Morphology of liver

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Abstract

Background Liver size is related to body surface area. The present study was conducted to assess liver size and to find its relationship with body parameters. Also, the external surface of liver was studied for presence of fissures, which may demarcate the vascular segments and the blood vessels beneath them and may help the surgeon for resection of liver segment.

Material and Methods Apparently normal liver specimens were obtained from 50 cadavers aged 19–65 years. Measurements of liver diameters were taken with the help of Vernier Calipers. Volume of liver was taken by water displacement method. Means and standard deviation of data were calculated and liver dimensions were co-related with body parameters.

Results The mean maximum transverse diameter was 199.4 ± 24.5 mm and maximum vertical diameter was 149.5 ± 18.7 mm. Significant correlations were observed between Maximum anteroposterior diameter and body mass index

($p < 0.05$); Vertical diameter at falciform ligament and body weight ($p < 0.01$); Highly significant correlation was seen between liver volume and body surface area ($P < 0.001$). The fissures showed underlying veins draining into the inferior vena cava in 40% cases.

Conclusions A significant increase in the body parameters with a corresponding increase in the liver dimensions was found. Study of morphology of liver can help the surgeons to dissect in proper planes to make the resection safe. The surface of liver showed 1–3 fissures distributed on all lobes in 70% specimens demarcating the vascular segments, which may help the surgeon during resection of liver.

Keywords Liver dimension · Fissure resection · Vascular segments

Introduction

The determination of liver size is important, which may be altered by various hepatic disorders. Clinical estimation of liver size has been attempted by radioactive rose Bengal scintiscans [1]. Methods like palpation, percussion, and inspection of conventional roentgenograms of abdomen, scintillography etc. give only an idea of the dimensions of liver and need for more exact methods were recognized. The hepatic size may be determined by palpating below coastal margin but it is an unsatisfactory method [2]. Liver span is also a prognostic marker of fulminant hepatic failure [3]. However, liver span measured by percussion underestimates liver size as compared to radiological methods [4, 5]. Liver volume also has been suggested to reflect liver atrophy [2].

The above studies are methodology oriented and gives data on liver size, volume and surface area in foreign

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populations [1, 2, 6, 9, 10]. Data on liver span and its correlations have also been presented on Indian population [4, 5, 7, 11, 14] but none of these studies give the dimensions at various planes of the liver. The present study gives the liver size by physical measurements of liver diameters and its volume and correlates them with body parameters. The external surface of the liver was also studied for morphological features such as presence of fissures and vessels below them, boxing, humps and relations of gall bladder with liver.

Material and methods

The study was conducted on 50 normal liver specimens obtained from cadavers aged 19–65 years. Livers showing signs of any organic disease or of hard consistency were excluded. Body parameters viz, age, body height, and body weight of cadavers were noted. Body mass index was calculated: (weight (kg)/ height (m [2])) and body surface area (BSA) was calculated from a nomogram [8]. Diameters (in mm) were taken on liver specimens with the help of Vernier Calipers (Mitotoyo, Japan) (Fig. 1):

- Maximum anteroposterior diameter
- Maximum transverse diameter
- Maximum vertical diameter
- Vertical diameter at fundus of gall bladder
- Vertical diameter at attachment of falciform ligament

Volume (ml) of liver was taken by water displacement method. The data was subjected to the statistical analysis, mean and standard deviations of liver diameters and volume were calculated and correlations between liver dimensions and body parameters were obtained. External surface of liver was observed for fissures, humps and boxes and relations of gall bladder. These fissures were slit open to observe the blood vessels beneath them. The incidence of presence of fissures on the lobes was noted.

Results

The mean body parameters of the present study cadavers showed mean age of 33.05 ± 11.51 years, mean of body mass index of 19.59 ± 3.32 , (Table 1). The mean liver dimensions show the maximum transverse diameter to be greatest, 199.4 ± 24.5 mm and vertical diameter at falciform ligament to be smallest, 96.8 ± 13.9 . Volume of liver was 1140.15 ± 244.68 ml, (Table 2).

Statistically significant correlations were observed between maximum anteroposterior diameter and BMI ($P < 0.05$); vertical diameter at falciform ligament and body weight ($P < 0.01$). Liver Volume correlated significantly with body height ($P < 0.05$), body weight ($P < 0.001$) and BSA ($P < 0.001$).

Morphological external features of the livers showed a partially embedded gall bladder with margins adherent

Fig. 1 A diagrammatic representation showing the methodology of measurement of diameter of the liver.

to liver mass in 4% specimens. Incidence of fundus of gall bladder remaining within the inferior margin of liver or projecting beyond it was equal (50%). Gallstones were not seen in the livers in the present study. Incidence of presence of accessory fissures besides new fissures on the surface of the liver was 70%. These accessory 1–3

fissures were observed which were distributed on all the lobes of the liver (Table-4). On dissection, these fissures, at places, corresponded to the intersegmental veins (Fig 2a, b). Quadrate lobe showed small appendages in 80% cases. Boxing was observed of the right lobe in one specimen only.

Table 1 Means and standard deviations of body parameters of the study sample

	Mean	Standard deviation	Range
Age (years)	33.05	11.51	19–65
Body height (cm)	166.25	9.34	149–188
Body weight (kg)	54.03	9.48	35–75
Body mass index (kg/m ²)	19.59	3.32	13–26
Body surface area (mm ²)	16528.23	1621.26	13587–20752

Table 2 Means and SD of liver dimensions

	Mean	Standard deviation	Range
Maximum anteroposterior diameter (mm)	87.3	18.7	60–158
Maximum transverse diameter (mm)	199.4	24.5	134–260
Maximum vertical diameter (mm)	149.5	18.7	116–173
Vertical diameter at center of fossa for gall bladder (mm)	133.0	16.7	97–166
Vertical diameter at falciform ligament (mm)	96.8	13.9	77–121
Volume of liver (ml)	1140.15	244.68	800–1720

Fig. 2 Photographs of livers after dissecting the fissures: (a) showing right Intersegmental hepatic veins deep to the fissure present on the surface of right lobe (b) showing middle hepatic vein.

Table 3 Correlation of liver dimensions with age, body height, body weight, body mass index and body surface area

	Age	Bd. Ht.	Bd. Wt.	BMI	BSA
Maximum anteroposterior diameter	0.451	0.170	0.210	0.052*	0.643
Maximum transverse diameter	0.802	0.370*	0.850	0.270	0.161
Maximum vertical diameter	0.339	0.187	0.140	0.890	0.246
Vertical diameter at center of fossa for gall bladder	0.984	0.240	0.550	0.587	0.344
Vertical diameter at falciform ligament	0.333	0.306	0.483**	0.087	0.079
Volume of liver	0.783	0.344*	0.429**	0.188	0.002***

***p < 0.001

** p < 0.01

* p < 0.05

Table 4 Incidence of fissures on various lobes on surface of liver

Fissures	N	%
Total no. of fissures present	35	70.0
Caudate lobe a) single fissure	21	45.7
Quadrangle lobe a) single fissure	24	52.2
b) two fissures	1	2.2
Right lobe a) single fissure	15	32.6
b) two fissures	4	8.7
c) three fissure	3	6.5
Left lobe a) single fissure	6	13.6
b) two fissures	7	15.2

Discussion

In the present study the mean maximum transverse diameter was greatest and at vertical diameter at falciform ligament, was smallest. The liver dimensions are comparable with other studies on liver size (1, 2, 4, 7, 9, 10,). Liver size taken in recumbent position at midclavicular line was 14.1 cm & at mid sternal line was 4.0 cm in normal adults [1]. In a report of task group on reference man the greatest diameter (length) was 20–30 cm, greatest anteroposterior diameter (width)—10–21 cm, greatest vertical diameter (height)—7–15 cm [9]. The knowledge of the dimensions of liver, is also useful in diagnosing cirrhosis of liver [10]. Liver span in normal Indian population (age group 8 days – 75 years) was reported to be 8.9 ± 2.1 cm [4]. and in another study the postmortem liver span was 16.3 ± 12.7 cm [7]. Liver size measured as volume was taken by roentgenological methods and was <850 ml/m (per square of patient surface area) in normal

livers [2]. In the present study it was 1140.15 ± 244.68 ml by water displacement method. The knowledge of morphology can help the surgeons to dissect in proper plane and make the resection safe.

Significant correlation between liver dimensions and body parameters as stated in the present study were also reported by previous workers. A significant correlation of liver surface area and liver weight with body weight has also been reported earlier [11]. A good correlation was found between antemortem liver span & postmortem liver weight ($r = 0.96$) in diseased livers and it was concluded that liver span fortells the liver weight [7].

Partially embedded gallbladder was observed in 4% of the specimens in the present study. Intrahepatic gall bladder has been reported to be present in infants and when detected in adults, it may contain stones, the mesentery of the gall bladder has been reported in 4% [12] but these findings were not found in the present work. Liver is comprised of two

main lobes & two accessory lobes, which are individualized by visible well-defined fissures [13]. Besides these fissures, the present study showed 1–3 accessory fissures to be present on all the surfaces of the lobes in 70% of specimens. The presence of fissures on the caudate lobe has also been reported previously [14]. Grooves / fissures numbering 1 to 7 were seen on the superolateral surface of the right lobe and they are usually discovered at laprotomy or postmortem. These fissures may occasionally be pedunculate-showing persistence of fetal lobulation with blood vessels and bile ducts in the pedicle. Humps or boxes, which could be present on the upper surface of right lobe, may distort the diaphragm and account for unusual chest x-ray appearances [15], however in the present study boxing was observed in one specimen only.

Conclusion

In the present study, the fissures on the surface of the liver, corresponded to hepatic veins, may be a useful landmark for demarcation of segment or sector during surgery.

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