3	348.7	−248.1	284.5	.0005	−17.1
Spleen	1358	112.4	46.2	− 15.3	44.1	.0005	−13.6
Kidneys	1422	230.3	47.8	− 27.1	46.5	.0005	−11.8
Pancreas	1072	76.8	40.9	− 4.7	40.2	.0005	− 6.1
Adrenal gl.	1061	10.4	2.7	− 0.7	2.7	.0005	− 6.7
Ovaries	976	9.1	6.6	+ 1.5	5.3	.0005	+16.5
Hypophysis (mg)	1044	524.6	102.4	− 2.7	100.6	–	− 0.5
Thyroid gl.	1068	31.4	21.0	+ 6.2	21.0	.0005	+19.8
Tonsils	803	4.6	1.9	+ 0.3	1.8	.0005	+ 6.5

Discussion

The effect of hypovolemia has not previously been studied in postmortems and a comparison of results is therefore impossible. In the light of the results in this study it seems that the decrease in weights is very significant in several organs. In spite of the fact that the differences between the estimated normal weight and the actual weighted value were statistically highly significant, only those observations which exceed about 8% of the mean organ weights in each case are of some value. The diminishing of the organ weights was most prominent in the liver, spleen and kidneys. The weight of all organs except the spleen diminished relatively more in women than in men. In the case of the liver, spleen and kidneys the difference between the estimated normal weight and the value which would have been observed if the persons had not bled and the hypovolemic value was significant. The estimated value gives the theoretical value; if the person had some condition or conditions affecting the weight of the organ the estimated difference was in many cases too small. It can positively be stated that with regard to the organs mentioned above the effect of hypovolemia must be taken in

account. No attempt was made to use this diminishing of the weight as some measure of the degree of the bleeding. In this study all cases had lost blood very significantly.

In hypovolemic shock the weight of the thyroid gland and of the ovaries increased. This can be explained by the increased hyperaemia. The very small changes in the weights of other organs are noticeable.

In the case of hypovolemia the degree of bleeding must be taken into account and the theoretical value must be calculated and this estimated value used when the organ weight is judged as normal or hypertrophied. If hypovolemia is not taken into account it will lead to an underestimation of a possible hypertrophia.

References

1. Proctor, H.: Principles for first aid for the injured. London: Butterworth's, 1962
2. Lehti, H.: Normal weights of human organs. A postmortem study on the cases of death from external causes. Helsinki: Thesis 1971

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