

# 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(12,13) 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(14). Variations in the MCL will inevitably lead to imprecision in liver span assessments(15). 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.

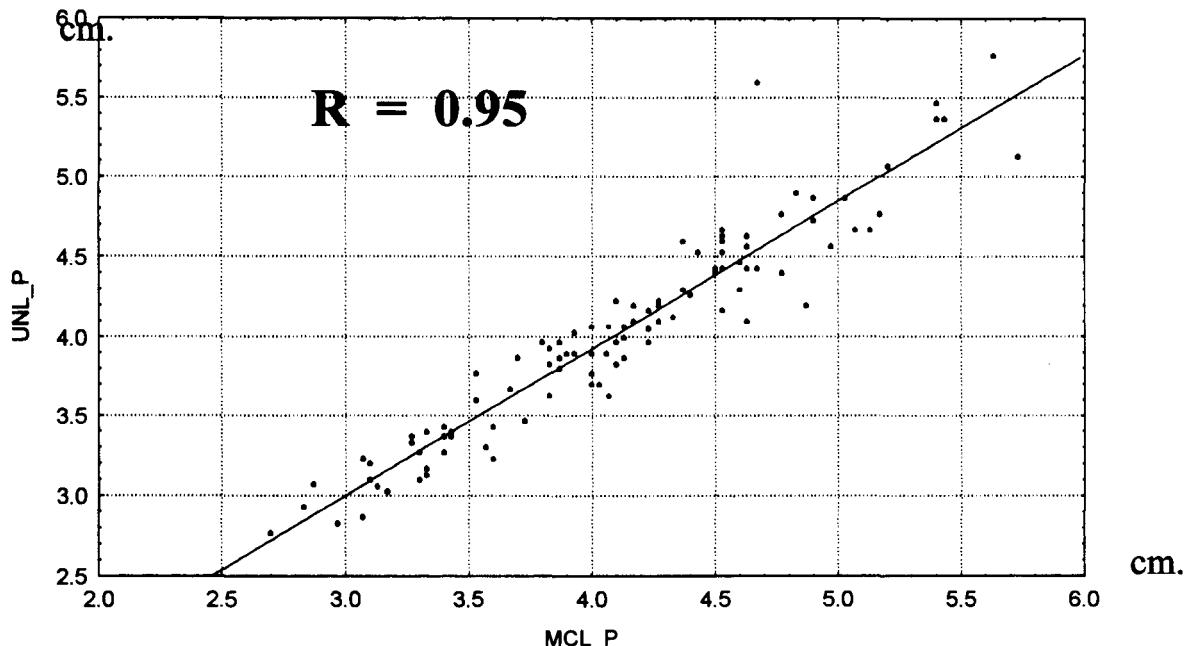
**Table 1. Measured liver size in normal newborns\*.**

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)

a P value &lt; 0.27

b P value &lt; 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*(16) reported that the liver was palpable

cm.

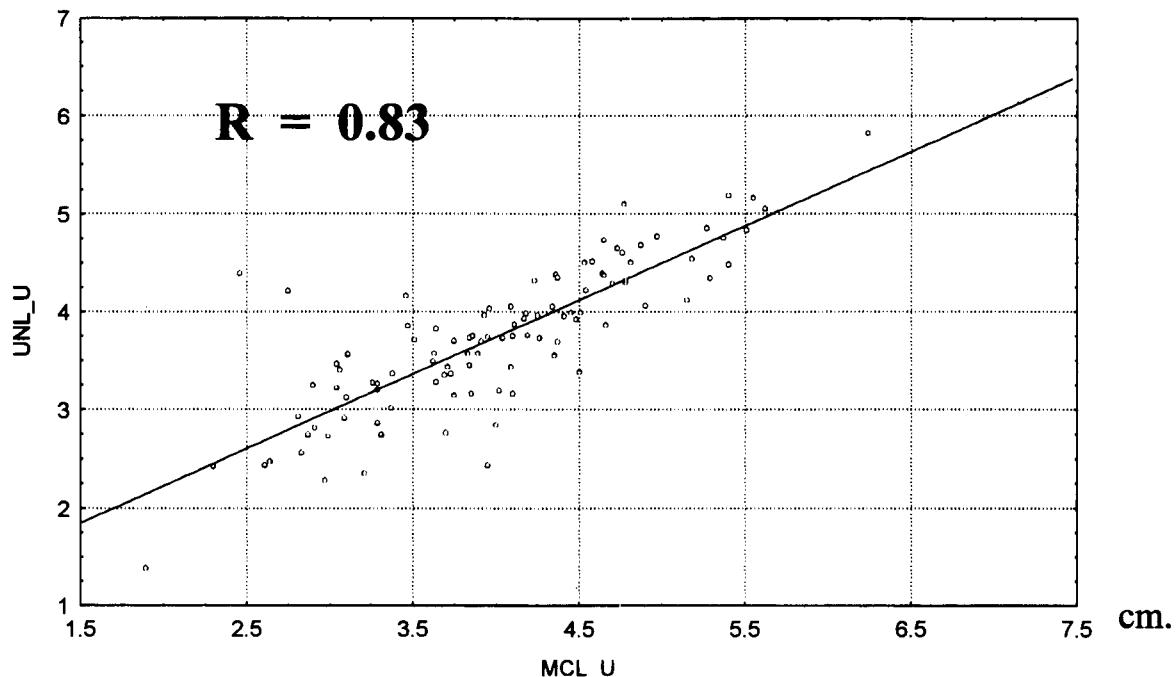


Fig. 2. The relation of liver sizes obtained along the mid-clavicular line (MCL) and the umbilicus-nipple line (UNL) by ultrasonic scanning (U).

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.

## REFERENCES

1. Walker WA, Mathis RK. Hepatomegaly. *Pediatr Clin North Am* 1975; 22: 929-42.
2. Meidl EJ, Ende J. Evaluation of liver size by physical examination. *J Gen Int Med* 1993; 8: 635-7.
3. Naylor CD, Phil D. Physical examination of the liver. *JAMA* 1994; 271: 1859-65.
4. Ashkenazi S, Mimouni F, Merlob P, Litmanovitz I, Reisner SH. Size of liver edge in full-term, healthy infants. *Am J Dis Child* 1984; 138: 377-8.
5. Reiff MI, Osborn LM. Clinical estimation of liver size in newborn infants. *Pediatrics* 1983; 71: 46-8.
6. Brion L, Avni FE. Clinical estimation of liver size in newborn infants. *Pediatrics* 1985; 75: 127-8.
7. Walk L. Assessment of liver size. *Digestion* 1968; 1: 289-94.
8. Riemschneider PA, Whalen JP. The relative accuracy of estimation of enlargement of the liver and spleen by radiologic and clinical methods. *Am J Roentgenol* 1965; 94: 462-8.
9. Deligeorgis D, Yannakos D, Doxiadis S. Normal size of liver in infancy and childhood. X-ray study. *Arch Dis Child* 1973; 48: 790-3.
10. Naftalis J, Leevy CM. Clinical estimation of liver size. *Am J Dig Dis* 1963; 8: 236-43.
11. Peter nel WW, Schaefer JW, Schiff L. Clinical evaluation of liver size and hepatic scintiscan. *Am J Dig Dis* 1966; 11: 346-50.
12. Rosenfield N, Treves S. Liver-spleen scanning in pediatrics. *J Pediatr* 1974; 53: 692-701.
13. Rasmussen SN. Liver volume determination by ultrasonic scanning. *Br J of Radiol* 1972; 45: 579-85.
14. Naylor CD, Mc Cormack DG, Sullivan SN. The midclavicular line : a wandering landmark. *Can Med Assoc J* 1987; 136: 48-50.
15. Harding SR, Cowan DHC. The midclavicular line : a wandering landmark. *Can Med Assoc J* 1987; 136: 921.
16. Bowyer K, Chavalitthamrong P, Marshall RE. Palpable livers and spleens in newborn infants. *Lancet* 1973; 2: 1397.
17. Weisman LE, Cagle N, Mathis R, Merenstein GB. Clinical estimation of liver size in the normal neonate. *Clin Pediatr* 1982; 21: 596-8.
18. Chen CM, Wang JJ. Clinical and sonographic assessment of liver size in normal chinese neonates. *Acta Paediatr* 1993; 82: 345-7.
19. Castell DO, O'Brien KD, Muench H, Chalmers TC. Estimation of liver size by percussion in normal individuals. *Ann Intern Med* 1969; 70: 1183-9.
20. Younoszai MK, Mueller S. Clinical assessment of liver size in normal children. *Clin Pediatr* 1975; 14: 378-80.
21. Carpenteri U, Gustavson LP, Leach TM, Bunce H. Liver size in normal infants and children. *South Med J* 1977; 70: 1096-7.
22. Lawson EE, Grand RJ, Neff RK, Cohen LF. Clinical estimation of liver span in infants and children. *Am J Dis Child* 1978; 132: 474-6.
23. Skrainka B, Stahlhut J, Fulbeck CL, Knight F, Holmes RA, Butt JH. Measuring liver span : bedside examination versus ultrasound and scintiscan. *J Clin Gastroenterol* 1986; 8: 267-70.

## เล่นอ้างอิงใหม่สำหรับการวัดขนาดตับในการกราฟแกรคลอตปกติ

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ได้ตัวร่วดขนาดตับของการกราฟแกรคลอตปกติจำนวน 103 ราย โดยวิธีเคาะหาความทึบของตับ และการใช้ค่าลีนเลียงความถี่สูงในแนว 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.) เมื่อตรวจโดยการใช้ค่าลีนเลียงความถี่สูง 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.) เมื่อตรวจโดยการใช้ค่าลีนเลียงความถี่สูง ค่าสัมประสิทธิ์แห่งความสัมพันธ์ระหว่างขนาดตับที่วัดในแนว MCL และ UNL โดยวิธีการเคาะหาความทึบของตับ และการใช้ค่าลีนเลียงความถี่สูงให้ผลตีและมีนัยสำคัญทางสถิติ ( $r = 0.95$ ,  $p < 0.0001$  และ  $r = 0.83$ ,  $p < 0.02$  ตามลำดับ) เล่นอ้างอิงใหม่สำหรับการวัดขนาดตับในการกราฟแกรคลอตปกติคือ UNL จะช่วยให้แพทย์ตรวจวัดขนาดตับได้สะดวกและแม่นยำมากขึ้น

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