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# A New Reference Line for Measuring the Liver Size in Healthy Newborns

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## Abstract

The liver span in 103 healthy newborns was determined by percussion and ultrasonic scanning along the midclavicular line (MCL) and the umbilicus-nipple line (UNL). The liver size (mean  $\pm$  SD) measured along the MCL was  $4.1 \pm 0.7$  cm (range 2.7 - 5.7 cm) by percussion and  $4.0 \pm 0.8$  cm (range 1.9 - 6.2 cm) by ultrasonic scanning. Along the UNL, the liver size determined by percussion was  $4.0 \pm 0.7$  cm (range 2.8 - 5.8 cm) and  $3.7 \pm 0.8$  cm (range 1.4 - 5.8 cm) by ultrasonic scanning. The correlation coefficient between liver measurement along the MCL and UNL by percussion and ultrasonic scanning was good and statistically significant ( $r = 0.95$ ,  $p < 0.0001$  and  $r = 0.83$ ,  $p < 0.02$ , respectively). The new reference line for measuring the liver size, the UNL, should allow the clinician to determine the liver size more easily and may improve the accuracy in examining the liver.

Clinical estimation of the liver size may be of considerable importance in detecting the presence of hepatomegaly which may require extensive evaluation<sup>(1-3)</sup>. Measurement of the liver size in the newborn frequently has been obtained only by palpation of the projection below the costal margin<sup>(4)</sup>. However, palpation alone yields an unreliable index of the liver span due to variations in liver axis, the presence of a Riedel's lobe, and the

position of the diaphragm. It has been suggested that the measurement of the liver span obtained by percussion/palpation could be a more reliable estimation of the liver size<sup>(5,6)</sup>. The liver size can also be assessed with accuracy by radiography<sup>(7-9)</sup> and by radioactive scintiscan procedures<sup>(10,11)</sup> but because of the cost, as well as the potentially harmful effects of radiation, these methods are not commonly employed with children. An ultrasonic

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scanning<sup>(12,13)</sup> promises to be a useful diagnostic technique and is particularly helpful in distinguishing between cysts and solid mass lesions of the liver. The liver size can be measured with high accuracy by this non-invasive technique.

The usual reference line for measuring the vertical liver span is the midclavicular line (MCL). However, unless care is taken during the examination, the MCL can be "a wandering land mark", with documented interobserver variations up to 10 cm<sup>(14)</sup>. Variations in the MCL will inevitably lead to imprecision in liver span assessments<sup>(15)</sup>. The potential error in locating the MCL in newborns is due to the difficulty in palpating the clavicle. We suggest another reference line for measuring the vertical liver span in newborns namely, the umbilicus-nipple line (UNL), which spaces from the umbilicus to the right nipple of the newborn. The UNL can be determined more easily than the MCL and may improve the accuracy in examining the liver. The present study was undertaken in order to establish the relative reliability of evaluating the liver size as determined by percussion and ultrasonic scanning along the new reference line, the UNL, in healthy newborns.

## SUBJECTS AND METHOD

After obtaining verbal informed consent from parents, a total of 103 newborns were examined by a pediatrician (JJ) and a radiologist (JK). We included in the study only the healthy, full-term newborns who were appropriate for gestational age and who were born after normal pregnancies and uncomplicated deliveries. Newborns at risk for demonstrating abnormal liver spans were excluded from the study. Newborns were excluded if they were ill, born with five-minute Apgar scores less than 7, had major congenital anomalies, or positive VDRL titers. Newborns of mothers suffering from chronic diseases, taking long-term medication were also excluded.

The liver size was determined between the ages of 1-5 days. All liver span determinations were measured along the MCL and UNL by percussion and ultrasonic scanning within the same day. During the examination, all newborns lay in a supine position. The incident finger was always perpendicular to the MCL and UNL. The lower borders were determined by soft percussion starting in the lower abdominal quadrant, percussing upward, and marked in the middle of the incident

finger when a change in dullness was noted. The upper borders were defined by percussion in a downward direction and marked at the middle of the incident finger when a distinct change in percussion was detected. The examiner then measured liver spans along the MCL and UNL determined by percussion of the upper and lower borders. Measurements were made to the nearest millimeter of a centimeter using a standard paper tape that was graduated in millimeters. After completion of the measurements by a pediatrician, sonographic measurements of liver span along the same MCL and UNL were carried out the same day by a radiologist who had no knowledge of the previous measurements. All sonographic images were obtained using a real-time scanner with a 3.5 MHz linear transducer (GE RT-2800). The upper and lower points of the measurements of the liver span along the MCL and UNL were marked and then measured from the sonographic image to the nearest millimeter of a centimeter.

Linear regression and correlation analyses were used to investigate the relationships between variables. Mean values for the liver size were compared by a student's T-test with significance set at  $p < 0.05$ .

## RESULTS

Of the 103 newborns examined, there were 53 male and 50 female infants. Birth weight (mean  $\pm$  SD) was  $3150 \pm 320$  g. The liver sizes, assessed by percussion and ultrasonic scanning are presented in Table 1. No significant differences in liver size were found between males and females. Liver measurements obtained along the MCL by percussion were not significantly different from those obtained by ultrasonic scanning ( $p < 0.27$ ). Along the UNL, the liver size measured by percussion was significantly larger than that measured by ultrasonic scanning ( $p < 0.005$ ). The relation of liver size obtained along the MCL and UNL by percussion and ultrasonic scanning is shown in Fig. 1, 2. The correlation coefficient between liver measurement along the MCL and UNL by percussion and ultrasonic scanning was good and statistically significant ( $r = 0.95$ ,  $p < 0.0001$  and  $r = 0.83$ ,  $p < 0.02$ , respectively).

No correlation was found between liver span and any of the following measurements: birth weight, birth length, head circumference, chest circumference, abdominal circumference.

Table 1. Measured liver size in normal newborns\*.

Measurement (cm.)	Total n = 103	Male n = 53	Female n = 50	P value
Mid clavicular line (MCL)				
Percussion	4.1 ± 0.7 <sup>a</sup> (2.7 - 5.7)	4.2 ± 0.7 (2.8 - 5.7)	4.0 ± 0.6 (2.7 - 5.4)	0.19
Ultrasonic scanning	4.0 ± 0.8 <sup>a</sup> (1.9 - 6.2)	4.0 ± 0.8 (2.3 - 5.5)	3.9 ± 0.8 (1.9 - 6.2)	0.59
Umbilicus - nipple line (UNL)				
Percussion	4.0 ± 0.7 <sup>b</sup> (2.8 - 5.8)	4.1 ± 0.7 (2.9 - 5.8)	4.0 ± 0.6 (2.8 - 5.5)	0.53
Ultrasonic scanning	3.7 ± 0.8 <sup>b</sup> (1.4 - 5.8)	3.8 ± 0.7 (2.4 - 5.2)	4.0 ± 0.6 (1.4 - 5.8)	0.35

\* values are mean ± 1SD (range)

<sup>a</sup> P value < 0.27

<sup>b</sup> P value < 0.005

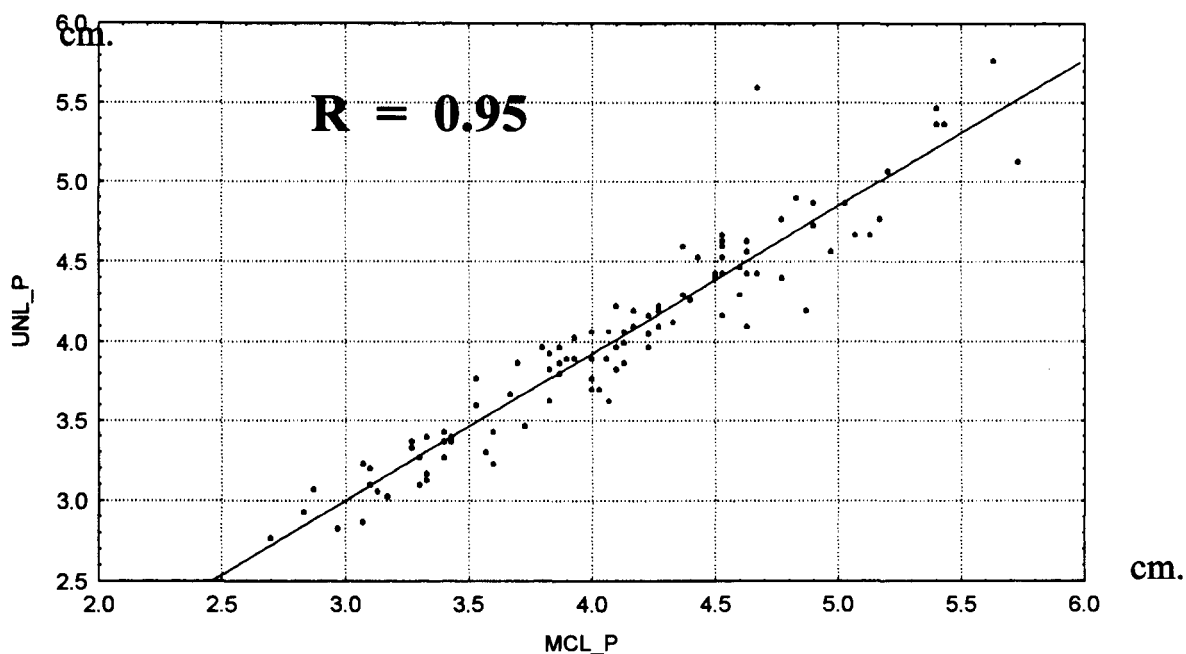


Fig. 1. The relation of liver sizes obtained along the mid-clavicular line (MCL) and the umbilicus-nipple line (UNL) by percussion (P).

## DISCUSSION

The data from this study established the average values of liver span in healthy newborns as determined by percussion and ultrasonic scanning along the MCL and UNL. We chose to measure the

liver size by percussing the upper and lower borders because the newborns were unable to sustain a full inspiration necessary for accurate palpation. Bowyer *et al*<sup>(16)</sup> reported that the liver was palpable

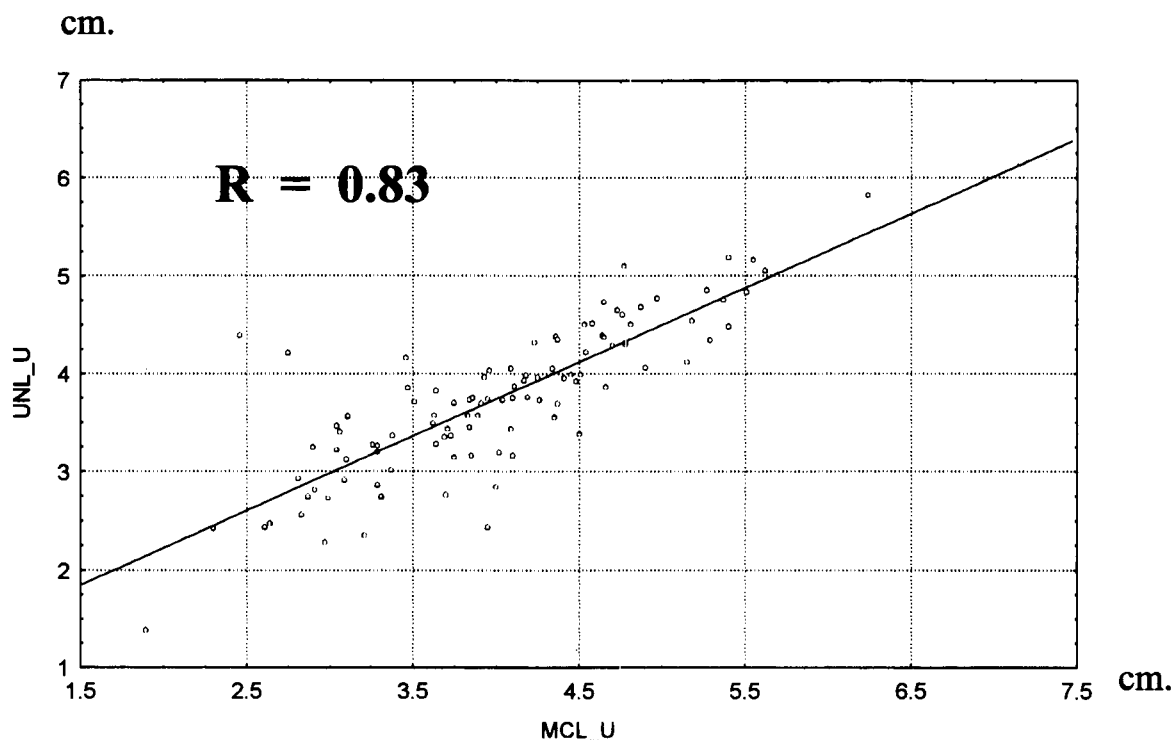


Fig. 2. The relation of liver sizes obtained along the mid-clavicular line (MCL) and the umbilicus-nipple line (UNL) by ultrasonic scanning (U).

in only 53 per cent of 60 newborns. In addition, a good correlation has been found between liver size in hepatic scans and the estimated liver span by percussion(10,11). The liver size obtained along the MCL in our study was approximately 1 cm smaller than that obtained in western neonates(5,6,17), but similar to Chinese neonates(18). Race specific influences on organ size presumably account for this finding.

Although a difference in the liver size between sexes appeared in later adolescence(10, 11,19) no such difference has been documented in any studies involving infants and children(17, 18,20-22).

Chen CM et al(18) and Skrainka B et al(23) found that the liver span clinically mea-

sured by percussion correlates with that measured by sonography which was different from our observation. The major limitation of ultrasonic scanning in determining the liver size was that the upper border of the liver could not be accurately located due to the variable amount of air-bearing lung tissue between the chest wall and the dome of the liver.

A new reference line for measuring the liver size, the UNL, had proved to correlate well with the liver size obtained along a standard reference line, the MCL, both by percussion and ultrasonic scanning. These data should allow the clinicians to determine the liver size more easily and may improve the accuracy in examining the liver.

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## เส้นอ้างอิงใหม่สำหรับการวัดขนาดตับในทารกแรกคลอดปกติ

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ได้ตรวจวัดขนาดตับของทารกแรกคลอดปกติจำนวน 103 ราย โดยวิธีเคาะหาความทึบของตับ และการใช้คลื่นเสียงความถี่สูงในแนว midclavicular line (MCL) และแนว umbilicus–nipple line (UNL) ค่าเฉลี่ยขนาดตับวัดในแนว MCL โดยวิธีเคาะหาความทึบของตับเท่ากับ  $4.1 \pm 0.7$  ซม. (พิสัย 2.7–5.7 ซม.) และเท่ากับ  $4.0 \pm 0.8$  ซม. (พิสัย 1.9–6.2 ซม.) เมื่อตรวจโดยการใช้คลื่นเสียงความถี่สูง ในแนว UNL ค่าเฉลี่ยขนาดตับโดยวิธีเคาะหาความทึบของตับเท่ากับ  $4.0 \pm 0.7$  ซม. (พิสัย 2.8–5.8 ซม.) และ  $3.7 \pm 0.8$  ซม. (พิสัย 1.4 – 5.8 ซม.) เมื่อตรวจโดยการใช้คลื่นเสียงความถี่สูง ค่าสัมประสิทธิ์แห่งความสัมพันธ์ระหว่างขนาดตับที่วัดในแนว MCL และ UNL โดยวิธีการเคาะหาความทึบของตับและการใช้คลื่นเสียงความถี่สูงให้ผลดีและมีนัยสำคัญทางสถิติ ( $r = 0.95$ ,  $p < 0.0001$  และ  $r = 0.83$ ,  $p < 0.02$  ตามลำดับ) เส้นอ้างอิงใหม่สำหรับการวัดขนาดตับในทารกแรกคลอดปกติคือ UNL จะช่วยให้แพทย์ตรวจวัดขนาดตับได้สะดวกและแม่นยำมากขึ้น

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