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Combined use of ultrasound and computed tomography in the evaluation of fetal intracranial abnormality

P. Kirkinen, I. Suramo, P. Jouppila, R. Herva

Departments of Obstetrics and Gynecology, Radiology and Pathology, University of Oulu, Finland

The clinical importance of conventional x-ray examinations such as native x-ray of the fetus and amnionfetography has diminished with the rapid development of diagnostic ultrasound. The applicability of computed tomography (CT) for the assessment of fetal pathology has been elucidated in only one case report up till now [7]. We therefore wish here to illustrate further the prospects offered by a combination of ultrasonic and CT examination in the assessment of fetal intracranial pathology.

Case 1

The mother was a 25-year-old IV-gravida. The first and second trimesters of the pregnancy were clinically normal. Symphyseal-fundal height was found to have grown abnormally quickly in the 28th gestational week. On ultrasonic examination in the 32nd gestational week, the cranial part of the fetal skull was found to be occupied by multilocular structures from which it was impossible to distinguish the normal ventricular walls or corpus callosum (Figs. 1a and 1b). The brain stem was dislocated by a dense, tumor-like structure. The left brain hemisphere was totally absent on ultrasonic examination, and the site of the right hemisphere featured high-level, irregularly arranged echoes. A round, tumor-like mass was found at the level where the bodies of the lateral ventricles ought to have been located. The transverse dia-

Curriculum vitae

PERTTI KIRKINEN, born in Finland in 1945. Graduated from University of Turku in 1971, specialized in obstetrics and gynecology 1972–1976 and in perinatology 1978–1982. Since 1978 a member of the staff of the Department of Obstetrics and Gynecology, University of Oulu (Head: Prof. P. A. JÄRVINEN). Medical Ph. D. thesis at University of Oulu 1979. Docent in obstetrics and gynecology 1982. Area of interest: Ultrasound in obstetrics, fetal activities.

meter of the skull was 14,8 cm, and ultrasound revealed findings typical of polyhydramnios. Since the nature of these tumor-like structures was not certain from the ultrasonic examination and it was not possible to determine whether or not part of the right brain hemisphere remained unharmed, two CT scans were taken in the 34th gestational week. The levels of these scans were established by ultrasound to enable the upper one to be made at the level of the round, tumor-like mass in the upper part of the skull and the other 2 cm caudally to this. Both scans revealed a mass of tissue of varying density inside the cranium of the fetus. This density analysis revealed local calcifications and bone structures (Figs. 2a and 2b).

Fig. 1a. Longitudinal ultrasonic scan of the fetus with intracranial teratoma. B = brain stem; T = tumor mass

Fig. 1b. Transverse ultrasonic scan of the same case 2 cm cranially from the level of the brain stem. T = tumor mass

Fig. 2a. CT scan of the same case, the most cranial level. T = calcified tumor mass inside the head; A = amniotic fluid

Fig. 2b. The caudal CT scan of the same case. The enlarged head fills almost the whole uterine cavity at this level. T = tumor mass with cystic areas and calcifications; F = fluid-filled area inside the head

The lower CT scan demonstrated that the dorsal part of the skull was full of cystic tissue and the anterior part was full of liquid. On the basis of these examinations the prognosis was considered to be so poor that vaginal delivery was allowed proceed when it started spontaneously in the 36th gestational week. After amniocentesis, which was followed by a discharge of 4000 ml of amniotic fluid, encephalocentesis was performed by the vaginal route and 600 ml of liquor was removed.

The fetal head was compressed during delivery, and a mass of tumor tissue measuring 14 cm × 10 cm × 18 cm was squeezed out of it (Fig. 3a). At autopsy, there was seen to be no cerebrum and a hypoplastic cerebellum was identifiable. The tumor tissue was composed histologically of all three germinal layers, thus being a teratoma. Occurrences of immature neuroepithelium and bone were frequent (Fig. 3b).

Fig. 3a. The irregular cystic tumor mass in the teratoma case

Fig. 3b. The tumor was composed of differentiated and embryonic tissues. Below embryonic neural tissue, and above, hepatic differentiation and immature tubular structures (hematoxylin and eosin X 40)

Case 2

The mother was a 19-year-old primigravida with White C diabetes mellitus. The biparietal diameter was normal on ultrasonic examination in the 25th gestational week, but a finding of incipient hydrocephalia was made, the ventricular/hemispheric ratio being 50% at the level of the frontal horns of the lateral cerebral ventricles and 70% at the beginning of the temporal horns. No other abnormalities were found. The severity of this hydrocephalic process remained unchanged up to the 32nd week, and by the 33rd week the biparietal diameter was 9,7 cm, the midline deviated to the right and the cerebral cortex was 7 to 10 mm thick and almost absent in the extreme cranial part of the skull (Fig. 4). The right side of the cortex was badly visualized by ultrasound, and a suspicion of porencephalia in this region was aroused (Figs. 5 and 6). This led to the performing of three CT scans under ultrasonic control, with the extreme cranial scan located at the level of the bodies of the lateral ventricles and the others 1 cm and 2 cm caudally to this. The two cranial scans revealed that the cortex on the right side was unbroken and 1 cm thick (Fig. 7), while the extreme caudal scan showed the structures of the enlarged ventricles to be symmetrical and the

brain tissue to be moderately intact (Fig. 8). In view of these findings suggestive of a possibility for life with reasonable neurological functions, and because of the rapid progress of the hydrocephalic process, an elective cesarean section was performed in the 34th gestational week. The hydrocephalic infant was treated by shunt-operation. At the age of 5 months, she now has temporary difficulties in eating and mild spasticity in the limb muscles, but no need for permanent hospital care.

Discussion

The ultrasonic findings in hydrocephaly are well documented [1, 2, 3, 5] and the ultrasonic appearance of intracranial teratoma is illustrated in two case reports [3, 4]. In the present cases these fetal abnormalities involved special problems in antenatal ultrasonography. In the teratoma case it was not possible by ultrasound certainly to decide whether the tumor-like masses inside the cranium were anomalous areas of brain tissue or some neoplastic tumor, and in the second case the deviation of the midline along with the poor visualization of the other brain hemisphere pointed to a porencephalic tendency, which carries a risk of a

Fig. 4. Transverse ultrasonic scan of the head of the fetus with hydrocephalia. The gestational age was 33 weeks. F = dilated frontal horn of the lateral cerebral ventricle; T = temporal horn

Fig. 5. The corresponding scan at the level of bodies of the cerebral ventricles. The occipital part of the right ventricle (V) is poorly visualized and the midline deviates to the right. It is not possible to measure the thickness of the cortex (C) on the right side of the head

Fig. 6. Longitudinal ultrasonic scan of the head of the same fetus. The midline is deviant and the right ventricle (V) is not so well illustrated as the left one

Fig. 7. The extreme cranial CT scan of the same case. The brain mantle (arrows) is unbroken on the right side of the head. P = placenta

Fig. 8. The extreme caudal CT scan of the same case. F = frontal horn of the cerebral ventricle; T = temporal horn; P = placenta

particularly poor postnatal prognosis [3]. CT enabled a better tissue characterization to be made in the teratoma case, demonstrating the calcified parts of the tumor, and showed in case 2 that the ventricular system of the brain was dilated, but that the brain structures were otherwise intact. In our opinion, the CT-findings, when combined with the information already achieved by ultrasonic examination, enriched our knowledge concerning the fetal affections. These findings were important in both cases for the selection of obstetrical care at delivery.

The use of CT carries a radiation load to the mother and the fetus of approximately 1 rad per scan of height 4 mm using our techniques. This can be compared with a radiation dose of approximately 1–2 rads over the whole uterus in amniotography. In CT scanning the parts of the fetus and mother not at the scanning level receive quite minimal amounts of radiation. An ovarian dose in excess of 200 rads has quite unambiguous clinical consequences, and an ocular lens dose is critical at 200 rads in adults [6]. Thus the radiation load entailed when using a limited number of CT scans cannot be seen as being too dangerous in relation to the vital information to be gained from this

examination. The lack of information on the response of the fetus to ionizing radiation, however, and especially the speculations concerning the connection between childhood neoplasia and intrauterine exposure to radiation [8], make it necessary to stress the special care which should be taken when using this technique. In order to keep the radiation load minimal while gaining optimal information, careful selection of the level at which the CT scan should be taken is necessary. In this sense it is also important for the mother to note any movement of the fetus after the ultrasonic scanning, so that the position can be checked before CT scanning.

We see that the general information concerning the structure and anatomy of the brain of the fetus gained from CT scanning cannot be as complete as that obtained by ultrasound examination. This is mainly due to the restricted number of scan levels. Our two cases demonstrated, however, that it is worth to use CT as a complementary and "second instance" examination when there are some specific problems after antenatal ultrasound before making vital decisions concerning the perinatal care of the fetus.

Summary

Antenatal ultrasonic findings in two pregnancies with fetal intracranial abnormality were completed by taking a restricted number of computed tomography (CT) scans under ultrasonic control. General information achieved by CT was not greater compared with ultrasonography. CT demonstrated better than ultrasound the calcified areas in the intracranial teratoma of the fetus. In the case of fetal hydrocephaly the existence of a dilated, but otherwise

intact cerebral ventricular system was established by CT after a somewhat controversial ultrasonic finding. CT can be used as a complementary examination when there are specific problems to be evaluated after antenatal ultrasonic scanning. CT should be used in these cases under ultrasonic control and the information of the both methods must be combined for the clinical decisions.

Keywords: Computed tomography, fetal abnormality, ultrasound.

Zusammenfassung

Kombinierte Nutzung von Ultraschall und Computertomographie in der Auswertung fetaler intrakranieller Abnormalität

Pränatale Unterschall-Befunde von zwei Schwangerschaften mit fetaler intrakranieller Abnormalität wurden durch eine begrenzte Anzahl von Computertomographien (CT) unter Ultraschallkontrolle vervollständigt.

Durch CT konnte im Vergleich mit Ultraschall nicht mehr Information gewonnen werden. CT zeigte besser als Ultraschall die verkalkten Bereiche im intrakraniellen

Teratom des Feten. Im Fall des fetalen Hydrozephalus wurde das Vorhandensein eines erweiterten aber sonst intakten zerebralen Ventrikelsystems durch CT festgestellt, nachdem der Ultraschallbefund nicht eindeutig war. CT kann als zusätzliche Untersuchung benutzt werden, wenn es nach einer pränatalen Ultraschallaufnahme spezielle Probleme abzuschätzen gilt. In diesen Fällen sollte CT unter Ultraschallkontrolle benutzt werden, und die Information aus beiden Methoden muß für die klinischen Entscheidungen berücksichtigt werden.

Schlüsselwörter: Computertomographie, fetale Abnormalität, Ultraschall.

Résumé

Utilisation couplée de l'échographie et du scanner pour l'appréciation des anomalies intracrâniennes fœtales

Au cours de deux grossesses avec anomalies fœtales intracrâniennes les données ultra-sonores anténatales ont été complétées par la prise d'un nombre restreint d'images avec un scanner sous contrôle échographique. Le scanner ne fournit pas globalement plus d'informations que l'échographie. Les zones calcifiées du cas de tératome fœtal intracrânien ont été mieux visualisées au scanner qu'à l'échographie. Pour le cas d'hydrocéphalie fœtale le

scanner a permis d'établir que le système ventriculaire cérébral était dilaté mais par ailleurs normal alors que les données échographiques antérieures étaient particulièrement controversées. On peut utiliser le scanner comme examen complémentaire pour l'évaluation de problèmes spécifiques après échotomographie anténatale. Dans ces cas, l'examen au scanner doit être pratiqué sous contrôle ultrasonore et les décisions des cliniciens doivent être fondées sur les données des deux méthodes couplées.

Mots-clés: Anomalies fœtales, scanner, ultrasons.

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P. Kirkinen, M.D.
Department of Obstetrics and Gynecology
University of Oulu
90220 Oulu 22
Finland