

LETTER TO THE EDITORS

THE VOLUME OF THE LIVER IN PATIENTS CORRELATES TO BODY WEIGHT AND ALCOHOL CONSUMPTION

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The measurement of liver volume has gained practical use in relation to liver transplantation (Kawasaki *et al.*, 1993). Liver volume may also relate to the many metabolic processes in which the liver is engaged (Homeida *et al.*, 1979; Marchesini *et al.*, 1988; Murry *et al.*, 1995; Reichel *et al.*, 1997; Kwo *et al.*, 1998; Andersen *et al.*, 1999). The present study was undertaken to measure liver volume by computerized tomography (CT) in patients and to investigate its potential correlation to height, age, body weight, body mass index (BMI), drinking, and smoking habits.

Patients were eligible for the study if they were referred for an abdominal CT scan and fulfilled the following criteria: (1) normal CT scan of the liver without focal lesions; (2) attenuation comparable to the spleen; (3) no history or clinical signs of liver disease. Patients who had received chemotherapy during the 2 years prior to the study, or upper abdominal radiation therapy, were excluded, as were patients below the age of 18 years, pregnant women, and patients with disorders known to affect the liver. All gave informed consent. Daily tobacco smoking and alcohol consumption were established by interview. Body height and weight were measured. BMI was calculated as body weight/height². Twenty-three women entered the study. They were 57.4 (51.8–63.0) years of age; height 165 (163–167) cm, body weight 69.6 (64.4–74.8) kg, BMI 26.0 (24.2–27.8) kg/m² [means (95% CI)]. Eight subjects smoked 3.3 (0–7.2) g of tobacco/day and seven alcohol consumers drank 6 (0–14) g alcohol/day [means (95% CI)]. All except one were out-patients. Thirty-three men entered the study. They were 51.9 (34.2–69.6) years of age; height 178 (176–180) cm, body weight 80.1 (76.8–83.4) kg, BMI 25.3 (24.2–26.4) kg/m². Sixteen subjects smoked 5.7 (2.9–14.3) g tobacco/day and 26 alcohol consumers drank 31 (26–36) g alcohol/day. Only two men were not out-patients. The CT examinations and calculation of liver volume were performed as described earlier (Andersen *et al.*, 1999). Multiple forward regression analysis using the liver size as dependent value was performed. The alcohol consumed was log 10 transformed before analysis and the analysis of tobacco consumption was done for smokers and non-smokers, respectively. The remaining parameters were distributed normally. Significance level (*P*) was set at 0.05. Statistical analysis was done using the

computer program manual *Statistica for Windows* (1996) (StatSoft, Inc., Tulsa, OK, USA).

Liver volume was 1398 (1294–1502) ml [mean (95% CI)] in female and 1831 (1796–1956) ml in male patients. The liver volume (LV) correlated to body weight (BW) in females $LV\ (ml) = 389 + 14.5 \times BW\ (kg)$ ($P < 0.01$) and to body weight and alcohol consumption (AC) in males $LV\ (ml) = 415 + 17.3 \times BW\ (kg) + 210.5 \times \log_{10} AC\ (drinks/day)$ ($P < 0.01$). There was no significant correlation to height, age or smoking habits ($P > 0.05$). The liver volume corrected for body weight (LV/BW) was 20.2 (19.1–21.3) ml/kg in females and 22.9 (21.5–24.3) ml/kg in males ($P < 0.01$). Men and women not consuming alcohol had LV of 1602 (1350–1854) ml and 1341 (1233–1449) ml, respectively.

Table 1 gives the data from the present study together with previously published data on liver volume and liver volume related to body weight. A considerable variation in liver volume is seen. This is mainly due to differences in body weight. Indeed, correcting the liver volume according to the body weight gives comparable values (Table 1). We found higher liver volumes in men than in women. However, we found no differences in liver volume corrected for body weight between women and men who did not consume alcohol. Thus, the higher liver volume found in men in our study was presumably due to higher body weight and alcohol consumption among men. This is in accordance with an investigation by ultrasound scanning, which showed no differences in LV/BW between men and women (Rasmussen, 1977). This was, however, in contrast with data from a recent study (Kwo *et al.*, 1998). We found a significant relation between alcohol consumption and liver volume in male patients. The same relation was not found in females, probably due to the small number of drinkers and their modest alcohol consumption. Another study addressing this question (Barrison *et al.*, 1987) found clinical hepatomegaly among 'drink-watchers', who had been heavy drinkers for at least 2 years. No significant correlation between liver volume and age, height or tobacco smoking was found in this study.

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Table 1. Data on human liver volume (LV) and liver volume corrected for body weight (LV/BW) obtained by ultrasonic (US) and computerized tomography (CT) scan

Method	Subjects	Sex	No. of participants	LV (ml) (CI)	LV/BW (ml/kg) (CI)	Reference
US	Patients	Male	15	1771	22.7	Rasmussen (1972)
US	Patients	Female	15	1343	20.5	Rasmussen (1972)
US	Patients	Male + female	20	1611 (1572–1650)	23.4	Kardel <i>et al.</i> (1971)
US	Healthy subjects	Male	35	1761 (1655–1867)	24.4 (23.3–25.5)	Rasmussen (1977)
US	Healthy subjects	Female	43	1479 (1409–1549)	24.9 (23.6–26.2)	Rasmussen (1977)
CT	Patients	Male + female	31	1148 (1098–1198)	20.5 (19.8–21.2)	Urata <i>et al.</i> (1995)
CT	Healthy subject	Male + female	11	1493 (1357–1629)	20–27	Henderson <i>et al.</i> (1981)
CT	Healthy subjects	Male	6	1086 (913–1259)		Nagasue <i>et al.</i> (1987)
CT	Healthy subjects	Female	6	1006 (904–1108)		Nagasue <i>et al.</i> (1987)
CT	Healthy subjects	Male	10	1540 (1040–2040)	19.3 (17.3–20.8)	Kwo <i>et al.</i> (1998)
CT	Healthy subjects	Female	10	1480 (1110–1850)	22.5 (20.3–24.6)	Kwo <i>et al.</i> (1998)
CT	Patients	Male	33	1831 (1706–1956)	22.9 (21.5–24.3)	Present study
CT	Patients	Female no alcohol consumed	16	1341 (1233–1449)	20.0 (18.6–21.4)	Present study
CT	Patients	Male no alcohol consumed	7	1602 (1350–1854)	21.1 (18.0–24.2)	Present study
CT	Patients	Female	23	1398 (1294–1502)	20.2 (19.1–21.3)	Present study

CI, confidence interval.

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