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Prenatal Sonographic Diagnosis of Hemivertebrae

Associations and Outcomes

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Objective. The purpose of this study was to evaluate associated anomalies and outcomes of fetuses with prenatally diagnosed hemivertebrae. **Methods.** Fetuses with prenatally diagnosed hemivertebrae, excluding those associated with spina bifida, were identified by searching the prospectively maintained ultrasound databases of 4 institutions from 1997 to August 2007. Associated birth defects were tabulated by organ system and hemivertebra location. Outcomes included karyotypes, gestational ages, and routes and outcomes of deliveries. **Results.** Nineteen fetuses had a diagnosis of hemivertebrae at a mean gestational age $\pm$ SD of 20.5 ± 5.4 weeks. Fourteen (73.7%) fetuses had additional anomalies, of which 5 (35.7%) were syndromic (4 with cloacal exstrophy and omphaloceles and 1 with Jarcho-Levin syndrome). Karyotypes were normal in all 11 available cases, each of which had additional anomalies. Fourteen (73.7%) neonates were live born at a mean gestational age of 34.9 ± 4.3 weeks, of which 7 (50%) were born by cesarean delivery. Ten neonates (71.4%) were delivered before term, and 4 (28.6%) were growth restricted (<10 th percentile). Two (14.3%) of these neonates died; both had cloacal exstrophy and large omphaloceles. The remaining pregnancies were terminated (4 [21.1%]) or had a fetal death (1 [5.3%]). **Conclusions.** Most fetuses with prenatally diagnosed hemivertebrae have additional anomalies, often syndromic, which affect the prognosis. Affected pregnancies have high rates of cesarean delivery and growth restriction. Neonates with nonisolated hemivertebrae are more often delivered before term and have higher mortality rates. **Key words:** hemivertebrae; prenatal diagnosis; scoliosis; sonography.

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Hemivertebrae are diagnosed in up to 1 per 1000 live births.^{1,2} Despite this incidence, surprisingly few published reports have addressed the importance of prenatally detected hemivertebrae.¹⁻³ Moreover, obstetric outcomes of affected fetuses remain largely unexplored. Therefore, we performed a multicenter retrospective cohort study to evaluate associated anomalies and outcomes of fetuses with prenatally diagnosed hemivertebrae.

Materials and Methods

Fetuses with prenatally diagnosed hemivertebrae were identified by searching the prospective-maintained ultrasound databases of 4 referral centers' maternal-fetal medicine practices from 1997 to August 2007. Cases with open spina bifida were excluded. Sonographic data included gestational age at diagnosis, hemivertebra location, and coexisting anomalies. Additional information included maternal demographics, fetal and neonatal karyotypes, and pregnancy outcomes. Institutional Review Board approval was obtained at each site. Data were analyzed with descriptive statistics and the Fisher exact test for dichotomous variables, with significance at $P < .05$.

Results

Nineteen fetuses meeting inclusion criteria had a diagnosis of hemivertebrae at a mean gestational age $\pm$ SD of 20.5 ± 5.4 weeks. There were 8 male and 9 female fetuses, with sex undetermined in 2 pregnancies terminated by dilation and evacuation. Fourteen (73.7%) fetuses had additional anomalies (Table 1), including 8 (72.7%) of 11 with thoracic and 6 (75%) of 8 with lumbar hemivertebrae ($P = .40$). Five (35.7%) of these

cases were syndromic (4 with cloacal exstrophy and omphalocele and 1 with Jarcho-Levin syndrome). Nine (90%) of 10 fetuses with multiple hemivertebrae had coexisting anomalies compared with 5 (55.5%) of 9 with single hemivertebrae ($P = .10$). Karyotypes were normal in all 11 cases tested, each of which had other birth defects. Postnatal radiographic confirmation of hemivertebrae was performed in 8 (57.1%) of 14 live-born neonates.

The mean maternal age was 27.2 ± 7.1 years. Fourteen (73.7%) neonates were live born at a mean gestational age of 34.9 ± 4.3 weeks, including 10 (71.4%) born before 37 weeks. Pregnancies with isolated hemivertebrae were less likely to be delivered before term (1/5 [20%]) than those with nonisolated hemivertebrae (9/9 [100%]; $P = .005$). The mean birth weight was 2335 ± 998 g, whereas 4 neonates (28.6%) were growth restricted (<10 th percentile).⁴ The frequency of growth restriction was not significantly different in fetuses with (3/9 [33.3%]) and without (1/5 [20%]) additional anomalies ($P = .42$). Seven (50%) of 14 neonates were born by cesarean delivery. The cesarean delivery rates were similar among cases with isolated (2/5 [40%]) and nonisolated (5/9 [56%]) hemivertebrae ($P = .37$) as well as those delivered before term (6/10 [60%]) versus at term (1/4 [25%]; $P = .24$). The 2 cesarean deliveries in

Table 1. Additional Anomalies Among Fetuses With Nonisolated Hemivertebrae

Organ System	Detected Prenatally	Detected Postnatally
Cardiovascular (n = 7)	Transposition of great vessels (1) Double-outlet right ventricle (1) Abnormal cardiac axis (2)	Transposition of great vessels (1) Atrial septal defect (2) Ventricular septal defect (1)
Genitourinary (n = 6)	Bladder exstrophy (1) Ambiguous genitalia (1) Hydronephrosis (2) Multicystic kidney (1)	Cloacal exstrophy (2) Cloacal persistence (1) Pelvic kidney (1)
Skeletal (n = 5)	Arthrogryposis (1) Clinodactyly (1) Trigonocephaly (1) Midfacial cleft (1) Short humerus and femur (1) Brachycephaly (1) Microphthalmia (1) Clubbed feet (2)	Short limbs (1)
Gastrointestinal (n = 4)	Omphalocele (4)	
Central nervous system (n = 4)	Ventriculomegaly (2) Encephalocele (1) Hydromyelia (1)	
Other (n = 2)	2-vessel cord (2)	

cases with nonisolated hemivertebrae were performed for 1 set of twins with a nonreassuring fetal heart rate pattern and 1 instance of type I maternal osteogenesis imperfecta. Among the 5 cesarean deliveries of neonates with nonisolated hemivertebrae, 2 (40%) were done because of the associated anomalies. Two neonates died; both had cloacal exstrophy and large omphaloceles. The remaining pregnancies were terminated (4 [21.1%]) or had a fetal death (1 [5.3%]).

Discussion

The vertebral body develops during the sixth week of embryonic life, initially arising from paired chordal centers and later from a single ossification focus transiently separated into anterior and posterior aspects by the notochord remnant. Lateral hemivertebrae result from lack of development of one of the paired chondral centers. Less commonly, posterior hemivertebrae result from failed anterior ossification.⁵

Hemivertebrae reportedly affect 0.33 to 1 per 1000 live births, with both sexes equally affected, as our findings confirm.^{1,2} The most striking prenatal sonographic feature of hemivertebrae is disruption of the normal spine alignment. Hemivertebrae appear as triangular wedge-shaped ossified structures within the vertebral column, causing contralateral spinal deviation. As confirmed by this study, the thoracic and lumbar portions of the spine are most commonly involved, with single and multiple hemivertebrae occurring with equal frequency.^{1,2} Although prenatal diagnoses of hemivertebrae are typically made by 2-dimensional sonography, 3-dimensional sonography is potentially useful in showing the accessory ossification center.⁶ We found the 3-dimensional x-ray mode particularly useful (Figures 1 and 2). The correct prenatal diagnosis in this particular case was confirmed by a neonatal radiograph (Figure 3).

Hemivertebrae are associated with additional sonographic anomalies in 59% to 67% of fetuses, comparable with our study's 73%.^{1,3} Hemivertebrae are nonisolated in 88.5% of neonates when newborn physical features detected by a geneticist's physical examination are additionally considered.² The cardiovascular, urinary, skeletal, gastrointestinal, and central nervous systems are

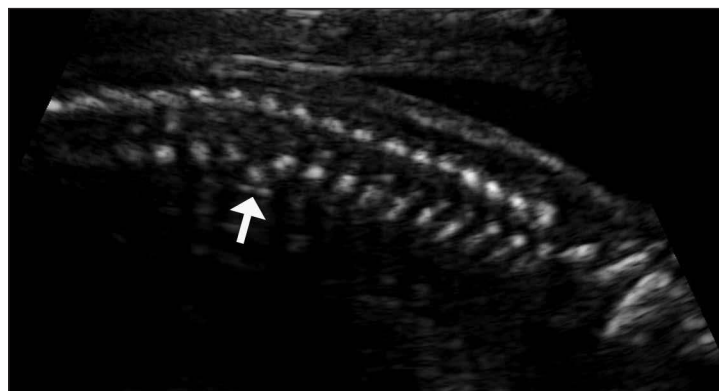


Figure 1. Longitudinal 2-dimensional image at 21 weeks' gestation showing a T5 hemivertebra (arrow).

Figure 2. Coronal 3-dimensional x-ray mode image at 21 weeks' gestation showing a T5 hemivertebra (arrow).



most commonly involved.¹⁻³ Importantly, these birth defects may occur as part of syndromes that may negatively affect the prognosis, such as VATER syndrome (vertebral anomalies, imperforate anus, tracheoesophageal fistula, and renal anomalies), VACTERL syndrome (VATER with cardiac and limb anomalies), Klippel-Feil syndrome, Jarcho-Levin syndrome, OEIS (omphalocele, bladder exstrophy, imperforate anus, and spine anomalies), the Potter sequence, and open spina bifida. Almost one-third of our neonates had hemivertebrae as part of a syndrome, of which half died. Therefore, we suggest that targeted sonography

and fetal echocardiography be performed when hemivertebrae are identified. Interestingly, fetal karyotypes are usually normal whether the hemivertebrae are isolated or nonisolated, as supported by this study.¹⁻³ However, fetal chromosomal analysis should be considered especially for nonisolated hemivertebrae because an increased risk of aneuploidy may exist.

Of note, almost three-fourths of the pregnancies delivered before term, including all with nonisolated hemivertebrae. More than one-fourth of live births in our series were growth restricted, similar to previous reports of 16.6% to 18.5%.^{1,3} Importantly, growth restriction likely reflects the influence of factors other than the hemivertebrae. Therefore, sonographic assessment of fetal growth appears to be reasonable, even in cases of apparently isolated hemivertebrae. Finally, half of the neonates were born by cesarean delivery, regardless of gestational age or additional anomalies. These data are potentially useful for counseling parents of fetuses with both isolated and nonisolated hemivertebrae. An additional advantage of diagnosing hemivertebrae prenatally is early recognition of scoliosis, potentially permitting early treatment and thereby improving the long-term outcome.

We recognize that several questions remain unanswered by our study. The retrospective use of referral center data and no universal neonatal screening for hemivertebrae precluded calculating the incidence and diagnostic false-negative rate in our population. Neonatal radiographic confirmation of hemivertebrae was available for 57% of the cases, likely reflecting the individual practice patterns of the neonates' pediatricians in ordering spine radiographs. Although we could not exclude the possibility of a false-positive diagnosis, all prenatally suspected cases imaged after delivery were confirmed. Therefore, we think that a false-positive diagnosis in the remaining cases was extremely unlikely.

In summary, fetuses with hemivertebrae have high rates of cesarean delivery and growth restriction. Neonates with nonisolated hemivertebrae are more often delivered before term and have higher mortality rates. These data are valuable for evaluating affected fetuses, counseling parents, and guiding obstetric care.

Figure 3. Plain radiograph obtained soon after birth showing a classic "butterfly" vertebra (bilateral hemivertebrae at T5 [arrow] with a forme fruste of same at T6).



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