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Skeletal Dysplasias That Cause Thoracic Insufficiency in Neonates

Illustrative Case Reports

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Abstract: Skeletal dysplasias are a heterogeneous group of conditions associated with various abnormalities of the skeleton. Some of them are perinatally lethal and can be diagnosed at birth. Lethality is usually due to thoracic underdevelopment and lung hypoplasia. A correct diagnosis and typing of the skeletal disorder is essential for the prognosis as is genetic counseling of the family. A retrospective review of 12 cases of clinico-radiologic diagnosis of skeletal dysplasia, leading to thoracic insufficiency, was conducted.

We aimed to make differential diagnosis with special emphasis on radiological findings, and to emphasize the importance of parental counseling.

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Abbreviations: ATD = asphyxiating thoracic dystrophy, COVESDEM = costovertebral segmentation defects with mesomelia, CRS = caudal regression syndrome, CS = congenital scoliosis, EvC = Ellis-van Creveld, KFS = Klippel–Feil syndrome, OI = osteogenesis imperfecta, SCD = spondylocostal dysostosis, SRPS = short-rib polydactyly syndrome, TD = thanatophoric dysplasia, VACTERL = vertebral, anal, cardiovascular, trachea, esophageal, renal, and limb defects, VATER = vertebral, anal, trachea-esophageal, and renal/radial defects.

INTRODUCTION

Skeletal dysplasias are a large heterogeneous group of disorders consisting of abnormalities of bone or cartilage growth or their structure. Recently, 436 different entities have been described, despite the fact that the total number has gone down compared with the previous revision (by grouping of phenotypically indistinguishable entities).[1] Although certain dysplasias individually are quite rare, their overall prevalence as a group has been reported to be 2.3 to 7.6 per 10,000 births in various epidemiologic studies.[2–4] Some of them are perinatally lethal and can be diagnosed at birth, whereas some others are nonlethal and compatible with short or long-term survival.[4,5] Approximately one-fifth of affected fetuses are stillborn, whereas one-third die during the first week of life.[4,5] Lethality in these entities is usually due to thoracic underdevelopment and lung hypoplasia.[5] Extensive vertebral and rib anomalies may result in thoracic cage deformity with adverse effects on thoracic growth and function.[6] The inability of the thorax to support normal respiration or lung growth leads to thoracic insufficiency.[6]

Because of the considerable heterogeneity, the diagnosis of a skeletal dysplasia can be difficult.[5] Despite advances in molecular genetics, as yet, there is no simple test available to achieve a diagnosis. Family history, and clinical and radiographic assessment all contribute to achieving a diagnosis. Radiographic evaluation is a common primary investigation in many diseases and is part of the skeletal survey for investigation of skeletal dysplasia. The initial identification and the decision to refer a patient for further molecular analysis and expensive genetic tests still frequently relies on clinical and radiological criteria.[5–9]

In this series, a review of 12 cases of clinico-radiologic diagnosis of skeletal dysplasia, which leads to thoracic insufficiency, is conducted. Thus, we intend to emphasize the examination of the skeletal radiographs based on the analysis of cardinal criteria, from which the most useful information is derived and which make further differentiation possible. Secondly, we would like to emphasize the importance of parental counseling, in accordance with that learned from case studies.

METHODS

The database of our hospital, which is a maternity and children's hospital, was screened for neonates diagnosed with skeletal dysplasia from January 2011 to December 2014. Twenty-six patients were found. Of them, 15 showed respiratory distress/insufficiency during their hospital course. All hospital records including radiographs of them were reviewed. Two experienced radiologists independently evaluated all available radiographs of the patients. Clinico-radiologic diagnosis of skeletal dysplasia was precisely established in 12 patients. Unfortunately, genetic tests could not be performed due to the retrospective nature of the study. Ethical approval was not required because this is a retrospective case report based on medical records according to the guidelines of the Ministry of Health. Patient consent was not obtained because the study does not include any intervention or private patient information.

RESULTS

Clinico-radiologic diagnosis of skeletal dysplasia in 12 patients were as follows: short-rib polydactyly syndrome

FIGURE 1. Radiograph of case 1 shows narrow thorax due to short and horizontally oriented ribs. The upper and lower limb long tubular bones are short. The pelvic appearance is normal. The metaphyseal ends of the long bones are rounded and there are extremely short ovoid tibiae (arrow).

(SRPS) type 2 (Majewski syndrome; Figure 1), thanatophoric dysplasia (TD) type I (Figures 2A and B), osteogenesis imperfecta (OI) type IIA (Figure 3A), OI type IIB (Figure 3B), OI type III (Figure 3C), asphyxiating thoracic dystrophy (ATD), Ellis-van Creveld syndrome (EvC; Figure 4), caudal regression syndrome (CRS; Figure 5), congenital scoliosis (CS; Figure 6), spondylocostal dysostosis (SCD; Figure 7), and Klippel–Feil syndrome (KFS; Figures 8A and B). Demographic, clinical, and radiographic features of the cases are provided in Table 1. No case had regular antenatal visits; thus, prenatal diagnosis of abnormality was possible only toward the end of the pregnancies. In case 9, the mother was a diabetic and had a poor obstetric history. The majority of the cases had parental consanguinity (except cases 11 and 12). Nine cases were term, whereas 2 cases (cases 4 and 7) were near term. Case 12 was delivered at 31 weeks of gestational age. Except for cases 6, 7, 8, and 11, the remaining 8 cases required intubation in the delivery room.

Eight cases died within the first week of life due to cardiopulmonary insufficiency. Cases diagnosed with ATD and EvC syndrome were maintained on ventilatory support until their deaths at 4 weeks of life. The patient diagnosed with SCD was discharged with oxygen supplementation. He later required frequent rehospitalizations due to pneumonia and respiratory distress. He is currently waiting for surgery. After primary care and family education, the patient diagnosed with

OI type III was discharged with a plan for regular clinical follow-ups of endocrinology, orthopedics, and physical therapy.

DISCUSSION

Whereas advances in genetic research are clearly important in the diagnosis of skeletal dysplasias and in developing better therapy for those conditions, the role of the pediatrician as the diagnostician has remained unchanged.[8–11] Because the widespread use of molecular genetic testing for bone dysplasias is not available in many areas of developing countries, the clinico-radiologic diagnosis is emphasized; distinction among the various bone dysplasias is based largely on clinical and radiographic findings.[8,9] The radiologic evaluation begins with a complete skeletal survey, ideally composed of a set of radiographs,[8] but because this study was designed retrospectively, the diagnoses of cases were achieved by limited radiography.

As seen in this small series, some bone dysplasias are lethal.[4] A correct diagnosis and typing of the skeletal disorder is essential for the prognosis as is genetic counseling of the family, including the possibility of prenatal diagnosis in subsequent pregnancies.[10] A number of these disorders (SRPS, EvC syndrome, ATD) are autosomal recessive inheritance, whereas some (OI type II and III, TD type I, achondroplasia), and most de novo mutations, are autosomal dominant.[1,9] The recurrence risk for future pregnancies is close to 25% in autosomal recessive disorders.[10] However, it is never 0 for the others, because of de novo mutation. An empiric recurrence risk is estimated as 2% to 3% among siblings resulting from parental mosaicism for the mutation that is lethal in the infant who is heterozygous for the same mutation or due to the rare recessive form.[10,12] In this series, the high rate of consanguineous marriages and irregularity of antenatal visits, despite the presence of family history, indicate the lack of competent parental counseling. Additionally, live-born infants affected with perinatally lethal skeletal dysplasias are usually the offspring of families with a low socioeconomic background who have not received prenatal follow-up.

Because sonography has become a routine component of prenatal care, many of these disorders are diagnosed prenatally.[6,7] The ability to achieve the correct specific diagnosis by prenatal ultrasound depends on the type of skeletal dysplasia and gestational age at which ultrasound is performed.[6,7] Discriminating between lethal and nonlethal forms of skeletal dysplasias is of major clinical importance. Sonographic markers of lethality are mainly based on the assessment of lung biometry, measurements of chest circumference and its relation to the abdominal circumference, femur length, and, finally, assessment of the pulmonary arteries by Doppler ultrasonography.[6,7] However, the accuracy of the specific diagnosis is still dependent on the molecular genetic or post mortem examination.[5]

Differential Diagnosis

Short-rib dysplasias (with or without polydactyly) include SRPS (SRPS I–IV), ATD, and EvC syndrome.[1] SRPS types 1 through 4 are lethal in the newborn period because of the severe pulmonary hypoplasia and other associated anomalies.[13–15] On the other hand, the EvC syndrome and ATD are not uniformly lethal.[16,17] Accurate prenatal diagnosis is important to provide adequate counseling.[13]

Overlap in the clinical and radiological features of SRPS types has led to difficulties in distinguishing between them. Type 1 SRPS (OMIM 613091) differs in shape (long bones with a torpedo-shape appearance) from type 3 SRPS (banana-peel shape), although there is a certain overlap of these features in
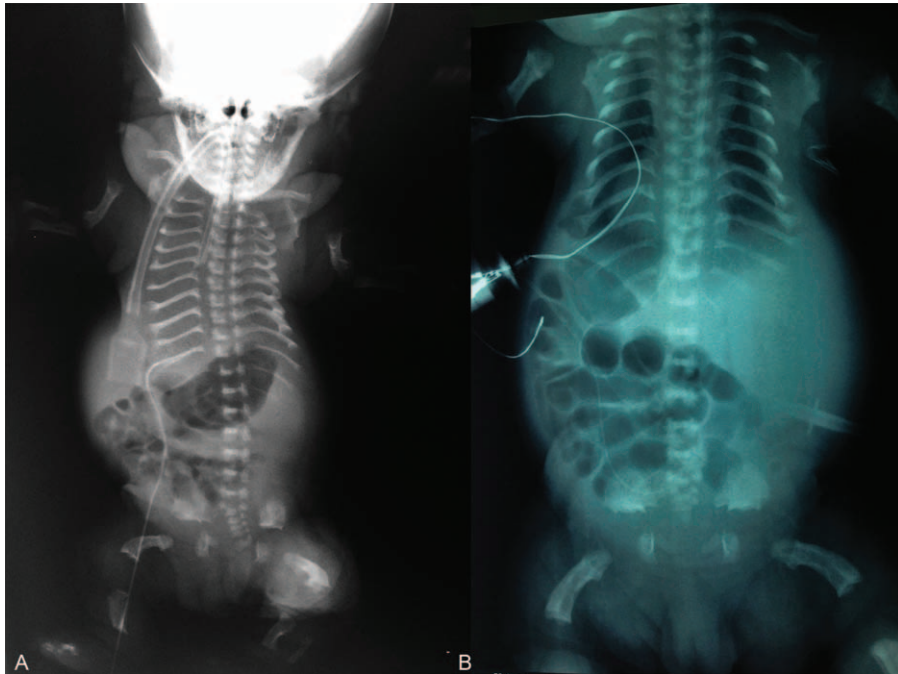
FIGURE 2. Radiographs of case 2 (A) and case 3 (B) show small thorax, and short and horizontal ribs with cupped anterior ends. The calvarium is relatively large (A). The humeri are curved and short. Platyspondyly with an H appearance of the vertebrae is noted. The ilia are small and squared, with a horizontal, trident-shaped acetabular roof. The greater sciatic notches are very small. The ischia and pubis are small, with widening of the symphysis and the sacroiliac joints. The femora show a ''telephone receiver'' shape. The femora are widened proximally with an oval area of decreased opacity similar to that seen in newborns with achondroplasia.
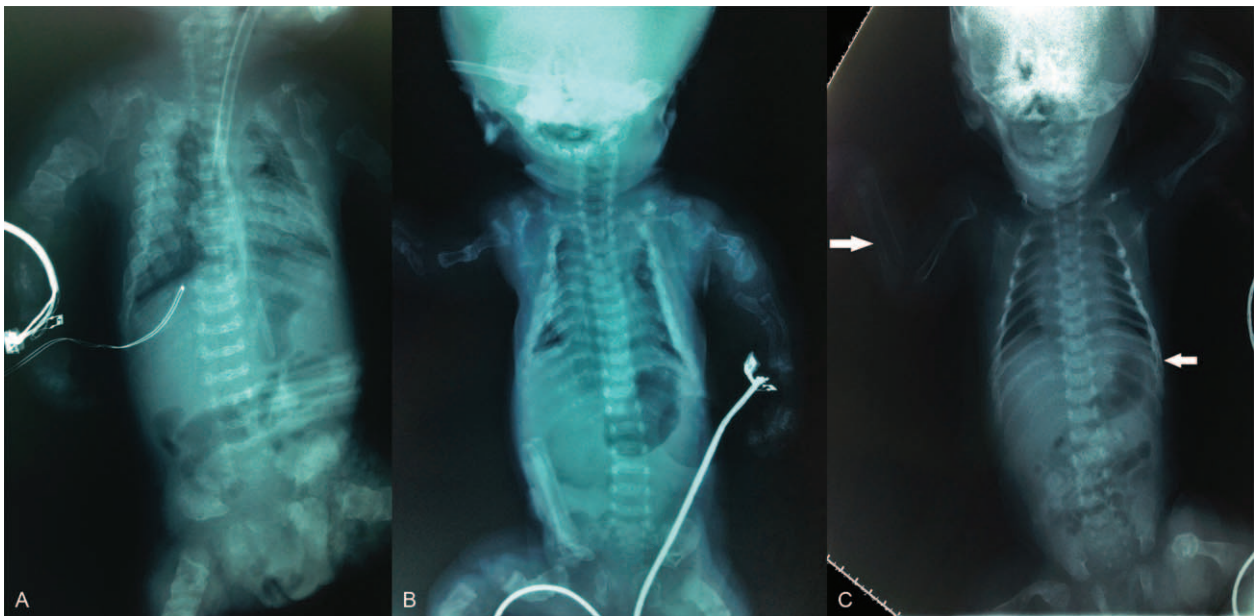

FIGURE 3. Radiographs of case 4 (A) and case 5 (B) show generalized undermineralization, short-limb dwarfism, rhizomelic limb shortening, small chest, and platyspondyly. Periosteal new bone in multiple healing fractures gives the ribs a beaded appearance. The ribs show continuous beading (A). All long bones are short, squared, and broad with crumpled shafts (due to multiple fractures with callus formation). Note ''telescoped'' or ''accordion-like'' appearance of femurs and humeri. The skull is poorly ossified (B). Note that bone changes in case 4 (A) are more severe than that in case 5 (B). In case 5, the ribs show multiple fractures in a discontinuous pattern with normal rib parts in between callus formation (discontinuous beading), and platyspondyly is less severe. In radiograph of case 6 (C), skull is large relative to facial bones, and calvarium is underossified. Biparietal diameter is increased. Bones of extremities are relatively long and thin, with bowing deformities and wide metaphyses. Ribs are thin, without overt fractures. Several fractures with callus formation are seen in rib, clavicles, and left femur. Two fractures without callus formation are seen in right radius and left 9th rib. Note radioulnar synostosis between the proximal radius and the ulna.
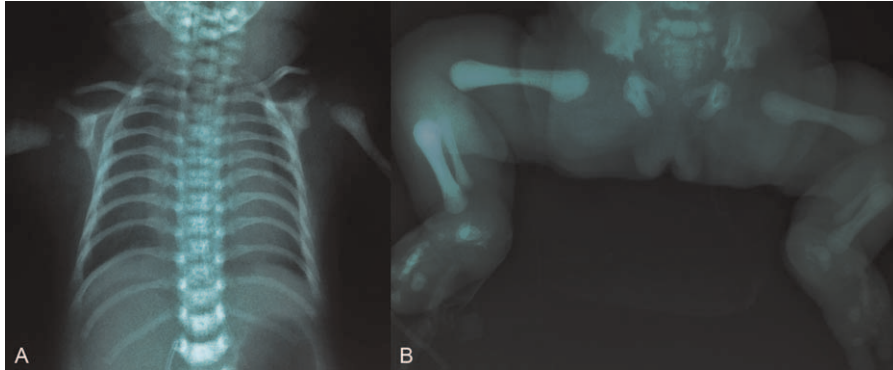
FIGURE 4. Frontal (A) chest radiograph of case 7 shows narrow thorax with slightly short ribs. The cardiomegaly is due to cardiac defect including atrial septal defect, ventricular septal defect, and patent ductus arteriosus. The vertebral bodies are unremarkable. Radiograph of lower limbs and pelvis (B) shows vertically shortened ilia, and their inferior margins, which are horizontal with a downward-pointing hook at the medial and lateral aspects of the acetabulae (trident or triradiate acetabulum). Femora and tibiae are short and broad, and their lower ends and proximal ends of tibiae are clubbed. Note that there is progressive distal shortening of limbs leading to mesomelia and acromelia. The appearance of the chest and pelvis closely resembles that of asphyxiating thoracic dystrophy.

the 2 disorders. In type 2 (OMIM 263520) and type 4 (OMIM 269860), the pelvis has a more normal appearance and the ends of the tubular bones are smooth. The occurrence of a median cleft lip also identifies type 2 and type 4 SRPS. However, short ovoid tibia are not seen in type 4 SRPS; this is the diagnostic finding of type 2 SRPS.[13–15]

FIGURE 5. Radiograph of case 9 shows absence of lumbosacral vertebrae, thoracic vertebral defects, malformed ribs, dysplastic and hypoplastic pelvic bones, and ''frog-like'' position of the right lower extremity. Spine terminates at the T12 level. The left radius is absent (the absence of left thumb is not well visualized). The orogastric tube does not pass through esophagus, and is twisted. There is no passage of gas into the stomach and intestines. Note shaft fracture of the left femur, and dislocated left knee.

FIGURE 6. Radiograph of case 10 demonstrates scoliosis in the thoracic spine and reduced lung volume. Note that there is unilateral unsegmented bar (arrow), and vertebrae at the curve region are smaller. Bilateral dislocation of hip is also seen.

FIGURE 7. Radiograph of case 11 shows multiple abnormalities of the thoracic vertebrae with hemivertebrae, fused vertebrae, and fusion and bifurcation of the ribs. Segmentation anomalies appear throughout the majority of thoracic spine. Thorax is asymmetrical, and has mild scoliosis. The right lung is somewhat smaller than the left. Note that despite multiple vertebral segmentation defects, a ''crab-like'' thoracic spine is not evident. The radiograph shows asymmetrical abnormalities of the vertebral bodies and ribs, but not the symmetrical posterior fusion of the ribs so characteristic of spondylothoracic dysplasia.

Ellis-van Creveld syndrome (OMIM 225500) is characterized by progressively acromelic and mesomelic limb shortening, with smooth rounded metaphyses, postaxial polydactyly, small chest, ectodermal dysplasia, and, in many cases, congenital heart defects.[16] The ribs are usually shorter in ATD (OMIM 208500), and heart defects and ectodermal dysplasia are not characteristics of ATD.[17] The association of a small thorax with short ribs and a small pelvis is also seen in Barnes syndrome (OMIM 187760), which is distinguished from ATD by the presence of laryngeal stenosis and the absence of long bone changes and iliac spurs in infancy.[18]

Short-rib polydactyly syndrome should also be differentiated from other bone dysplasias presenting with micromelia and narrow thorax, namely achondrogenesis, TD, hypophosphatasia, and OI type II. These disorders are differentiated by their spinal, pelvic, and long bone changes.[9,10] However, postaxial polydactyly is present only in SRPS.[13]

In achondrogenesis (OMIM 200600), there are unossified vertebral bodies, short ribs with splayed ends, hypoplastic ilia, and short, misshapen tubular bones with minimal tubulation.[10,19] Infantile hypophosphatasia (OMIM 241500) is associated with severe demineralization and metaphyseal ossification defects reaching far into the diaphyses (the tubular bones are short and bowed with V-shaped ossification defects at their ends reaching deep into the diaphyses).[10,20] Metaphyseal cupping and fraying of tubular bones have also been observed in Jansen metaphyseal dysplasia (OMIM 156400), which differs by the presence of splayed rib ends and normal alkaline phosphatase.[9,10] In contrast to infantile hypophosphatasia, life expectancy is normal in Jansen metaphyseal dysplasia.[10] OI type II (OMIM 166210) differs by the presence of rib and long bone fractures, and the absence of metaphyseal lesions.[21] Flat vertebral bodies, squared iliac wings with wide, horizontal inferior margins, and curved femora with radiolucent upper ends in TD (OMIM 187600) rule out other lethal chondrodysplasia.[10,22] A radiologically similar disease with favorable outcome is achondroplasia (OMIM 100800). The appearance of the vertebral bodies, pelvis, and tubular bones in achondroplasia is similar but milder than those in TD.[10]
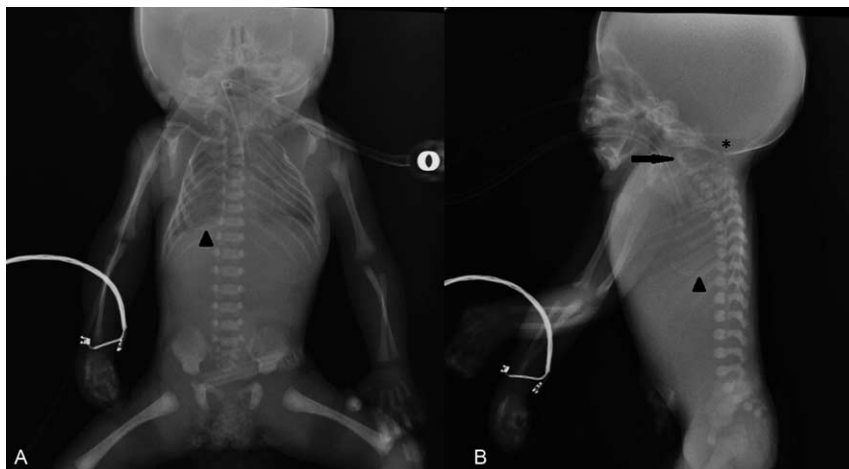
FIGURE 8. Frontal (A) radiograph of case 12 shows asymmetrical thoracic cage, and thin and deformed ribs. Sprengel deformity (congenital elevation of the scapula) is bilaterally present. Note that there is no passage of gas into the stomach and intestines. The orogastric tube does not pass through esophagus into the stomach, and is twisted in the thoracic cage (arrowhead). Lateral spine radiograph (B) shows fusion of adjacent cervical vertebral bodies (arrow), moderate dorsiflexion of cervical spine, and wide foramen magnum (asterisk). The calvarium is relatively large.

TABLE 1. Demographic, Clinical, and Radiographic Features of Cases

No. of Cases	Sex	BW, g; L, cm; HC, cm	Maternal Age	Sibs	Clinical Features	Radiographic Features	Diagnosis	Outcome
1	F	1900; 38; 35	25	1 unaffected	Hydropic face, cleft upper lip, very narrow thorax, shortening of all limbs, symmetrical postaxial polydactyly on the upper limbs	Narrow thorax, short and horizontally located ribs, short upper and lower limb bones, normal iliac bones, extremely short ovoid tibiae, and rounded metaphyseal ends of long bones (Figure 1)	SRPS type II (Majewski syndrome)	Died at 7 hours of life
2	F	2750; 38; 33	30	5 unaffected	Dysmorphic features, relative macrocephaly, midfacial hypoplasia, depressed nasal bridge, low set ears, short limbs, short narrow thorax with relative protuberance abdomen	Very short ribs with cupped anterior ends, narrow thorax, flat vertebral bodies, small sacrosciatic notches, extremely shortened long bones of the limbs, "telephone-receiver"-like curved femora (Figure 2A)	TD type I	Died at 5 days of life
3	F	3250; 40; 39	32	1 stillbirth at the 34th week of gestation	Macrocephaly, midfacial hypoplasia, depressed nasal bridge, low set ears, short limbs, short narrow thorax with relative protuberance abdomen	The findings were mostly the same with case 2 (Figure 2B)	TD type I	Died at 2 days of life
4	M	1750; 35; 34	30	2 unaffected	Thin and soft skin, soft calvarium, wide fontanels, dark blue sclerae, small chest, beaded ribs, short and deformed limbs, pronation of hands and feet	Generalized osteopenia, small chest with beaded and broad ribs, multiple fractures with callus formation, flat vertebral bodies, short, broad and crumpled long bones ("telescoped" or "accordion-like" appearance of femurs and humeri) (Figure 3A)	OI type; II-A	Died after 24 hours
5	F	2100; 36; 36	25	1 affected	Thin and soft skin, soft calvarium, wide fontanels, blue sclerae, narrow thorax, short, bowed and deformed limbs	Thin ribs with discontinuous beading, mildly platyspondyly. The remaining findings were mostly the same with case 4 (Figure 3B)	OI type; II-B	Died on third day
6	M	2700; 44; 36	22	First child	Mild hypotonia, relatively large cranium, triangular face appearance, wide fontanels, mildly small chest appearance, short and deformed limbs, crepitus at the right radius	Underossified calvarium, thin ribs, radius and rib fractures, short, deformed and angulated long bones, radioulnar synostosis (Figure 3C)	OI type III	On follow-up
7	F	2600; 46; 33	22	First child	Multiple small alveolar notches, partial cleft lip, moderate narrow thorax, short limbs, broad hands and feet, sausage-shaped fingers with hypoplastic nails, bilateral postaxial polydactyly in hands, ASD, VSD, and PDA	Narrow thorax with slightly short ribs, vertically shortened ilia, trident acetabulum, short and broad long bones, progressively distal shortening of segments (Figure 4)	EvC syndrome	Died at 25 days of life
8	M	2600; 48; 34	20	1 unaffected	Long and narrow thorax with relative protuberance abdomen, short limbs	Small and bell-shaped thorax with short and horizontally oriented ribs, short limbs relative to trunk, short iliac wings, trident acetabulum	ATD	Died at 28 days of life
9	M	2000; 45; 35	39	2 unaffected; 2 affected	Asymmetric chest appearance, short and deformed left forearm, fixed flexion contracture of wrist, absent left thumb, imperforate anus, sacral cystic mass, flexion contractures of hips and knees, palpable fracture at left femora, talipes equinovarus deformities, bilateral cryptocordism and hypospadias, esophageal atresia	Absence of lumbosacral vertebrae, hemivertebrae at thoracic spine, ribs deformities, fracture of femoral shaft, absence of radius (Figure 5)	CRS	Died at 6 hours of life
10	F	3050; 51; 35	32	3 affected; 4 unaffected	Asymmetric and small chest appearance, thoracic spinal scoliosis, dislocated hips, extended knees, equinovarus deformity, weakness in the lower limbs	Scoliosis in the thoracic spine, reduced lung volume, unilateral unsegmented bar at T4 to T5 level, dislocated hips (Figure 6)	CS	Died at 20 hours of life
11	M	3000; 48; 35	27	2 unaffected	Short neck, asymmetric and increased anterior posterior diameter of the chest wall, thoracic spinal scoliosis	Normal arms and legs with foreshortened thorax, thoracic vertebral segmentation anomalies and asymmetrical rib fusion (Figure 7)	SCD	On follow-up
12	F	1500; 36; 32	28	2 abortus; 1 unaffected	Macrocephaly, hydrocephalus, short neck, low posterior hairline, limitation of neck motion, asymmetrical appearance of chest, esophageal atresia	Asymmetrical thoracic cage, thin and deformed ribs, Sprengel deformity, fusion of adjacent cervical vertebral bodies, dorsiflexion of cervical spine (Figure 8)	KFS	Died at 10 hours of life

ASD = atrial septal defect, ATD = asphyxiating thoracic dystrophy, BW = birth weight, CRS = caudal regression syndrome, CS = congenital scoliosis, EvC = Ellis-van Creveld, F = female, HC = head circumference, KFS = Klippel–Feil syndrome, L = length, M = male, OI = osteogenesis imperfecta, PDA = patent ductus arteriosus, SCD = spondylocostal dysostosis, SRPS = short-rib polydactyly syndrome, TD = thanatophoric dysplasia, VSD = ventricular septal defect.

The other rare skeletal dysplasias associated with narrow thorax and micromelia include campomelic dysplasia (OMIM 114290; bowed femora and tibia, normal bone density, hypoplastic scapula and vertebrae, and eleven pairs of ribs), Schneckenbecken dysplasia (OMIM 269250; short ribs with splayed ends, small ilia with medial projection from the inner margins, shortened, dumbbell-shaped tubular bones), fibrochondrogenesis (OMIM 228520; radiologically similar to Schneckenbecken dysplasia, small ilia with spurs extending caudally from the acetabular roof), metatropic dysplasia (OMIM 156530; mushrooming of the long tubular bones), and lethal metaphyseal chondrodysplasia (OMIM 250220; short ribs with splayed posterior ends and cupped anterior ribs ends, mildly shortened tubular bones with metaphyseal cupping and irregularity).[9,10]

Osteogenesis imperfecta type II is characterized by early prenatal onset of severe bone shortening and bowing of the long bones due to multiple fractures, poor demineralization of the skull, and a narrow and bell-shaped chest caused by fractures of the ribs.[21,23] OI type II has been divided into OI types II-A, II-B, and II-C on the base of radiological characteristics.[21] OI type II differs in the shortened, crumpled long bones, especially compressed (''telescoped'' or ''accordion-like'') femurs and/or humeri, and continuous beaded and broad ribs from OI type III (OMIM 259420), which has thin ribs with rare fractures and markedly angulated long bones, with wide metaphyses and thinner diaphyses.[10,21] Although OI type III is not uniformly lethal in early infancy, as seen in this study, due to continuing fractures after birth, the appearance of the long bones can change in the course of time to the thick tubular bones seen in newborns with type II bone changes.[10,21] In OI type III, thoracic insufficiency is also evident in later periods.[21]

Congenital scoliosis is a skeletal disorder in which lateral curvature of the skeletal spine results from asymmetric biomechanical forces, and can occur with many conditions including abnormal vertebral segmentation, neuromuscular disorders, and rare congenital syndromes.[24] Therefore, it may be described as a clinical finding rather than a precise diagnosis. Severe CS may produce a progressive loss of torso mobility, resulting in fixed postural asymmetry, reduction in chest wall movement, and a consequent pulmonary hypoplasia and thoracic insufficiency.[24]

Caudal regression syndrome (OMIM 600145) is a rare and often sporadic congenital malformation of the lower vertebral column, characterized by partial or complete absence of sacrum and lumbar vertebrae.[25] Associations most often reported with CRS include genitourinary, anorectal, vertebral, and cardiopulmonary anomalies, and may also include VACTERL association (OMIM 192350; abnormality of vertebrae, anus, cardiovascular system, trachea, esophagus, renal system, and limb buds), and sirenomelia (fusion of the lower limbs).[25,26] Respiratory problems may arise from abnormal chest shape and size.[25]

Spondylocostal dysostosis is one of the 2 forms of Jarcho–Levin syndrome (OMIM 277300), which is characterized by distinctive malformations of bones of the spinal column (vertebrae) and the ribs, respiratory insufficiency, and/or other abnormalities.[27] It is important to distinguish between SCD and spondylothoracic dysplasia (STD), because survival may be possible in the former, but the latter is usually fatal.[27] SCD is differentiated by vertebral malformations, frequent dramatic rib malformations, and the absence of fan-like or crab-like thoracic configuration, whereas STD is characterized by vertebral body

malformations and ribs that flare in a fan-like pattern, but that are not significantly malformed.[27] The differential diagnosis of a patient with vertebral and rib anomalies includes KFS (OMIM 118100; cervical vertebral fusion, Sprengel deformity of the shoulder),[28] dyssegmental dysplasia (OMIM 224400; micromelia with reduced mobility, bowing of the long bone with dumbbell-shaped metaphyses), CS, VATER/VACTERL, and COVESDEM (OMIM 268310; costovertebral segmentation defects with mesomelia) associations.

CONCLUSIONS

The clinical findings and examination of the skeletal radiographs permit precise diagnoses in the majority of cases with skeletal dysplasias, since the classification of skeletal dysplasias is largely based on clinico-radiographic findings. Knowledge of the main findings allows us to make the differential diagnosis. The high rate of consanguineous marriages and the irregularity of antenatal visits, plus the presence of a family history of skeletal dysplasias, emphasize the importance of both detailed and persistent parental counseling.

ACKNOWLEDGMENTS

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