

Autopsy Study of Organ Weights in a Tertiary Care Centre in Kerala

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Abstract

Background : Organ weight and its morphometric parameters are one of the most important indicators of possible organ defects or diseases, therefore, many studies have evaluated the normal range of body and organ morphometric parameters, such as organ size, weight, and volume, in different ethnic groups all over the world. Weighing organs during Autopsy is not a mere physical exercise, but carries great medico legal significance.

Methods: A retrospective study was conducted by the Department of Forensic medicine at Government TD Medical College Alappuzha from autopsy data collected between January 2013 and December 2018. A total of 1206 cases (936 males and 270 females) were included in the study on the basis of inclusion criteria and the findings were recorded in the pre-designed proforma and analyzed.

Conclusions : The average age of patients was 46.81 (between the ages 18 and 98), males 46.68 (between the ages 18 and 95) and females 47.23 (between the ages 18 and 98). In Males, the average weight of the brain was 1266.39g (between 700 and 1976g), right lung was 484.41g (between 110 and 1400g), left lung was 425.09g (between 83 and 1426g), Heart was 289.56g (between 112 and 732g), Liver in male was 1356.99g (between 116 and 2822g), spleen in male was 107.79 (between 12 and 948g), right kidney was 119.53g (between 16 and 270g) and left kidney in male was 127.16 (between 46 and 886g).

In females the average weight of the brain was 1140.11g (between 725 and 1620g), right lung was 346.05g (between 98 and 992g), left lung was 303.43g (between 22 and 760g), was 241.13g between (68 and 479g); Liver was 1171.78g (between 550 and 2880g); spleen was 100.16g (between 18 and 509g); right kidney was 101.91g (between 36 and 624g) and left kidney was 104.23g (between 20 and 234g).

Keywords-- Autopsy, Liver, Lung, Heart, Spleen, kidney, organ weight.

Introduction

Organ weight and its morphometric parameters are one of the most important indicators of possible organ defects or diseases.¹Therefore, many studies have evaluated the normal range of body and organ morphometric parameters such as organ size, weight and volume in different ethnic groups all over the world.² Weighing organs during Autopsy is not a mere physical exercise, but carries great medico legal significance.³ Organ weights are important benchmarks in disciplines like surgery, pharmacology and radiation medicine.⁴ Organomegaly is considered as a sign of disease and can only be established if the reference range of data

for an internal organ is available. Identification of organomegaly helps identify risk factors for certain diseases like sudden cardiac death.⁵ Organ weights also play a significant role in estimation of body weight and height and thereby establishment of identity of an individual.⁶ Standard textbooks such as Gray's Anatomy and Ludwig give normal reference weight of organs.^{7,8} But, most of these use Caucasoid population which might not correlate with Indian population. There is great variation in the organ weights amongst the various races in the world, just as there is in stature and appearance. Therefore, this study aimed to assess the reference range of values of various organs in the population of Kerala.

Aims and Objectives

- To obtain a reference value for various organ weights in the population of Kerala
- To compare the organ weights amongst sexes in the various age groups

Materials and Methods

Source of Data

This retrospective study is being conducted by the Department of Forensic medicine at Government TD Medical College Alappuzha. This study analyses data from January 2013 to December 2018. A total of 1206 cases (males and females were included in the study on the basis of inclusion criteria. The study was conducted after approval from IEC (50/2019 dated 20/06/2019).

Inclusion Criteria

All cases subjected for autopsy from Jan 2013 to Dec 2018 whose completed profile and data were known are included in this study.

Exclusion Criteria

Decomposed bodies

Gross organ pathology

People with congenital anomalies/ Manifest macroscopic disease or anomaly

History of prolonged medical illness

Procedure

The data was collected from the post mortem records and standard protocol was maintained for collection of parameters. The weight of the naked body was taken using an electronic weighing machine. The height of the decedent is measured in centimeters using measuring tape in the supine position from head to heel. Standard autopsy protocol and procedures proposed by Ludwig was employed for organ removal. Organ weight measurements were made using an electronic weighing scale having accuracy of +0.1gm, after the removal of foreign tissues.

Statistical Analysis

The data was entered into Microsoft Excel work sheet and was analyzed using Statistical Package for Social Service SPSS software version 16. Descriptive statistics such as frequency, percentage, minimum, maximum, mean \pm SD and range were used.

Results and Discussion

1206 cases met with all criteria prescribed for the study during the period of January 2013 to December 2018. The data was obtained from the records stored in the department and the cross-sectional retrospective study conducted. (All results in table form Table 1 & 2)

The gender distribution of the study participants was that 936 were female (77.6%) and 270 (22.4%) were male. The age distribution was evenly distributed in the following manner: 18 -30 years- 263 (21.8%), 31-40 years - 212 (17.6%), 41-50 years – 224 (18.6%), 51-60 years – 242 (20.1%), 61-70 years – 159 (13.2%), 71-80 years – 79 (6.6%), more than 80 years. The mean age of the study population was 46.81 \pm 17.07. In females the mean age was 47.23 \pm 19.60(18-98) while in males it was 46.68 \pm 16.27 (18-95).

The mean organ weight of Brain in males was 1266.39(1976-700) and in females was 1140.11 (1620-725). The mean organ weight of Right lung in males was 484.41(1400-110) and in females was 346.05 (992-98). The mean organ weight of Left lung in males was 425.09(1426-83) and in females was 303.43(760-22). The mean organ weight of Heart in males was 289.56 (732-112) and in females was 241.13 (479-68). The mean organ weight of Liver in males was 1356.99(2822-116) and in females was 1171.18 (2880-550). The mean organ weight of Spleen in males was 107.79(948-12) and in females was 100.16 (509-18). The mean organ weight of Right kidney in males was 119.53 (270-16) and in females was 101.91 (624-36). The mean organ weight of Left kidney in males was 127.16 (886-46) and in females was 104.23 (234-20).

Table 1 : ORGAN WEIGHT IN VARIOUS AGE GROUPS IN MALES

Age group	Variables	Brain	Right lung	Left lung	Heart	Liver	Spleen	Right kidney	Left kidney
18-30 (n=192)	Mean	1306.73	443.27	396.02	262.05	1323.82	116.57	115.79	123.40
	SD	126.36	167.09	141.97	54.91	328.73	51.25	28.44	27.62
	Range	754	962	880	334	2334	310	254	200
31-40 (n=170)	Mean	1271.19	452.34	400.52	278.78	1501.23	118.81	121.83	128.08
	SD	133.48	174.15	151.73	63.93	353.22	65.19	29.36	29.90
	Range	820	1240	1194	382	1804	448	190	210
41-50 (n=184)	Mean	1276.96	505.92	448.36	290.83	1449.97	108.63	129.19	139.96
	SD	133.68	190.21	176.69	65.92	323.44	55.12	31.39	64.05
	Range	1276	1246	1290	584	2096	326	222	804
51-60 (n=199)	Mean	1260.08	502.74	446.45	306.70	1363.18	102.98	123.80	129.94
	SD	136.32	157.74	150.47	75.24	329.20	52.73	32.71	33.72
	Range	972	840	854	478	2060	392	161	210
61-70 (n=123)	Mean	1236.96	501.92	432.27	305.60	1203.04	91.03	109.49	117.02
	SD	120.08	154.68	129.90	66.39	267.47	44.66	27.37	31.94
	Range	634	992	840	360	1248	230	162	226
71-80 (n=54)	Mean	1195.61	553.89	441.33	314.43	1128.28	86.42	106.72	113.20
	SD	134.07	232.19	174.84	90.23	265.46	34.24	28.35	32.62
	Range	736	1020	867	508	1015	146	152	192
>80 (n=14)	Mean	1137.14	472.86	387.00	300.71	984.86	140.28	92.57	102.29
	SD	86.50	208.94	118.57	63.16	211.24	235.06	20.31	19.38
	Range	252	774	368	238	570	912	70	54

Table 2 : ORGAN WEIGHT IN VARIOUS AGE GROUPS IN FEMALES

Age group	variables	Brain	Right lung	Left lung	Heart	Liver	Spleen	Right kidney	Left kidney
18-30 (n=71)	Mean	1182.93	300.55	271.49	192.55	1130.65	99.66	98.76	104.24
	SD	99.90	101.62	106.82	42.21	283.89	41.27	32.57	29.13
	Range	594	574	622	240	1226	218	216	184
31-40 (n=42)	Mean	1152.86	407.86	352.02	237.29	1282.62	131.95	110.98	113.88
	SD	110.54	174.83	131.49	53.10	407.27	72.61	36.30	36.54
	Range	576	798	546	224	2240	444	214	180
41-50 (n=40)	Mean	1166.68	364.53	297.23	236.25	1232.10	102.05	103.83	112.93
	SD	130.22	128.80	92.06	55.23	321.52	74.51	26.67	34.54
	Range	716	566	410	256	1506	475	142	142
51-60 (n=43)	Mean	1116.02	358.30	332.47	263.70	1209.91	105.79	111.98	105.70
	SD	138.77	139.12	136.97	55.76	230.83	63.19	83.95	32.81
	Range	895	594	616	288	930	319	556	146
61-70 (n=36)	Mean	1128.44	333.75	291.14	280.81	1147.81	83.38	96.67	96.67
	SD	103.75	109.83	105.56	47.72	303.96	37.35	27.66	22.01
	Range	408	482	394	198	1164	194	106	82
71-80 (n=25)	Mean	1083.80	332.64	304.80	282.56	1126.84	82.56	89.88	95.76
	SD	100.85	147.56	105.06	51.99	265.75	33.80	24.34	21.82
	Range	360	624	422	236	1246	150	104	90
>80 (n=13)	Mean	1003.69	357.38	275.23	269.77	879.38	56.07	88.31	78.69
	SD	76.43	107.52	72.01	88.14	248.82	29.37	34.59	27.80
	Range	232	340	240	291	738	97	110	100

Table 3 : Comparative study of Mean Organ weight in Grams in Males

	BRAIN	RIGHT LUNG	LEFT LUNG	HEART	LIVER	SPLEEN	RIGHT KIDNEY	LEFT KIDNEY
Present Study	1266.39	484.41	425.09	289.56	1356.99	109.71	119.53	127.16
Kohli & Aggarwal Delhi ⁹	1219.7	417.6	376.8	259.9	1210.9	131.3	108.3	104.2
Tanna ¹	1392-1025	560-435	546-392	352-260	1812-895	154-99	136-114	151-116
Modi's text book ¹⁰	1342.86	514.55	469.65	283.5	1241.16	170.95	103.19	170.10
Sahni et al ¹¹							108.7±22.6	118.8±23.3
Singh et al ⁴	1324.05	568.85	516.62	291.87	1426.62	155.17	128.15	137.74
Jain et al ¹²	1255.3±170.8	980.6±144		250.5±58.4	1325.8±192	149±53.6	211.1±42.4	
Batra et ¹³	1213.6	365.3	346.6	277.6	1205.3	191.6	113	114.3
Puttaswamy ¹⁴	1325.06	569.9	516.65	291.9	1427.72	155.18	128.18	137.75
Molina DK ^{5,15}	1407	445	395	331	1561	139	129	137
Chandan et al ¹⁸	1209.25±129.37	549.95±187.54	476.10±168	292.27±87.56	1246±357.59	142.47±107.37	133.86±50.73	126.26±49.47
Narongchai ¹⁹	1311	321	296	291	1252	104	106	112
Mathuramon ²⁰	1330	831		302	1390	96	252	
Mubbunu ²¹	1335±125.5	504.6±174.6	442±152.3	279.2±44.9	1285.3±270.1	169.9±107.2	110±22.8	117.9±27.4

Table 4 : Comparative study of Mean Organ weight in Grams in Females

	BRAIN	RIGHT LUNG	LEFT LUNG	HEART	LIVER	SPLEEN	RIGHT KIDNEY	LEFT KIDNEY
Present Study	1140.11	346.05	303.43	241.13	1171.78	100.16	101.91	104.23
Kohli & Aggarwal Delhi	1156.2	369.7	340.6	217.7	1092.5	121.8	98.6	98.3
Tanna ¹	1198-845	515-348	506-324	325-226	1285-885	128-89	135-89	140-98
Modi's text book	1085.52	382.78	333.12	184.28	1084.39	145.27	87.32	83.63
Sahni et al							96.6±19.3	99.4±25.3
Singh et al	1195.73	421.2	392.87	235.69	1292.9	132.17	117.35	125.90
Jain et al	1220.4±119.5	966.2±166.5		238.7±37.3	1283.1±195.1	146.4±28.5	206.5±32.1	
Batra et al ¹³	1077.6	309.6	297	215.6	1055	113.6	86.3	89
Molina DK ^{16,17}	1233	340	299	245	1288	115	108	116
Chandan et al	1125.16±107.16	438.04±125.8	382.56±104.8	272.01±76.79	1175.83±300.82	123.75±64.17	124.94±45.99	119.07±45.44
Narongchai ¹⁹	1170	271	251	246	1106	77	97	98
Mathuramon ²⁰	1208	659		259	1211	81	222	
Mubbunu ²¹	1228.3±76.4	405 ±116	365.7±119.8	268.4±64.2	1367.9±357.2	161.7±93.4	101.2±20.3	108.3±23

Brain

The weight of the brain is maximum in the age group 18-30 years and its mean is 1306.73 in males and 1182.93 in females in this group. In a study conducted by Batra¹³ the weight of brain was maximum in the age group 31-40 years and its mean was 1254 in males. Singh et al⁴ also identified the 31-40 years age group to have maximum weight of brain in males which was 1336.85, while Murkey²² identified the brain weight in this age group to be 1268.14. In his study Batra¹³ identified the female brain to weigh the most in the age group 11-20 years (1132), while Singh et al⁴ (1210.21) and Murkey²²(1233.65) identified that it was highest in the age group 21-30 years. Irrespective of sexes, in the study conducted on Thai population²⁰ the maximum brain weight was obtained in the age group 11-20 years. Similar to this study it was noted that the weight of the brain decreases as age increases in both sexes.^{13,4,22}. It was also noted that irrespective of the age groups the brain weighed less in the female population.

Lungs

It should be remembered here that, in acute deaths the postmortem lung weight may primarily depend on an individual lung volume and persistent circulatory disturbance (congestion and edema) before death which is related to vital activity and survival time, this causes the lung weights to change easily after death²³. In all the studies analyzed here it was noted that the right lung was heavier than the left lung in both sexes. The weight of the Right lung is maximum in the age group 71-80 years in males and is 553.89, while in females it is maximum in the age group 31-40 years (407.86). The weight of the Left lung is maximum in the age group 41-50 years in males and is 448.36 in males, while in females it is maximum in the age group 31-40 years and is 352.02. The data regarding the decrease of lung weights in females as age progresses correlates with the other studies^{13,4,20,22}. It was noted that the lungs were lighter in females than in males

Heart

The weight of the heart is maximum in the age group 71-80 years for both sexes and its mean is 314.43 in males and 282.56 in females in this age group. It was noted that the weight of the heart progressively increases

up to the weight of 80 years beyond which there is a slight decrease. Deepika et al noted that the weight of the heart increases with increasing age. She observed the maximum weight of the heart in the age group of 51-60 years with a range of 228 to 390 with the female hearts weighing lesser²⁴. This relationship of weight of the heart was also observed by Singh D et al, Narongchai et al and Mathuramon P^{4,19,20} Puttaswamy noted that after attaining the peak all organ weights tend to decrease, except the weight of the heart¹⁴. This was explained by many authors as due to deposition of epicardial fat and incidence of cardiomyopathy, and undiagnosed systemic hypertension amongst the elderly^{14,20,22}.

Liver

The weight of the Liver is maximum in the age group 31-40 years for both sexes and its mean is 1501.23 in males and 1282.62 in females in this age group. The mean weight of the Liver showed a progressive decrease as age advanced, with the lowest mean weight being recorded above the age of 80 years, their values being 984.86 and 879.38 respectively for males and females. In most studies it is observed that the peak weight of the Liver was in the age group of 51-60 years^{4,24}. The present study shows that the liver was heavier in males when compared to females, and this is consistent with Singh D et al, Narongchai et al, Mathuramon P and Deepika et al^{4,19,20,24}. Mubbunu in a study conducted on Zambian people noted that the Liver weighed more in females when compared to males²¹. This was attributed to genetic factors.

Spleen

The spleen showed a progressive decrease in weight amongst males with advancing age commencing from the age of 40 onwards. It was noted that the mean weight of the spleen in the group aged above 80 years was 140.28. On perusal of data, it was noted that it was a case of an 82 year old male with portal hypertension and hematemesis with aspiration of blood into the lungs. The abnormal weight of the spleen in this case has increased the mean weight of the organ in this relatively small sized age group. Amongst the females, the maximum weight of the spleen was noted in the age group 31-40 years and the mean in this age group was 131.95, thereafter the organ showed decreasing weight with advancing age. As in all other organs the weight of the spleen was noted to

be more in males. This is consistent with other studies conducted all over the world^{1,4,9,15, 19,20,21}

Kidneys

In our study, it as observed that the kidneys are slightly heavier on the left side in males, the maximum weight being on the age group 41-50years. In females, there was no significant difference in the weights of the kidney on either sides; the right kidneys weighing maximum in the 51-60year age group, and the left in 31-40 years. In both sexes the kidneys progressively decreased in weights after their peak weights were attained. P.N. Murkey noted that the weight of kidneys increased up to the age 50years in females while in males it increased up to the age of 70 years Batra also noted that the kidneys weighed maximum in the age group 61-70years, while Singh D observed the maximum weight of kidneys to be in the age group 31-40 years. Sahni observed statistically significant differences in weights of both kidneys amongst the sexes¹¹.

The normal values of organ volume, weight, and size change with time probably under the influence of genetic factors and environmental factors and it may act as a good diagnostic criterion for autopsy only if normality is accurately and regularly defined.

Conclusion

From this study, we can conclude that weights of all organs are more in males when compared to females. There is no significant differences in organ weights obtained in our studies when compared with other studies conducted in India. The brain and liver weights in both sexes were slightly lower when compared to studies conducted abroad. The weight of the spleen was less than the average weight recorded from the rest of India and abroad; but was consistent with studies conducted in Thailand. The weight of the heart positively correlates with increasing age.

Implications

With this study we have reference values for organs which can be put to practical use during autopsy studies. But for these values to be valid and reliable for forensic and non forensic evaluation of organ pathologies, these values need to be correlated with variables like height, weight, and body mass index.

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