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A Study of the Volume and Specific Gravity of Organs.[1]

BY SIDNEY L. OLSHO, M.D.

(From the Laboratories of the Jefferson Medical College Hospital.)

THE three linear dimensions in which the size of an organ examined at autopsy is recorded give to the reader a rather indefinite idea as to the actual size of the specimen. Viscera are irregular. The expressions "the organ is large," "fairly large," "voluminous," "larger than its fellow," "contracted," "splenic tumor," etc., are inaccurate and unscientific.

In order to determine and accurately register the size of any viscus, the following plan, employed at some institutions for registering the volume of the brain, should be adopted: Each organ as it is removed is submerged in a vessel filled with water to a level at which an overflow is provided. The water displaced overflows into a container

[1] Read by invitation.

graduated in cubic centimeters; the amount so obtained represents the volume or displacement of the organ in cubic centimeters. The organs are weighed in grams; the weight in grams, divided by the displacement in cubic centimeters, equals the specific gravity.

The heart is submerged opened or unopened. A "voluminous" emphysematous lung is pressed beneath the surface of the water by a rod thrust into the bronchus. It has been ascertained that no water enters the lungs—no bubbles appear because the contained air cannot be displaced. The liver, spleen, kidneys, or a tumor may be similarly measured. The record is thereby supplied with definite facts by which it is possible to appreciate the size of an emphysematous lung as compared with its atelectatic mate. The displacement in cubic centimeters constitutes a record, conveying an idea not obtainable from linear measurements even when the weight also is given.

Dr. L. Vervaeck, of Belgium, determined the specific gravity of organs and published his results in 1901. The method he used requires two weighings: one in and one out of water. His tabulations were based on the general clinical diagnosis of the case and not on the pathological condition observed in each organ. The specific gravity of the lungs was not determined.

In order to determine the practical value of the methods suggested I examined the organs from one hundred autopsies made at the Philadelphia Hospital.[1]

HEART.—While the average specific gravity of hearts manifesting no evident abnormality was 1029, individual apparently normal hearts varied from 939 to 1152. It is not likely that healthy heart muscle varies in specific gravity to the extent indicated. Any marked deviation from the normal specific gravity, in a heart macroscopically normal, indicates that a histological study is necessary. In cloudy swelling—8 cases—the average specific gravity was found distinctly lowered, namely, to 1004. This conforms to observations made during the study, namely, that parenchymatous change lowers the specific gravity of the affected organ. In so-called chronic myocarditis, including general atrophy (20 cases), the average specific

[1] The notes of the cases studied may be found in the Philadelphia Hospital records, 1906, xxi.

gravity was 1008; lowest, 833; highest, 1088. Hypertrophied and dilated hearts (31 cases) yielded an average specific gravity of 1037; lowest, 969; highest, 1114. In simple hypertrophy (13 cases) the average specific gravity was 1032; lowest, 975; highest, 1128. Comparing hypertrophy with hypertrophy and dilatation combined, the previous observations seemed again to hold true. In dilatation, failure of nutrition and parenchymatous degeneration, the specific gravity was, as a rule, lower than in simple hypertrophy. The same general tendency obtains in chronic dilatation and fatty degeneration. Here with even greater parenchymatous change (12 cases) the average specific gravity is still lower, namely, 1025; lowest, 843; highest, 1214. Fatty infiltration presents a contrasting picture. Here with an intact musculature the specific gravity remained high, the average of 5 cases being 1061; lowest, 1000; highest, 1151.

KIDNEY.—The average specific gravity of the normal kidney (only 8 such available) was 1098; lowest, 1000; highest, 1190. In acute diffuse nephritis (20 kidneys) the average specific gravity was lowered to 1072.

In chronic parenchymatous nephritis (103 kidneys), commonly a diffuse lesion, the average specific gravity was further lowered, 1049. In one case the right kidney had a specific gravity of 1400. The left kidney was less granular; accordingly its specific gravity was only 1200. In chronic interstitial nephritis (58 kidneys) the average specific gravity, 1053, was higher than in chronic parenchymatous nephritis. As illustrating the influence of morbid processes in the displacement—size—of the organ, a comparison of the average volumes of the kidneys is interesting and suggestive.

Average volume, chronic interstitial nephritis (58 cases)	150 c.c.
Average volume, apparently normal kidneys (8 cases)	160 c.c.
Average volume, chronic parenchymatous nephritis (103 cases) . . .	166 c.c.
Average volume, acute diffuse nephritis (20 cases)	185 c.c.
Average volume, acute diffuse nephritis and congestion (8 cases) . . .	186 c.c.

While parenchymatous change seems to lower the specific gravity of the organ, the formation of fibrous tissue, on the other hand, raises it. This is perhaps best indicated by examination of the kidneys in chronic interstitial nephritis. Assuming that the kidneys of the smallest volume have undergone the most interstitial change—are most fibrous—the following comparisons may be made:

8 kidneys chronic interstitial nephritis, vol. 100 c.c. or less, av. sp. gr. 1257.
42 kidneys chronic interstitial nephritis,[1] vol. 100 to 200 c.c., av. sp. gr. 1025.
8 kidneys chronic interstitial nephritis,[2] vol. over 200 c.c. av. sp. gr. 994.

The organ becomes more dense because it contracts. The increased specific gravity contributed by fibrous-tissue formation is not demonstrable in every case, be it heart, liver, or kidney, because fibrous or interstitial processes are rarely dissociated from parenchymatous change. Where fibrosis is most marked, as in the group of small kidneys in chronic interstitial nephritis, the consequent increase of specific gravity is best illustrated.

LIVER.—In organs not the seat of any macroscopically evident lesion (11 cases) the average specific gravity was 1057; lowest, 1029; highest, 1088. The specific gravity is lowest in fatty infiltration of the liver (21 cases); average, 1028; lowest, 720; highest, 1098. In cloudy swelling, parenchymatous degeneration (12 cases), the average specific gravity was 1055; lowest, 1025; highest, 1086. In atrophic cirrhosis (7 cases) the average specific gravity was 1056; lowest, 1029; highest, 1069. In congestion amounting to red atrophy, average specific gravity was 1077; lowest, 973; highest, 1100.

SPLEEN.—Except in miliary tuberculosis the average specific gravity of the spleen is highest in chronic splenitis (28 cases), 1139, succeeded in order by the following: Acute splenitis (19 cases), 1110; congestion (17 cases), 1108; apparently normal (33 cases), 1043; acute suppurative splenitis (2 cases), 1040; amyloid (3 cases), 1027.

LUNGS.—As regards the lungs this method offers a more perfect mode of comparison of size of the two organs than can be obtained in any other way. In support of this statement the following cases may be cited:

CASE 38.[3]—Patient aged twenty-six years. Right lung: weight, 460; volume, 850; specific gravity, 541; chronic caseous tuberculosis. Left lung: weight, 780; volume, 770; specific gravity, 1013; chronic caseous tuberculosis and atelectasis of lower lobe.

[1] Probably less fibrous.
[2] Probably least fibrous.
[3] Weight is given in grams and displacement, or volume, in cubic centimeters.

It is clear in this case that the right was the functionating lung; less weight, greater displacement, lower specific gravity.

CASE 39.—Patient, aged thirty-five years. Right lung: weight, 590; volume, 810; specific gravity, 728; edema and congestion; tuberculosis of lower lobe, hence higher specific gravity. Left lung: weight, 400; volume, 640; specific gravity, 625; edema and congestion.

CASE 53.—Patient, aged fifty-seven years. Right lung: weight, 560; volume, 580; specific gravity, 965; emphysema, congestion, healed tuberculosis. Left lung: weight, 190; volume, 180; specific gravity, 1055; atelectasis.

No description could give as adequate an idea of the conditions in this case as the figures quoted.

CASE 76.—Patient, aged twenty-four years. Right lung: weight, 460; volume, 670; specific gravity, 686; acute miliary tuberculosis. Left lung: weight, 460; volume, 610; specific gravity, 754; acute miliary tuberculosis.

The two lungs weighed the same; the right lung was larger; the left should have weighed less; the specific gravity of the left was the higher. From the figures alone it is proper to conclude that the left lung was the more involved.

CASE 88.—Patient, aged forty-six years. Right lung: weight, 660; volume, 1200; specific gravity, 500; emphysema. Left lung: weight, 940; volume, 1300; specific gravity, 723; lobar pneumonia involving part of upper lobe; the remainder of the organ emphysematous.

CASE 108.—Patient, aged fifty years. Right lung: weight, 540; volume, 1150; specific gravity, 469; the organ apparently normal, crepitating throughout. Left lung: weight, 1790; volume, 1780; specific gravity, 1005; lobar pneumonia; nowhere crepitant.

These few cases are sufficient to illustrate what is already known, namely, that conditions like fibrosis, atelectasis, and pneumonia increase the specific gravity of the lung. Comparison of weights, volumes, and specific gravity of the two lungs gives an approximate idea of the amount of functionating tissue present in each.

CONCLUSIONS.—A statistical study of the organs of 100 consecutive autopsies seems to indicate:

1. Parenchymatous degeneration lowers the specific gravity of organs proportionately to the degree of parenchymatous change.

2. Fibrotic change, while diminishing the volume of the organ, also raises its specific gravity proportionately to the amount of fibrosis.

3. Although useful in systematic studies of all organs, the specific gravity records are most striking in pulmonary affections.

March 12, 1908.

Note on the Occurrence of a Ciliate (*Opalinopsis nucleolobata, n. s.*) in the Liver of a Mammal (*Canis latrans*).

By ALLEN J. SMITH, M.D., and HERBERT FOX, M.D.

(From the McManes Laboratory of Pathology of the University of Pennsylvania, and the Laboratory of Comparative Pathology of the Philadelphia Zoölogical Gardens.)

The following record seems to the writers worthy of publication, because, so far as they are aware, there is but one other case mentioned in medical literature in which a ciliate was noted as a parasite of the mammalian liver, and because, provided the identification of the organism here dealt with as of the family of *Opalinidæ* be correct, it is the first time in which it has been found that any member of this family has been parasitic in a mammal, the various species being known only as parasites of worms and other invertebrates, and of frogs and toads.

In stained sections[1] of the liver of a prairie wolf, *canis latrans*,[2] these ciliates were discovered in large numbers. Unfortunately, the writers are forced to depend entirely upon preserved material, as no idea of their occurrence was had prior to their discovery in the finished histological preparations. This fact materially limits the study, as much of the examination of such specimens is necessarily or preferably to be carried out upon the fresh and living protozoa.

The coyote had been in the Zoölogical Gardens for about two years, but was a poor inbred specimen, was never on exhibition, and was ordered killed on April 3, 1907. The autopsy was performed very shortly after death and the material for microscopic examina-

[1] University of Pennsylvania Path. Hist., No. 2199.

[2] Philadelphia Zoölogical Garden Laboratory, 1048.

tion at once fixed in formaldehyde solution. There existed a hypostatic congestion of both lungs, and a slight grade of general visceral fibrosis, an interstitial nephritis being especially developed. In various places in the liver there were indefinitely outlined areas, varying from 15 to 30 millimeters in diameter, which upon the surface of the organ formed slightly convex prominences, somewhat paler than the rest of the hepatic substance and a trifle softer, superficially suggesting the appearances of small abscesses. In section, these swelled out above the rest of the cut surface and seemed to consist of irregularly shaped liver lobules with blotches of a brownish or yellowish-brown pigment in and among them. The alimentary canal was grossly normal, and no part was saved for microscopic examination.

In the histological preparations of the liver there were no notable alterations of the general structure (beyond a slight perilobular cirrhosis) save in connection with these areas. In the latter the blood-vessels were irregularly dilated, at places the tissue approaching the appearance of an angioma, this affecting especially the intralobular capillaries here and there, and there was a small amount of hemic pigmentary deposit. Here and there in these nodes were patches of hepatic cells presenting a fine vacuolation, converting the protoplasm into a fine reticulum, but without involvement or change in the nuclei (probably edema of the cells rather than fatty change). Between the liver cells and often definitely within the dilated blood channels of these nodes the ciliates were found, sometimes widely separated from each other or again in numbers in the tissue of a single field of the microscope. In the vicinity of the infusoria, and about them, there was often a minor infiltration of the tissue by polynuclear and rather large mononuclear leukocytes; but there was in no instance any definite encapsulation of the organisms. The gall-ducts showed no invasion by the parasites, the epithelial lining of these channels being quite normal, although in places there appeared a slight increase of the peribiliary connective tissue in the sections examined.

The organisms are spheroid to short ovoid in outline, the largest ones attaining a long diameter of 0.035 mm. (exclusive of the ciliary border); the smaller recognized individuals often being less than half of this measurement. In case of many of the parasites no ciliated border can be made out, this being particularly true of small