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Short Communication

Prenatal diagnosis of fetal omphalocele by ultrasound: A comparison of two centuries

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Abstract

An omphalocele, a fetal abdominal defect, is a very important congenital anomaly. Prenatal diagnosis of fetal omphalocele is crucial to clinical management.

Objective: To investigate the accuracy of prenatal diagnosis for fetal omphalocele, we undertook a retrospective and consecutive analysis of our ultrasound database between January 1994 and December 2011.

Materials and Methods: In total, ultrasound (US) detected 52 fetuses with an omphalocele *in utero*.

Results: The incidence of fetal omphalocele is estimated as 1:1249 (0.08%). We also compared the gestational age at US diagnosis between the two centuries. In the 20th century, 22 cases of omphalocele were detected: four (18%) cases at first trimester, 17 (77%) cases at second trimester, and 1 (5%) case at third trimester. In the 21st century, 30 cases of omphalocele were detected: 13 (43%) cases at first trimester, 15 (50%) cases at second trimester, and two (7%) cases at third trimester. The gestational age at diagnosis of omphalocele is significantly earlier in the 21st century than in the last century.

Conclusion: With the advancement and improvement in US equipment, the early detection of fetal omphalocele is feasible, which will substantially contribute to fetal wellbeing.

Keywords: diagnosis; omphalocele; prenatal

Introduction

Omphalocele is characterized by the herniation of the abdominal viscera into the base of the umbilical cord, secondary to the failed fusion of the lateral folds during early embryonic development [1]. To date, three theories have been proposed concerning the etiology of omphalocele formation: (1) persistence of the primitive body stalk, (2) failure of the bowel to return to the abdomen, and (3) failure of complete lateral-body fold migration and body wall closure [2]. The incidence of omphalocele around the world is estimated as 1 in every 3000–5000 fetuses [1,2]. Nevertheless, the incidence of fetal omphalocele in Taiwan has never been reported.

With the introduction of first trimester ultrasound (US) screening of nuchal translucency for Down syndrome, the prenatal diagnosis of congenital anomalies is now feasible as early as 11–14 weeks of gestation [3]. An early gestational scan at 11–14 weeks may be able to detect fetal omphalocele simultaneously [3]. To investigate the accuracy of a prenatal diagnosis of fetal omphalocele, we undertook a retrospective and consecutive analysis of our ultrasound database between January 1994 and December 2011. We also compared the gestational age at US diagnosis of fetal omphalocele between

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the two centuries to comprehend how early we can make an accurate diagnosis of omphalocele, especially during the first trimester. To the best of our knowledge, our series may be the first report of prenatal diagnosis for fetal omphalocele in Taiwan.

Materials and methods

Subjects

A retrospective and consecutive analysis of our ultrasound (US) database was undertaken to investigate the accuracy of prenatal diagnoses of fetal omphalocele that were determined between January 1994 and December 2011. All fetal omphalocele cases were diagnosed prenatally by US at the Antenatal Ultrasound Lab, Department of Obstetrics and Gynecology of National Cheng Kung University Hospital in Tainan, Taiwan. Prenatal data and characteristics were reviewed retrospectively by searching the computer data base, videotapes, and chart records, and by US. This study was approved by the Institutional Review Board of our hospital.

US Examinations

At the study period, we used conventional high-resolution, real-time two-dimensional (2D) US scanners (Medison Accuvix V20, Seoul, Korea; Aloka SSD-680, Tokyo, Japan) and/or a three dimensional (3D/4D) US scanner (GE Voluson 730 Expert, Milwaukee, WI, USA) with 3.5–7.0 MHz transabdominal probes. Transvaginal probes were used when additional information was needed. All the scanning images were recorded on videotapes and/or optic disks. During the study period, well-trained fetologists and ultrasonographers performed the US examinations.

When an US examination was undertaken, a level II fetal US examination using 2D US scanners was first performed to find the region of interest (i.e., the fetal omphalocele) (Fig. 1A). The fetal and placental circulation around the fetal omphalocele was then illustrated by using 2D color Doppler US (Fig. 1B). The fetal omphalocele was finally scanned by a 3D volume scanner and the surface rendering mode was generated to depict the lesion (Fig. 1C).

Additional tests

After the prenatal diagnosis of fetal omphalocele, the parents received genetic consultations to decide whether to continue pregnancy or termination at our hospital or other clinics. Karyotyping was also performed by amniocentesis or cord blood sampling. Autopsy was undertaken for select cases after the family gave informed consent.

Statistics

The Chi-square test was used to examine the gestational age at the time of US diagnosis of fetal omphalocele between two centuries. A value of $p < 0.05$ was considered statistically significant.

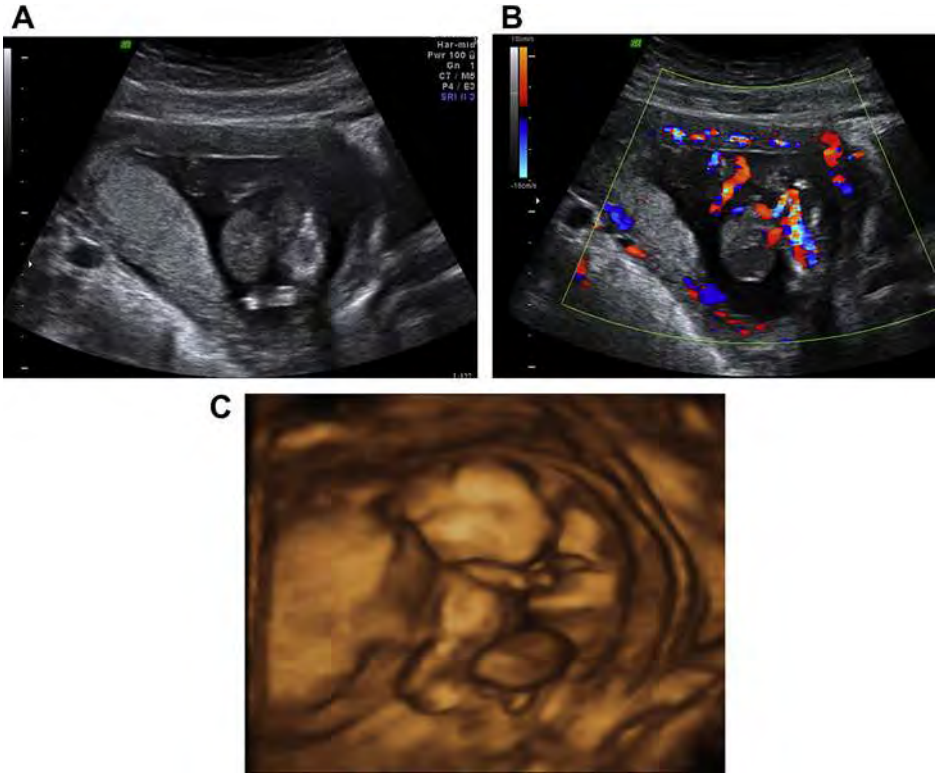

Fig. 1. The fetal omphalocele at 13 weeks of gestation depicted by using the surface rendering mode of three-dimensional (3D) ultrasound. (A) The omphalocele on two-dimensional (2D) ultrasound image; (B) the omphalocele on color Doppler image; and (C) the omphalocele on 3D ultrasound image, using the surface rendering mode.

Results

From 1994 to 2011, prenatal US *in utero* examination detected 52 fetuses with omphalocele (Fig. 1). During the same period, 64,962 files of US examinations were collected in our computer database. The incidence of fetal omphalocele was accordingly estimated at 1 (0.080%) of 1249 births in our hospital. Among them, 30 cases are isolated omphalocele (57%). The incidence of isolated fetal omphalocele was estimated as 1:2165 (0.046%). The detection rate and accurate rate of fetal omphalocele were 100 % and 100% respectively.

The gender ratio of male to female fetuses is 1.6:1. The ages of mothers ranged from 19 to 39 years (with an average of 31 years). Thirty cases were primigravida (57%) and 22 cases were multipara (43%). The earliest age of diagnosis was 10 weeks of gestation and the latest age of diagnosis was 38 weeks of gestation. The average time of diagnosis was 18.1 weeks of gestation.

Table 1 lists the results of the prenatal diagnosis of fetal omphalocele in the last century (i.e., 1994–2000). The gender ratio of male to female is 1:1. The ages of mothers ranged from 21 to 38 years (average, 29 years). Thirteen cases were primigravida (59%) and nine cases were multipara (41%). The earliest age of diagnosis was 13 weeks of gestation and the latest age was 38 weeks of gestation. The average time of diagnosis was 20 weeks of gestation.

By contrast, Table 2 presents the results in the 21st century (2001–2011). The gender ratio of male to female is 5:1. The ages of the mothers ranged from 19 to 39 years (average, 32 years). Seventeen cases were primigravida (57%) and 13 cases were multipara (43%). The earliest age of diagnosis was 10 weeks of gestation and the latest age of diagnosis was 36 weeks of gestation. The average time of diagnosis was 16.8 weeks of gestation.

Table 3 shows the comparison of the gestational age at the prenatal diagnosis of omphalocele between two centuries. The Chi-square test was used to examine the gestational age at the US diagnosis of fetal omphalocele between the two centuries. The results indicated the gestational age at diagnosis of omphalocele in 21st century is significantly earlier than that in last century ($p < 0.05$).

Discussion

Incidence

To date, the incidence of total fetal omphalocele has been reported [7–16]. In this series, the incidence of fetal omphalocele (including isolated and complicated omphalocele) was estimated as 1 (0.080%) of every 1249 births in our hospital. However, previous medical literature reports that isolated omphalocele occurs in approximately 1 in 5000 live births [7]. In this series, the incidence of isolated omphalocele (57%, 30/52) was estimated to be 1:2165 (0.046%), which seemed higher than previous reports. The underlying reasons for this difference between our series and western countries are still unknown.

Several factors may be considered. First, the denominator in our series is the total files of "examinations" which came to our hospital for US examination, while the denominator in the western series is "live births" collected by neonatologists [7]. Second, the numerator in our series is "fetuses with

Table 1
Prenatal diagnosis of fetal omphalocele in 1994–2000.

Case	MA (y)	GP	GA (wk)	Ultrasound findings	Associated findings	Karyotype
1	21	G2P1	13	Omphalocele	Nil	46,XX
2	26	G1P0	14	Omphalocele L	Nil	46,XX
3	24	G1P0	14	Omphalocele	Ectopia cordis	ND
4	25	G1P0	14	Omphalocele	Nil	ND
5	34	G5P0	15	Omphalocele	Nil	ND
6	32	G4P0	17	Omphalocele	Nil	ND
7	35	G3P0	17	Omphalocele	Nil	46, XX
8	30	G3P1	18	Omphalocele	Nil	ND
9	27	G1P0	18	Omphalocele	Nil	46, XX
10	28	G3P1	19	Omphalocele	Nil	46, XY
11	33	G1P0	19	Omphalocele	Nil	ND
12	35	G3P2	20	Omphalocele	CHD, Small chest	ND
13	23	G2P1	20	Omphalocele	Nil	ND
14	27	G1P0	20	Omphalocele	Scoliosis	ND
15	38	G4P3	20	Omphalocele	Nil	47, XY, trisomy 13
16	25	G1P0	21	Omphalocele	Nil	46,XX
17	37	G3P2	22	Omphalocele	Nil	47,XY, trisomy 18
18	30	G1P0	22	Twin A, normal;twin B, omphalocele	Nil	ND
19	22	G1P0	23	Omphalocele	VSD	ND
20	30	G1P0	28	Omphalocele	Nil	46,XX
21	30	G2P1	28	Omphalocele	Nil	ND
22	26	G3P1	38	Omphalocele	Nil	ND

CHD = congenital heart disease; F = female; GA = gestational age; GP = gravida/para; M = male; MA = maternal age; NA = not available; omphalocele L = liver-containing omphalocele; VSD = ventriculoseptal defect.

Table 2
Prenatal diagnosis of fetal omphalocele in 2001–2011.

Case	MA (y)	GP	GA (wk)	Ultrasound findings	Associated findings	Karyotype
1	27	G1P0	10	Omphalocele	Ectopic cordis, hydrops (pentology of Cantrell)	ND
2	19	G1P0	12	Omphalocele	Nuchal edema	ND
3	33	G2P1	12	Omphalocele	Nil	ND
4	33	G1P0	12	Omphalocele	Acrania	ND
5	34	G2P0	13	Omphalocele	Nil	ND
6	29	G2P1	13	Omphalocele	Nil	ND
7	25	G4P0	13	Omphalocele L	Nil	ND
8	27	G3P0	13	Omphalocele	Nil	ND
9	34	G3P2	14	Omphalocele	Hydroencephaly	ND
10	26	G1P0	14	Omphalocele	Nil	ND
11	31	G3P2	14	Omphalocele L	Nil	ND
12	27	G1P0	14	Omphalocele	Nil	ND
13	30	G2P0	14	Omphalocele	Nil	ND
14	35	G3P2	15	Omphalocele	Cystic hygroma, heart anomaly, club foot	47,XY, trisomy 18
15	37	G2P1	15	Omphalocele	Nil	ND
16	35	G2P1	15	Omphalocele L	Nil	ND
17	34	G1P0	15	Omphalocele	Holoprosencephaly, cyclopia, probosis, VSD	ND
18	39	G1P0	16	Twin A, acrania;twin B, omphalocele	Nil	ND
19	24	G2P1	16	Omphalocele	Nil	46,XX
20	36	G2P1	16	Omphalocele	Meningocele	ND
21	37	G2P1	16	omphalocele	Nil	ND
22	30	G1P0	17	Omphalocele	Nil	ND
23	39	G2P1	17	Omphalocele L	Holoprosencephaly,probosis	47,XY, trisomy 13
24	39	G1P0	17	Twin A, normal;twin B, omphalocele	Twin A, normal;twinB, CHD	ND
25	28	G1P0	19	Omphalocele	Holoprosencephaly	ND
26	35	G2P1	22	Omphalocele	Dandy-Walker syndrome, CHD	ND
27	32	G1P0	24	Twin A, normal;twin B, omphalocele	Nil	46,XY
28	28	G1P0	26	Omphalocele	CHD	ND
29	36	G2P1	34	Omphalocele	Clench hand, VSD, Hydrocephalus	47,XY, trisomy 18
30	39	G1P0	36	Omphalocele	Clenched hand, diaphragm hernia	ND

CHD = congenital heart disease; F = female; GA = gestational age; GP = gravida/para; M = male; MA = maternal age; NA = not available; ND = not done; omphalocele L = liver-containing omphalocele; VSD = ventriculoseptal defect.

omphalocele", whereas that in the western series it is "live newborns with omphalocele" [7]. Third, ethnic factors cannot be neglected—different populations and peoples in different regions may have different incidences of omphalocele [8–16]. Therefore, further international collaboration studies for investigating the true incidence of fetal omphalocele are warranted.

Maternal age

Fetal gastroschisis reportedly possesses a very strong association with young maternal age; most mothers are aged 20 years or younger [17,18]. By contrast, omphalocele is associated with advancing maternal age; most mothers are over 30 years old [19]. In our series, the average maternal age was 31.9 years, which was consistent with the previous medical literature [18,19].

Diagnosis rate

In 1996, a report in the medical literature from England indicated that 95% of omphaloceles can be accurately diagnosed with US [8]. In this series, the detection rate and accuracy rate of fetal omphalocele were 100% and 100%, respectively. With the advent of prenatal US, the improvement in the prenatal diagnosis of fetal omphalocele can be expected. Because our series encompassed 1994–2011, the highly accurate rate in prenatal diagnosis of omphalocele further validated the study of highly accurate rate in England in the last century [8].

Table 3
The comparison of gestational ages at prenatal diagnosis between two centuries.

Years	1st trimester (11–14 wk)	2nd trimester (15–28 wk)	3rd trimester (29–40 wk)	Total
1994–2000	4 (18%)	17 (77%)	1 (5%)	22 (100%)
2001–2011	13 (43%)	15 (50%)	2 (7%)	30 (100%)
Total	17 (33%)	32 (62%)	3 (5%)	52 (100%)

Chi-square test: $p < 0.05$.

Gestational age at prenatal diagnosis

As Table 3 lists, 22 cases were diagnosed in the 20th century: 4 (18%) cases at the first trimester, 17 (77%) cases at the second trimester, and 1 (5%) case at the third trimester. The average age at diagnosis was 20 weeks of gestation. In the 21st century, 30 cases of omphalocele were detected: 13 (43%) cases at the first trimester, 15 (50%) cases at the second trimester, and 2 (7%) cases at the third trimester. The average age at diagnosis was 17 weeks of gestation. According to the analysis of our data, the detection of omphalocele could be promoted to earlier weeks of gestation. The earliest diagnostic time during 1994–2000 was 13 weeks of gestation, whereas that during 2001–2011 it was 10 weeks of gestation. The proportion of the diagnostic rate during the first trimester can be elevated (20th century vs. 21st century rates were 18% vs. 43%, respectively). In Table 3, the gestational ages at prenatal diagnosis of omphalocele between two centuries are significantly different ($p < 0.05$).

Differential diagnosis with physiologic midgut herniation

To make a definite diagnosis of omphalocele before 12 weeks of gestation, differential diagnosis with physiologic midgut herniation must be made cautiously [2,4–6]. As Table 2 shows, we had one case diagnosed before 12 weeks. In that patient, a diagnosis was made because of the huge size of omphalocele and because of the associated fetal anomalies (e.g., ectopic cordis, hydrops, pentology of Cantrell). By contrast, a definite diagnosis of omphalocele after 12 weeks of gestation can be made definitely since physiologic midgut herniation should disappear after that point.

Aneuploidy

In Taiwan, one author (Dr Chen) had reviewed the association between aneuploidy and omphalocele [20–23]. As stated in a previous review, chromosomal abnormalities are common in 50–70% of omphalocele cases [11,15,20–23] whenever any of the following features are present: (1) associated anomalies; (2) absence of liver in the herniated sac; (3) hydramnios; or (4) oligohydramnios [11,15,16,20–23]. Chromosomal abnormalities—particularly aneuploidy such as trisomy 18, 21, or 13—is present in 40–60% of fetuses with omphaloceles not containing liver [16]. Therefore, prenatal testing for fetal karyotyping should be offered for omphaloceles with (1) associated anomalies; (2) absence of liver in the herniated sac; (3) hydramnios; or (4) oligohydramnios [11,15,16,20–23]. In our patients, 14 (27%) of 52 fetuses had received karyotyping. Among these, five (35%) of 14 fetuses showed aneuploidy; three (21%) of 14 fetuses showed trisomy 18; two (14%) of 14 fetuses showed trisomy 13; and the remaining nine (64%) of 14 cases were normal. From this series, our results of aneuploidy in omphalocele were similar to other previous reports [11,15,16,20–23].

Associated anomalies

The incidence of associated anomalies with omphalocele ranged 50–70% [9,20–23], but has been reportedly as high as 80–90% in some studies [10–12]. The anomalies were not only confined to the gastrointestinal tract—they also involved the heart (up to 40%) [12], neural tube [13], lip and palate, or cloaca [20–23]. Some studies suggest that smaller defects (less than 4 cm) are correlated with gastrointestinal defects, whereas larger defects are more likely to be associated with cardiac defects [14,20–23]. In our series, 30 cases had an isolated omphalocele (58%). The incidence of associated anomalies accounted for 42% ($n = 22$ cases), which included 10 (45%) patients with heart defects, 10 (45%) patients with neural tube defects, and four (10%) patients with gastrointestinal tract involvement. From this series, our results of associated anomalies with omphalocele were similar to the results of previous reports [9–12,14,20–23]. Nevertheless, we did not observe the phenomenon of smaller defects being correlated with gastrointestinal defects and larger defects being associated with cardiac defects [14,20–23]. Further studies are warranted to clarify the difference between our reports and previous reports.

Conclusion

Prenatal diagnosis of fetal structural anomalies and growth abnormalities is very important in modern obstetrics [20–26]. Early diagnosis of fetal structural anomalies and growth abnormalities would make early consultation and management possible, and thus improve maternal and fetal wellbeing. In this series, prenatal diagnosis of fetal omphalocele is a good example.

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