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Standard Liver Volume in Thai Population

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Abstract

Objective: **To measure standard liver volume in Thai population**

Patients and Methods: **A total of 18-male and 2-female autopsy livers from the Department of Forensic Medicine, age ranging from 15-60 years, were investigated for this study. Liver volumes were estimated by water displacement. BSA and BMI were calculated from height and weight.**

Results: **The prospective data was analysed by correlation coefficient. The body weight was found to correlate with liver volume most closely (r = 0.841), while body mass index (r = 0.807), body surface area (r = 0.773) and body height (r = 0.477) correlate less closely. A linear regression formula to estimate total liver volume (TLV) based on body weight was obtained: TLV = 19.59 ± weight (kilogram; r2 = 0.988; P <.0001). A formula based on body mass index also was derived: TLV = 53.95 ± BMI (r2 = 0.987; P <.0001). A formula based on body surface area also was derived: TLV = 721.31 ± BSA (square meter; r2 = 0.981; P <.0001).**

Conclusions: **Total liver volume was found to correlate with body weight, body mass index (BMI) and body surface area (BSA). The formulas for the calculation of TLV were established by linear regression analysis as follow: TLV = 19.59 ± weight; TLV = 53.95 ± BMI; TLV = 721.31 ± BSA**

It has been shown that increasing in major hepatic resection and liver transplantation (living donor and split-liver transplantation) cure more malignant disease and end stage liver disease patients.

In major hepatic resection (left, right and extended right and left hepatic lobectomy), most surgeons believe that at least 25-35% of the liver must be left in place after resection to ensure that the patient has sufficient hepatic tissue to meet metabolic demands. The standard liver volume and the volume of remaining hepatic lobe should be measured to ensure adequate remaining hepatic function.[1]

Living donor and split-liver transplantation technique require the calculation of a standard liver volume (SLV) as reference point for the minimal volume necessary for the recipient.[2,3]

There has been no study on standard liver volume in Thai population. This study was designed to determine a formula predicting standard liver volume (SLV) and segments of liver in Thai adult population.

Patients and Methods

During the period between 2003 and 2004, a total of 18 male and 2 female autopsy livers from the Department of Forensic Medicine, age ranging from

15-60 years, were dissected for this study. Total liver weights were measured. Total liver volumes were estimated by water displacement. Liver division (first-order, second-order, third-order) were performed. Segmental weights and volumes were estimated. B ody weight and body height were recorded. Body surface area (BSA) was calculated according to method of Dubois and Dubois (1916) using formula BSA = W $0.425 \times H\ 0.725 \times 0.007184$ where W is body weight in kilograms and H the height in centimeters. Body mass index (BMI) was calculated from Quetelet's formula (Criqui et al., 1982): BMI = $(10,000 \times W) / H2$. A total of 20 autopsy livers were used to derive formulas.

Statistic Analysis

Statistical analysis used correlation coefficient and linear regression analysis.

Results

Results are summarized in Table 1. There were a total of 20 subjects in this study.

The liver volume data was analysed by correlation coefficient. The body weight was found to correlate with total liver volume most closely (r = 0.841) while body mass index (r = 0.807), body surface area (r = 0.773) and body height (r = 0.477) correlate less closely. A linear regression formula to estimate total liver volume (TLV) based on body weight was obtained: TLV = 19.59 x weight (kilogram; r2 = 0.988; P <.0001). A formula based on body mass index also was derived: TLV = 53.95 × BMI (r2= 0.987; P <.0001). A formula based on body surface area also was derived: TLV = 721.31 × BSA (square meter; r2 = 0.981; P <.0001).

The liver weight data was analysed in similar fashion. Again, the body weight was found to correlate with total liver weight most closely (r = 0.841) while body mass index (r = 0.807), body surface area (r = 0.773) and body height (r = 0.477) correlate less closely. A linear regression formula to estimate total liver weight (TLW) based on body weight was obtained: TLW = 21.33 × weight (kilogram; r2 = 0.988; P <.0001). A formula based on body mass index also was derived: TLW = 58.34 × BMI (r2 = 0.988; P <.0001). A formula based on body surface area also was derived: TLW = 780 × BSA (square meter; r2= 0.984; P <.0001).

Discussion

With advances in surgical technique and anesthesia, major hepatic resection and liver transplantation have become more common. Adult-to-adult living liver transplantation and split liver transplantation can increase donor pool and are becoming the accepted treatment in many countries. All require calculation of liver volume especially adult-to-adult living liver transplantation to ensure adequate liver mass for both recipient and donor. There are many formulas to predict total liver volume. Some of which are:

The formula developed on Western population (adult)[4]

total liver volume (ml) based on body surface area = -794.41 + 1267.28 × body surface area (m^2)

total liver volume (ml) based on weight = 191.80 + 18.51 × weight (kilogram)

The formula developed on Caucasian population[5]

total liver volume (ml) = 1072.8 × body surface area (m^2) - 345.7

The formula developed on Japanese population[6]

total liver volume (ml) based on weight and height = 2.223 × body weight(kilogram)0.426 × body height (cm) 0.682

Table 1 Descriptive data

	N	Minimum	Maximum	Mean	Std. Deviations
Age	20	16	60	32.10	13.506
Weight (kg)	20	42	86	59.24	12.308
Height (cm)	20	150	184	164.05	8.617
BSA (cm^2)	20	1.33	2.06	1.6380	0.19254
BMI	20	17.58	28.65	21.8653	3.32968
TLV (cm^3)	20	807	1,647	1,177	2.337455
TLW (gm)	20	870	1,770	1274.29	249.7663

total liver volume (ml) based on body surface area[6,7] = 706 × BSA (m^2) + 2.4

These formulas were derived differently and from different population. Liver volume derived from Japanese formula was 322.6-335.8 g less than that of Caucasian population. Most of these formulas use body surface area, which is difficult to obtain accurately, for the calculation of liver volume. Other measurements such as helical computed tomography and ultrasonography were used to assess liver volume. The mean liver volume varies among different studies (1545.4 ± 255 ml)[8], (18.1 ± 0.5 ml/kg body weight),[9] (1402 in men, 1257 in women).[10] Liver volume correlates with body weight, height, body surface area and body mass index.[7]

Our study was done in Thai population which are homogeneous. The body weight and height did not vary widely. We found the liver volume to correlate most closely with body weight. We also found that in patients with the same body weight, taller patients (bigger body surface area) have smaller liver volume than shorter patients (smaller body surface area). This finding is opposite to what one would imagine. But, as we mentioned earlier, our study is based on a rather homogeneous group of population. This implies that one must be cautious in using this formula on a very fat or very tall patient.

Summary

In this study, we developed formulas to predict liver volume and weight based on body weight, body surface area and body mass index. The most accurate and easy-to-use is a formula based on body weight.

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