SONOGRAPHIC MEASUREMENT OF LIVER, SPLEEN AND KIDNEYS AND ITS CORRELATION WITH THE PARAMETERS OF THE BODY IN 203 VOLUNTEERS.

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RUNNING TITLE The Sonographic Correlations
KEYWORDS ultrasonography, liver, spleen, kidneys, measurement, BMI
WORD COUNT 1715
CONFLICT OF INTERESTS no conflict of interest

ABSTRACT

Ultrasound examination has recently become widely popular and now it constitutes an examination of choice in the majority of cases. One of the basic features assessed during the ultrasound procedure is the size of the particular organ. To find correlation between the size and the age, weight, height and BMI (Body Mass Index) and also to check if already established normal values can be modified accordingly to these body parameters. 206 healthy volunteers without any known chronic disease and under no chronic treatment were examined in this study. In the analysis the following factors were taken under consideration: the size of the liver in the midclavicular line, the size of left kidney in midaxillary line, the size of right kidney in anterior axillary line and the size of spleen in posterior axillary line in correlation with age, weight, height and BMI. Considering whole group there is statistically significant positive correlation between age, weight, height and BMI with the size of liver and both kidneys. Spleen size doesn't correlate with age \( p > 0.05 \) \((p=0.091)\) whereas it correlates positively with, weight, height and BMI. The most significant correlation exists between weight and liver size \( p = 0.6428 \) p value <0.001. Body parameters are positively correlated with the size of internal abdominal organs. The age of the patient always should be taken under consideration during sonographic assessment of organs. It is essential to calculate and specify normal organ measurements adjusted to height, weight and BMI during abdominal sonography.
BACKGROUND

Ultrasound examination has recently become widely popular and now it constitutes an examination of choice in the majority of cases. Even though alternative diagnostic techniques are more accurate and precise, ultrasound is the fastest, the cheapest and the most available diagnostic device. One of the basic features assessed during the ultrasound procedure is the size of the particular organ. It usually gives abundant set of information about one’s health immediately.

PURPOSE OF THE STUDY

The purpose of the study is to find the correlation between the size of particular organs and age, weight, height and BMI (Body Mass Index), as well as to check if already established normal values can be modified accordingly to these body parameters. Currently there are no established normal values of the measurements of abdominal organs correlated with BMI, weight and height.

MATERIALS AND METHODS

The study was performed at the Diagnostic Imaging Department, 2nd Medical Faculty, Medical University of Warsaw. Two hundred and six healthy, young (between 20 and 30 years of age) volunteers without any known chronic disease and under no chronic treatment were examined in this study. Participants were enrolled via online advertisement. Ultrasound examinations were performed by five young sonographers between 8th April 2016 and 22nd June 2016 under the supervision of the experienced Nuclear Medicine specialist. Each sonographer had two years of experience in performing abdominal ultrasound examinations, during which had done at least 200 abdominal ultrasounds. All participants had filled out questionnaire before ultrasound examinations and participated with informed consent. The participants' body weights and heights were obtained before examinations and BMIs were calculated accordingly to the following formula: BMI = weight[kg]/(height[m])². Ultrasound examinations were performed on Toshiba Apio XG, using 3-6 MHz convex transducer. Examinations were conducted with the participants always lying in the supine position. All participants were examined by a team consisting of two random sonographers. Measurements of a given organ were taken separately and independently by each of them. Average measurement of patient’s organ was calculated from two separate measurements in the team.

Statistical analysis was performed using the Statistica 12 software (StatSoft). Pearson correlation coefficients were used to assess the correlation between variables.

- The size of a liver was measured in the midclavicular line (with measurement AP always during a complete inspiration). Transducer was always placed in line with standards, that is perpendicularly to the abdominal wall.
- The size of a left kidney was measured in midaxillary lines (bipolar renal length).
- The size of a right kidney was measured in anterior axillary line (bipolar renal length).
- The size of a spleen was measured in the posterior axillary line (bipolar spleen diameter).

EXCLUSION CRITERIA

Participants completed questionnaire to exclude any conditions and factors that might affect the size of particular organs. 3 out of 206 participants were excluded from organ measurement analysis. One subject due to diabetes and two of them due to temporary infections.

RESULTS

Measurements statistic

Of the total of 203 participants 146 were females and 57 males. The mean size with outliers excluded was 123.88 mm for liver, 101.89 mm for spleen and 107.37 mm and 108.7 mm for right and left kidney respectively (tab.1). The biggest SD (Standard Deviation) concerns liver and it is 14.98 mm, whereas the smallest SD concerns right kidney and it is 8.067 mm. According to the Tukey test outliers were excluded. Thus, the number of organs included in the study was: 197 spleens, 193 left kidneys, 194 right kidneys and 197 livers. The study also revealed that the size of organs depends on a gender of a subject. Female subjects have smaller abdominal organs (liver, spleen, as well as both kidneys). The differences in measurements between females and males are statistically significant (p value < 0.001).

Correlations

In considering the whole group, there is a statistically significant positive correlation between age, weight, height and BMI with the size of liver and both kidneys (tab.2). Spleen size does not correlate with age p = 0.091, whereas it correlates positively with weight, height and BMI. The most significant correlation exists between weight and liver size p = 0.6428 p value <0.001. Among female participants age does not correlate with spleen and liver size, and BMI does not correlate with spleen size and, interestingly, with a right kidney. Among male subjects the study revealed that age is not correlated with spleen (p = 0.391 ) and kidneys size( left kidney p=0.187; right kidney p=0.883). Among males BMI is strongly positively correlated with the size of a spleen but these parameters are not correlated with each other among female subjects.

DISCUSSION

In our study involving 203 people we assessed the mean size of liver, spleen and kidneys and tried to find correlations between the size of organs and weight, height and BMI. Another study among adults aged between 18 and 80 showed a positive correlation between body weight and BMI and kidney length [1]. Our study revealed similar results. According to El-Reshaid et al. there is no statistically significant correlation between the size of kidneys and height or age. This finding was not confirmed in our study, which showed a positive correlation between these parameters. Possibly the difference in findings is a result of a narrow age group in
our study. Earlier analysis concerning 4,035 adult subjects reported that the size of both kidneys is positively correlated with height, weight, BMI and age[2]. Our results also show this positive correlation. The results suggest the significant importance of an appropriate organ size interpretation, which should always be relative to body parameters mentioned above.

Wolfgang et al. revealed a positive correlation between liver size in midclavicular line and age, height as well as BMI accordingly to our study results [3]. BMI and height are the most significantly correlated with liver size. Organ sizes of individuals in the same age group, can be remarkably different, depending on body parameters. Bhavna et al study highlighted significant correlation between the size of a liver as well as spleen and height and body weight among children aged between 1 month and 12 years [4]. Based on this data they determine a correct range of values according to age, body weight and height. There is no doubt that childhood is characterized by significant variability of body weight and height. However, our study conducted among people aged between 20 and 30 also demonstrates that normal values of organs should be verified and adjusted to the body weight and height. Niderau et al. study concerning a group of people aged between 18 and 65 showed a correlation between height and liver as well as spleen size [5]. Moreover, their study indicated that liver and spleen dimensions decrease with age. Our results show that liver size increases with age. Disagreement in results might be caused by a different population of subjects. Perhaps, there is a threshold age after when liver size stops increasing and begins to decrease. Probably the study conducted among people aged between 20 and 30, does not give a possibility to notice mentioned threshold age. What is more, Buchholz et al. (2000) noticed the fact that there is an age threshold up to which kidneys grow. According to the authors, kidney size increases up to the age of 30, then, in the middle age, reaches plateau and decreases in the old age [2]. It may suggest that there is a necessity to develop standardized organ measurement values during their growing period, as well as from the moment of their decreasing due to the physiological process of aging. The earlier study showed that the size of internal organs is determined by sex. Females have statistically smaller measurements of spleen and liver when compared to males[5]. Our study shows similar results. In addition, our study reveals that females have statistically smaller measurements of kidneys when compared to males. Among Jordanian population spleen size is not correlated with age, but, on the other hand, it is positively correlated with body weight, as well as BMI[6]. Our study reveals corresponding results. Once again research data confirmed that the size of a particular organ should always be verified in aspect of holistic patient assessment.

CONCLUSIONS

As we can see numerous body parameters are positively correlated with the size of internal abdominal organs. The age of the patient always should be taken under consideration during sonographic assessment of organs. Based on our own study and the overview of literature we can easily notice that measurements of abdominal organs could bring extremely important diagnostic clues to sonography. Standardized normal values adjusted individually to the patient could be instrumental and beneficial in assessment if the size of the particular organ in the particular patient is within normal limits. Alternations of organ sizes can be associated with underlying pathological processes occurring in particular organ or even in a whole organism. Therefore, in our opinion, it is essential to calculate and specify normal organ measurements adjusted to height, weight and BMI (thus body physiological parameters) during abdominal sonography. The development of algorithms adjusting measurements to body parameters is the most reasonable solution. However, the limited number of participants demands a more comprehensive study to develop such algorithms. We deeply believe that our study will inspire other researchers to conduct further studies concerning subjective interpretation of abdominal organs size deviations. Our study suggests that body features such as weight, height and BMI are correlated with sizes of liver, spleen and kidneys.

ACKNOWLEDGEMENTS

The authors of this article acknowledge the support of Professor Wieslaw Jakubowski, as well as the whole Diagnostic Imaging Department of Second Medical Faculty, Medical University of Warsaw, and would like to thank for allowing us to work with professional medical equipment. The authors express their gratitude to Emanuel Tataj for performing thorough statistical analyses. We also thank Justyna Chyla for the motivation, endorsement and positive feedback. Thanks also go to Julia Szczepanska for proofreading.

CONFLICT OF INTEREST

The authors whose names are listed above certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers’ bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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LIST OF THE TABLES

Tab. 1. Measurements statistic

<table>
<thead>
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<th>Organ</th>
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<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
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