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Sonography of the circumrenal and horseshoe adrenal gland in the newborn

E. M. Burton[1,3], **M. E. Strange**[2], **D. B. Edmonds**[4]

[1] Department of Radiology, AMI-Brookwood Medical Center, Birmingham, Alabama, USA
[2] Department of Pediatrics, AMI-Brookwood Medical Center, Birmingham, Alabama, USA
[3] Department of Radiology, Carraway Methodist Medical Center, Birmingham, Alabama, USA
[4] Department of Pediatrics, Carraway Methodist Medical Center, Birmingham, Alabama, USA

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Abstract. The adrenal gland can be visualized using ultrasonography in at least 90% of fetuses of more than 26 weeks gestation. The fetal and neonatal adrenal gland is described as a structure having a characteristic V or Y shape. Despite the frequency of visualization of the neonatal adrenal gland, few reports of adrenal anomalies are present in the radiologic literature. The purpose of this paper is to describe and depict the sonographic appearance of the "horsedhoe" and the "circumrenal" adrenal gland and to discuss adrenal anomalies in general.

Adrenal anomalies, usually found in conjunction with renal anomalies, are uncommon, but may be identified using ultrasonography in neonates. To our knowledge, this report is the first to depict the sonographic appearance of the "horseshoe" and the "circumrenal" adrenal gland.

Case 1

This 3550 g term female newborn was the product of an uncomplicated pregnancy. Although delivery was complicated by transient bradycardia, the Apgar scores at 1 and 5 min were 8 and 9, respectively. Physical examination was unremarkable except for the presence of a single umbilical artery. Renal ultrasound demonstrated that the kidneys were normal in size, shape, and position. The limbs of the left adrenal gland extended below the level of the upper pole of the left kidney and were joined together (Fig. 1). The right adrenal gland had a similar appearance; its limbs extended below the upper pole of the right kidney and joinded forming a loop smaller than that of the left adrenal gland. Physical exam was otherwise unremarkable. The neonatal course was uneventful. There was no clinical nor laboratory evidence of adrenal dysfunction.

Case 2

This term male was the 4280 g product of a pregnancy complicated by polyhydramnios. Amniocentesis was normal. An elective Cesarean section was performed for unstable breech presentation. The Apgar scores at 1 and 5 min were 5 and 7, respectively. Despite supplemental oxygen the infant remained cyanotic. Physical examination disclosed lowset abnormally shaped ears, a systolic ejection murmur, and a single second heart sound. The infant's cry was soft in amplitude and the child was mildly hypotonic.

Echocardiography on the first day of life demonstrated a left cervical aortic arch, truncus arteriosus, apical muscular ventricular septal defect, a right-to-left shunt at the levels of the foramen ovale and the ventricular septal defect, and a retro-aortic mass. High-resolution real-time ultrasonography disclosed that the retro-aortic mass was a fused ("horeshoe") adrenal gland lying behind the aorta (Fig. 2). In addition, there was a left pelvic kidney; the right kidney was normal in size, shape, and position. Chromosomal analysis was normal. There was no clinical nor laboratory evidence of adrenal dysfunction.

Discussion

The primitive adrenal cortex is derived from the epithelium of the posterior abdominal wall located between the mesentery and the head of the mesonephros and is visible by the sixth week of gestation. In the third month of gestation, chromaffin cells from the neural crest migrate centrally into the developing adrenal gland and differentiate into the adrenal medulla [1]. Additional proliferation of epithelial cells caps the primitive cortex and forms the outer definitive zone, destined to become the adult cortex [2].

The adrenal gland is relatively large at birth, but by 2 weeks of age the adrenals have regressed by 1/3 of their birth weight. Between 3–12 months of life, the fetal zone is replaced by the zona glomerulosa, fasciculata, and reticularis. By one year of age, the fetal cortical zone involutes and disappears.

By the eighth week of gestation the kidney has migrated cranially to abut the lower pole of the adrenal gland. As the kidney approaches the lower pole, the adrenal gland assumes a conical shape and later becomes pyramidal. Unlike the kidney, the adrenal gland undergoes no marked shift either cranially or caudally during development [1].

In approximately 90% of newborns of more than 26 weeks gestation, the adrenal gland can be visualized

Correspondence to: E. M. Burton, MD, Department of Radiology, Medical College of Georgia, Augusta, GA 30912-3900, USA

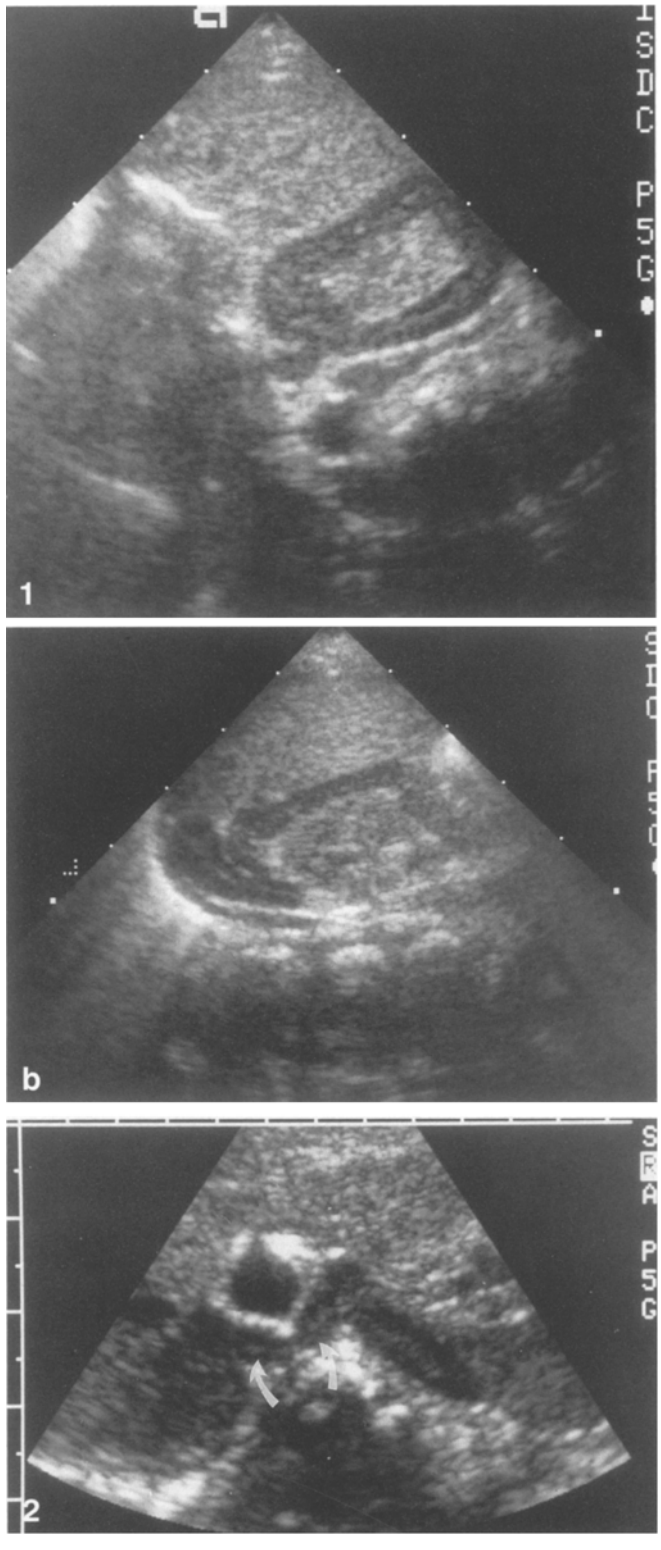

Fig. 1 a, b. *Case 1.* Transverse sonograms of the left adrenal gland demonstrate a "circumrenal" contour (**a**) around the upper pole of the left kidney. The superior limb (1.8 cm in length) of the left adrenal gland is attached (**b**) and completes the "lasso" appearance. The right adrenal gland (not shown) has a similar appearance, but with a smaller loop to its "lasso"

Fig. 2. *Case 2.* Transverse sonogram demonstrates fusion between the medial limbs of the right and left adrenal glands. The lateral limbs each are 1.7 cm in length. An adrenal isthmus *(arrows)* posterior to the aorta completes this "horseshoe" adrenal gland

using ultrasonography [2]. Oppenheimer et al demonstrated the right gland in 97% and the left gland in 83% of cases [3]. Typically, the adrenal gland is uniformly thick with a central linear zone of hyperechogenicity and a peripheral zone that is hypoechoic. The central zone is thought to represent the adrenal medulla; the thicker hypoechoic periphery is considered to be the cortex. The majority of adrenal glands in normal neonates are "Y" or "V" shaped; occasionally a "reverse Z," "omega," or "trilobed" appearance can be identified [3]. The mean adrenal length is 1.2 cm, 1.4 cm, and 1.7 cm for newborns of 25–30 weeks, 31–35 weeks, and 36–40 weeks gestation, respectively [3]. Using serial ultrasonography, Scott et al noted a decrease of diameter, circumference, and length of the adrenal gland by approximately 50% for each measurement from days 1–42 of life [4].

With the exception of accessory adrenal tissue, congenital adrenal anomalies are considered to be either uncommon or rare [1]. These anomalies include adrenal agenesis, hypoplasia, fusion, or heterotopia. Agenesis of the adrenal gland is thought to be due to failure of the entire nephrogenic ridge, occurring early in the fourth week of gestation. Unilateral agenesis of the adrenal gland is almost always associated with agenesis of the ipsilateral kidney. In 10% of cases of renal agenesis, the adrenal gland is absent on the ipsilateral side [1]. In those instances the adrenal gland is usually flat, discoid, and elongated in appearance instead of pyramidal in shape [5–7]. A similar appearance of the adrenal has been described in patients with renal ectopia [7]. Adrenal hypoplasia usually accompanies anencephaly and may be associated with hypoplasia of the thyroid and gonads, suggesting an abnormal hypothalamic-pituitary relationship in such fetuses [1].

In general, fusion of the adrenals behind the aorta accompanies fusion of the kidney (horseshoe kidney) [1]. Droste et al described one patient with bilateral renal agenesis and a horseshoe adrenal in association with Chiari malformation and meningomyelocele [5]. Case 2 presented here is the first to demonstrate a horseshoe adrenal in association with unilateral renal ectopia.

Adrenal heterotopia may be classified as adrenal ectopia, accessory adrenal tissue, and adrenal rests. In adrenal ectopia, the adrenal gland is in its normal location but lies under the capsule of the kidney or of the liver (adrenal-renal or adrenal-hepatic ectopia). In most cases the heterotopia is bilateral. In these ectopias, a thin connective tissue layer is found between the adrenal parenchyma and adjacent tissue, but this layer is almost always incomplete. Inclusion of the adrenal gland under the capsule of the kidney or liver occurs during the eighth week of fetal development when the ascending kidney comes into contact with a lower pole of the developing adrenal gland [1]. Because the kidney, liver, and adrenal are enveloped in peritoneum in early gestation, fusion between the adrenal and liver or kidney may take place. Similarly, fusion between the limbs of the adrenal may occur if there is subsequent destruction of the intervening layers of coelomic epithelium. The process is analogous to the fusion that may occur between the two kidneys themselves in the formation of a horseshoe kidney [1] and may explain formation of a "horseshoe" or "circumrenal" adrenal.

In conclusion, we have reviewed the embryology and spectrum of adrenal anomalies and have depicted adrenal anomalies in two asymptomatic patients. Because the adrenal glands in the newborn are commonly visualized using ultrasonography, careful attention to the shape and size of the adrenals should allow discrimination of congenital anomalies.

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References

1. Gray, SW and Skandalakis, JE (1972) Embryology for surgeons. The embryological basis for the treatment of congenital defects. Saunders, Philadelphia, pp 553–562
2. Rosenberg ER, Bowie JD, Andreotti RF, Fields SI (1982) Sonographic evaluation of fetal adrenal glands. AJR 139: 1145–1147
3. Oppenheimer DA, Carroll BA, Yousem S (1983) Sonography of the normal neonatal adrenal gland. Radiology 146: 157–160
4. Scott EM, Thomas A, McGarrigle HH, Lachelin GC (1990) Serial adrenal ultrasonography in normal neonates. J Ultrasound Med 9: 279–83
5. Droste S, Fitzsimmons J, Pascoe-Mason J, Shepart TH, Mack LA (1990) Size of the fetal adrenal in bilateral renal agenesis. Obstet Gynecol 76: 206–9
6. Rizza JN, Downing SE (1971) Bilateral renal agenesis in two female siblings. AJDC 121: 60–63
7. Hoffman CK, Filly RA, Callen PW (1992) The "lying down" adrenal sign: a sonographic indicator of renal agenesis or ectopia in fetuses and neonates. J Ultrasound Med 11: 533–6

Literature in pediatric radiology

Continued from p. 340

American Journal of Roentgenology *(Baltimore)*

Extracranial cerebellum: CT and MR findings of an unusual variation of the Chiari II malformation. Kesack, C.D., Mamourian, A.C. (Mamourian, A.C., Dept of Rad., The Milton Med. Center, P.O. Box 850 Univ. Dr., Hershey. PA 17033, USA) 160:849 (1993)

John Caffey Award. Colonic perforation by air and liquid enemas: comparison study in young pigs. Shiels II, W.E. et al. (Dept. of Rad., Walter Reed Army Med. Center, Washington, DC 20307, USA) 160:931 (1993)

Pneumatization of the paranasal sinuses: normal features of importance to the accurate interpretation of CT scans and MR images. Scuderi, A.J. et al. (Harnsberger, H.R., Dept. of Rad., Univ. Med. Center, 50 N. Med. Dr., Salt Lake City, UT 84132, USA) 160:1101 (1993)

Volume of the spleen in children as measured on CT scans: normal standards as a function of body weight. Schlesinger, A.E. et al. (Dept. of Rad., Univ. Hosp. C.S. Mott Children's Hosp., 200 E. Hosp. Dr., Ann Arbor, MI 48109-0252, USA) 160:1107 (1993)

Malignant meningioma in a child: Ct and MR findings. Greenberg, S.B. et al. (Dept. of Diagn. Rad., Temple Univ., St. Christopher's Hosp. for Children, Front St. at Erie Av., Philadelphia, PA 19134, USA) 160:1111 (1993)

Applied Radiology *(Port Washington NY)*

Pediatric respiratory emergencies: a practical imaging approach. Crowley, J.J. et al. (Dept. of Diagn. Rad., Allegheny General Hosp., Med. College, Pittsburgh, PA) 22:15 (1993)

Nursing services in pediatric radiology departments. Cohen, M.D. (Dept. of Rad., Riley Hosp. for Children, Univ. Med. Center, Indianapolis, IN, USA) 22:26 (1993)

In utero sonographic diagnosis of urinary tract dilatation. Avni, E.F. et al. (Dept. of Rad., Erasme Hosp., Univ. Clinics, Brussels, Belgium) 22:37 (1993)

Radiological case of the month: chondroblastoma. Kilpatrick, S.E. et al. (Dept. of Pathol., Bowman Gray School of Med., Winston-Salem, NC, USA) 22:42 (1993)

Canadian Association of Radiologists Journal *(Montreal)*

Nonrenal cystic masses in neonates and children. Cramer, B. et al. (Dept. of Rad., The Dr. Charles A. Janeway Child Health Centre, Janeway Place, St. John's, NF A1A 1R8) 44:93 (1993)

Evolution of bone anomalies in 49, XXXXY syndrome. Tumba, A. et al. (Laboratoire de biologie cellulaire, Faculté de med., Xavier Bichat, 16, rue Henri Huchard, F-75018 Paris, France) 44:107 (1993)

Body composition and bone mineral distribution during growth in females. Gordon, C.L. et al. (Webber, C.E., Dept. of Nucl. Med., Chedoke-McMaster, Hops., 1200 Main St. W, Hamilton, ON L8N 3Z5, Canada) 44:112 (1993)

Clinical Nuclear Medicine *(Philadelphia)*

Inhalation scintigraphy with an ultrafine aerosol in infants with functional bronchial stenosis. Kropp, J. et al. (Univ.-Klinik für Nukl. Med., Sigmund-Freud-Str. 25, W-5300 Bonn 1. FRG) 18:223 (1993)

Scintigraphic findings of crossed hemihypertrophy in association with Wilms' tumor. Yeo, E.E., low, J.C. (Dept. of Nucl. Med., Kaiser Permanente Hosp., 9985 Sierra Av., Fontana, CA 92335, USA) 18:247 (1993)

Tc-99m HMPAO SPECT brain imaging of Gilles de la Tourette's syndrome. Sieg. K.G. et al. (38-2 Barkley Circle, Fort Myers, FL 33907, USA) 18:255 (1993)

Radionuclide scrotal imaging in anaphylactoid purpura. Melloul, M.M., Garty, B.Z. (Nucl. Med. Dept., Beilinson Med. Center, Petah Tiqva 49100, Israel) 18:298 (1993)

Salmonella osteomyelitis in an HLA-B27 patient. Leckie, R.G. et al. (Dept. of Rad. and the Nucl. Med. Serv., Tripler Army Med. Center, Honolulu, HI, USA) 18:346 (1993)

Tc-99m HDP bone scintigraphy of ameloblastoma with panorex, CT, MRI, and gross correlation. Leckie, R.G. et al. (Watabe, J.T., Dept of Rad., Tripler Army Med. Center, Tripler AMC, HI 96859-5000, USA) 18:350 (1993)

The lymphoscintigraphic evaluation of patients with Klippel-Trenaunay syndrome. Du Cret, R.P. et al. (Univ., Hosp. and Clinic, Dept. of Rad., Div. of Nucl. Med., Box 382 UMHC, 420 Delaware St. S.E., Minneapolis, MN 55455, USA) 18:444 (1993)

Detection of soft tissue hemangioma of the leg by Tc-99m DTPA-HSA blood pool imaging. Oshima, M. et al. (Dept. of Rad., Teikyo Univ. School of Med., 2-11-1 Kaga, Itabashi-Ku, Tokyo, 173, Japan) 18:454 (1993)

Clinical Pediatrics *(Philadelphia)*

Use of abdominal and pelvic ultrasound in the evaluation of chronic abdominal pain. Schmidt, R.E. et al. (Dept. of Ped., Children's Hosp. Med. Center, 3350 Elland Av., ASB 4-17 Cincinnati, OH 45229-2899, USA) 32: 147 (1993)

Multiple cerebral venous thromboses in a child with ulcerative colitis. Calderon, A. et al. (Becker, L.E., Dept. of Pathol., The Hosp. for Sick Children, 555 Univ. Av., Toronto, Ont., Canada M5G 1X8) 32:169 (1993)

Journal of Bone and Joint Surgery. American Volume *(Boston)*

Scoliosis in children after thoracotomy for aortic coarctation. Van Biezen, F.C. et al. (Dept. of Orthop. Surg., Univ. Hosp., Dr. Molewaterplein 40, NL-3015 GD Rotterdam, The Netherlands) 75-A:514 (1993)

continued on p. 368