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Original Research Article

Prenatal diagnosis, management and challenges of fetal defects: an epidemiological survey in a low-income Country

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ABSTRACT

Background: The objective of this study was to describe the epidemiology and outcomes of fetal anomalies and malformations in a low-income country.
Methods: This was a descriptive, retrospective, cross-sectional study conducted over 18 months in various hospitals in Senegal. All fetuses diagnosed with a structural or functional fetal anomaly were included. Cases presenting with intrauterine fetal death (IUFD) were excluded, due to lack of ultrasound diagnosis. Data were collected via a database using Filemaker® software and analyzed using Statistical Package for Social Sciences version 20.0 (SPSS). Qualitative variables were described by proportions, while quantitative variables were expressed using their dispersion parameters.
Results: A total of 155 cases of fetal pathologies were recorded. The anomalies primarily affected the central nervous system (20.6%), the urinary system (51%), the musculoskeletal system (11.6%), the abdomen and digestive tract (11.3%), and the heart (11%). Among the fetuses, 57 (36.8%) had in utero complications, with 13 cases of intrauterine fetal death (8.8%). Invasive diagnostic procedures were performed on 15 patients (9.7%), and antenatal treatment was administered to 10 patients (6.5%). The mean gestational age at delivery was 35.6 weeks. Caesarean delivery was predominant (76.3%). Postnatal care was medical for 43 patients, surgical for 26, and palliative for 22. Neonatal mortality was 51.4%. Among this neonatal death, 30% of cases linked to the lack of postnatal care.
Conclusions: The prevalence of fetal malformations remains stable and similar across countries. The organization of prenatal diagnosis and specialized care must be a priority.

Keywords: Congenital malformation, Fetal medicine, Prenatal diagnosis, Surgery

INTRODUCTION

Congenital anomalies affect 2 to 3% of live births. Congenital anomalies are among the leading cause of infant mortality and handicap, with a mortality rate of 20%.[1-3] These anomalies are also responsible for 25.3 to 38.8 million disability-adjusted life years (DALYs) worldwide.[4] Thanks to advances in molecular biology techniques and imaging, prenatal diagnosis has made significant progress.[5,6] These technological advances have led to the creation of specialized centers for managing fetal defects which have significantly improved outcomes for affected fetuses.[7,8] However, despite substantial progress in the world, the advances in diagnostic and treatment of congenital defects remain largely confined to high-income countries. The majority of mortality related to fetal anomalies occurs in low- and middle-income countries, where 97% of deaths occur.[9] In these countries, fetal medicine remains a nascent or sometimes non-existent specialty and faces numerous challenges.[10]

In Senegal, a fetal medicine working group was established, three years ago, to meet the need for the management of structural and functional anomalies of fetuses. The objective of this work was to describe the epidemiology, management and outcomes of fetal defects in a low-income country, managed buy this working group.

METHODS

It was a retrospective, descriptive cross-sectional study over a period of 18 months, from June 1, 2022, to December 31, 2023. The study took place in several hospitals in Dakar, Senegal. The multidisciplinary working group consisted of various perinatal specialists established in different hospitals. Fetal defects detected across the country were referred to the working group for diagnosis and management.

We included all fetuses in which a structural or functional anomaly was detected. We excluded fetuses when intrauterine fetal death occurred before a diagnostic.

Data were collected daily using the SOSEPERD® database, managed with Filemaker software, and analyzed using Statistical Package for Social Sciences version 20.0 (SPSS). The parameters studied included maternal sociodemographic data, gestational age at diagnosis, type of fetal defect, and data related to management and outcomes.

Quantitative variables were expressed using their dispersion parameters (means, medians, standard deviations, and extremes). Qualitative variables were described as proportions.

For each anomaly, we calculated three proportions with different denominators: i) proportion relative to the entire sample; ii) proportion relative to all pathologies of the affected organ; iii) proportion relative to all anomalies in the sample.

This study received approval from the local ethics committee under with the reference numbers N°131UD/23. As the study was retrospective in nature and the data used did not disclose any personal information, obtaining informed consent was deemed unnecessary.

RESULTS

General characteristics

Over an 18-month period, 155 children with one or more congenital defects were managed by the working group. The population was relatively young, with an average maternal age of 28 years and a range from 18 to 41 years. The average parity was 1.05, with a median of 1.0. The total sibling recurrence rate was 7.7%. The recurrence rate for similar fetal defect was 3.9%. These recurrences involved Zellweger syndrome, epidermolysis bullosa, congenital adrenal hyperplasia, hypoplastic left heart syndrome (HLHS), multicystic dysplastic kidney, and microcephaly.

We identified teratogenicity in two patients, related to angiotensin-converting enzyme inhibitors and isotretinoin. The average gestational age at ultrasound diagnosis was 27.12 weeks. Nearly 6.45% of patients had an abnormal nuchal translucency identified at first-trimester ultrasound. Fetal defects diagnosed in the first trimester were megacystis (1 case), omphalocele (2 cases), and anencephaly (1 case).

Prevalence of congenital defects

We reported each type of anomaly relative to the total number of fetal anomalies observed. A fetus could have multiple anomalies. Thus, for a sample of 155 fetuses, 301 structural or functional anomalies were recorded (Table 1).

Table 1: Distribution of congenital defect according to the affected organ or system.

Organs and systems affected	Number (%)
Central nervous system	62 (20.6)
Urinary tract	51 (16.9)
Limbs	35 (11.6)
Abdominal wall and digestive tract	34 (11.3)
Heart	33 (11.0)
Face	28 (9.3)
Thorax	26 (8.6)
Cranial anomalies	18 (6.0)
Specific complications of twin pregnancy	7 (2.3)
Fetal tumors	7 (2.3)
Total	301 (100.0)

Central nervous system (CNS) malformations were the most frequent, with a prevalence of 20.6%. Renal and urinary tract anomalies accounted for 16.9%. The third most prevalent anomalies were limb, abdominal, and heart malformations (around 11% for each). Nearly 9% of fetuses had facial malformations. The occurrence of thoracic anomalies was 8.6%. The incidence of complications from multiple pregnancies was 2.3%, as well as that of fetal tumors.

Occurrence of cranial, central nervous system and facial anomalies

Cranial anomalies represented 13.5% of the sample. Lethal cranial anomalies such as anencephaly and exencephaly represented 44.7% of these cranial anomalies. Occipital encephalocele constituted 22.2% of cranial anomalies (Table 2).

CNS anomalies were found in 34.8% of fetuses. The most common central nervous system anomalies were ventriculomegaly and midline defects

(holoprosencephaly), which represented 30.6% and 14.5% of CNS anomalies, respectively. Posterior fossa anomalies, including mega cisterna magna, cerebellar agenesis of vermis, and cerebellar agenesis, accounted for 9.7%, 8.1%, and 6.5% of central nervous system anomalies, respectively. This group of anomalies also included 4.8% of dysraphism and one case of a Galen vein aneurysm (1.7% of central nervous system anomalies).

Table 2: Distribution of cranial, central nervous system and facial anomalies.

	Number	Prevalence/number of fetuses (%) n=155	Prevalence/number of each organ anomalies (%)	Proportion/number of anomalies (%) n=301
Cranial defects n=21				
Anencephaly	5	3.4	23.8	17.0
Anomalies of shape of skull	5	3.4	23.8	17.0
Occipital encephalocele	4	2.7	19.0	13.0
Exencephaly	3	2.0	14.3	10.0
Microcephaly	2	1.4	9.5	6.6
Soft skull	2	1.4	9.5	6.6
Central nervous system anomalies n=54				
Ventriculomegaly	19	12.8	35.2	63.1
Septal agenesis	10	6.8	18.5	33.2
Mega cisterna magna	6	5.1	11.1	17.3
Cerebellar vermis agenesis	5	3.4	9.3	16.6
Cerebellar agenesis	4	2.7	7.4	13.3
Thalamic fusion	3	2.0	5.6	10.0
Spinal dysraphism	3	2.1	5.6	9.9
White matter abnormalities	1	0.7	1.8	3.3
Corpus callosum agenesis	1	0.7	1.8	3.3
Galien vein Aneurysm	1	0.7	1.8	3.3
Subependymal pseudocyst	1	0.7	1.8	3.3
Facial anomalies n=28				
Micrognathia	5	3.4	17.8	16.6
Eye position anomalies	5	3.4	17.8	16.6
Retrognathia	4	2.7	14.3	13.3
Cleft lip and palate	4	2.7	14.3	13.3
Forehead shape anomalies	4	2.7	14.3	13.3
Ear anomalies	2	1.4	7.1	6.6
Absence of nasal bones	1	0.7	3.6	3.3
Rudimentary nose	1	0.7	3.6	3.3
Cyclopia	1	0.7	3.6	3.3
Microphtalmy	1	0.7	3.6	3.3

Nearly 18.1% of patients had facial malformations. Micrognathia was the most frequent facial anomaly, representing 17.8% of this group, followed by retrognathia (14.3%). Rare anomalies such as cyclopia and a rudimentary nose were observed. Cleft lip and palate anomalies accounted for 14.2% of facial anomalies.

Prevalence of abdominal wall, digestive tract, kidney and urinary tract anomalies

Abdominal and digestive tract anomalies were found in 23.2% of fetuses. Ascites was the most common, representing 35.3% of abdominal anomalies. We noted 17.6% of laparoschisis and 11.8% of omphalocele. Anorectal malformations were also frequent, accounting for 14.7% of abdominal anomalies. The prevalence of esophageal atresia was 0.7% in the all samples (Table 3).

We identified 32.3% of urinary system anomalies in all fetuses. The most frequent features were pylectasis (25.5%), megacystis (21.6%), multicystic dysplastic kidney (15.6%), and ureterohydronephrosis (9.9%).

Thoracic and cardiac anomalies

Thoracic anomalies occurred in 16.1% of fetuses. Among these, pleuritis was the most common (38.5%). Diaphragmatic hernia represented 7.7% of thoracic anomalies and were found in 1.4% of fetuses. The prevalence of ectopia cordis was similar to that of diaphragmatic hernias (Table 4).

Table 3: Distribution of abdominal wall, digestive tract, kidney and urinary tract anomalies.

	Number	Prevalence/number of fetuses (%) n=155	Prevalence/number of each organ anomalies (%)	Proportion/number of anomalies (%) n=301
Abdominal wall et digestive tract n=36				
Ascitis	12	8.1	35.3	39.9
Laparoschisis	6	4.1	17.6	19.9
Omphalocele	6	4.1	17.6	19.9
Anorectal malformation	3	2.1	8.8	10.0
Intestinal atresia	3	2.1	8.8	10.0
Dilatation digestives	2	1.4	5.9	6.6
Duodenal atresia	2	1.4	5.9	6.6
Esophageal atresia	1	0.7	2.9	3.3
Bowel dilatation	1	0.7	2.9	3.3
Kidney and urinary tract anomalies n=50				
Pyelectasis	13	8.8	26.0	43.2
Megacystisis	11	7.0	22.0	36.5
Multicystic kidney dysplasia	8	5.2	16.0	26.6
Uretero-hydronephrosis	5	3.4	10.0	16.6
Hyperechoic kidney	3	1.9	6.0	10.0
Kidney agenesis	3	1.9	6.0	10.0
Bladder exstrophy	2	1.4	4.0	6.6
Kidney cyst	2	1.4	4.0	6.6
Urinary ascites	2	1.4	4.0	6.6
Megaureter	1	0.7	2.0	3.3

Table 4: Distribution of thoracic and cardiac anomalies.

	Number	Prevalence/number of fetuses (%) n=155	Prevalence/number of each organ anomalies (%)	Proportion/number of anomalies (%) n=301
Thoracic anomalies n=25				
Pleural effusion	10	6.8	38.5	33.2
Narrow thorax	6	4.0	23.1	19.9
Hypoplastic lung	5	2.8	19.2	16.6
Ectopia cordis	2	1.4	7.7	6.6
Diaphragmatic hernia	2	1.4	7.7	6.6
Heart defects n=33				
Arythmia	8	5.4	24.3	26.6
Ventricular septal defect	7	4.7	21.2	23.3
Atrioventricular septal defect	4	2.7	12.1	13.3
HLHS[a]	4	2.7	12.1	13.3
Hypertrophic cardiomyopathy	4	2.7	12.1	13.3
Double outlet right ventricle	3	2.1	9.1	9.9
Tetralogy of Fallot	2	2.1	9.1	9.9
Rhabdomyoma	1	0.7	3.0	3.3

HLHS[a] = Hypoplastic left heart syndrome.

We recorded 21.3% of cardiac anomalies in all fetuses. Rhythm disorders were the most frequent, representing 24.3% of cardiac anomalies. Ventricular septal defects were second most frequent with 21.2% of prevalence. Among cardiac malformations, atrioventricular communications and left ventricular hypoplasia each represented 12.1%, as did hypertrophic cardiomyopathy. Conotruncal heart defects made up 12.1% of cardiac anomalies.

Other congenital defects

Among the fetuses studied, 22.6% had limb anomalies. We observed 28.5% of cases of clubfoot, 25.7% of shortened fetal long bones, and 11.4% of arthrogryposis. Spinal deformities represented 1.9% of the sample. Congenital anomalies of the external genitalia were noted in 4% of all fetuses. In our series, 5.1% of fetal tumors were identified,

primarily sacrococcygeal teratomas (2%). Boland's tumor and ovarian teratoma were rarer (0.7%).

We also reported 2% of conjoined twins and 2.8% of twin-to-twin transfusion syndrome.

Table 5: Distribution of other congenital defects.

	Number	Prevalence/number of fetuses (%) n=155	Prevalence/number of each organ anomalies (%)	Proportion/number of anomalies (%) n=301
Limb congenital disorders n=38				
Club foot	10	6.8	28.5	33.2
Short long bones	9	5.8	25.7	29.9
Arthrogryposis	7	4.5	20.0	23.3
Radial clubhand	3	1.9	8.6	10.0
Polydactyly	4	2.7	11.5	13.3
Amniotic bands	2	1.4	5.7	6.6
Clinodactyly	2	1.4	5.7	6.6
Ectrodactyly	1	0.7	2.9	3.3
Fetal tumor n=7				
Sacrococcygeal teratoma	3	2.0	42.9	10.0
Hygroma	2	1.4	28.5	6.6
Teratoma ovary	1	0.7	14.3	3.3
Boland's tumor	1	0.7	14.3	3.3

Management and antepartum evolution

A diagnosis was made in 129 patients, representing 83.2% of the patients. For fetuses without diagnosis, we have made a description of the ultrasound aspects.

Invasive diagnostic procedures were performed on 15 patients (9.7%). Among them, 5 underwent amniotic fluid biochemical analysis, 2 had molecular genetic testing, and 4 had karyotyping for suspected chromosomal abnormalities on amniotic fluid. Two other patients had amniotic fluid samples for specific diagnoses. We performed six amnioreduction procedure for acute hydramnios and two amnioinfusions for oligohydramnios. We, also, performed bladder drainage for megacystis.

Fifty-seven fetuses (36.8%) had intrauterine complications, among which we counted 12.9% of intrauterine growth restriction (IUGR).

Postnatal management and outcomes

The average gestational age at delivery was 35.6 weeks. In our series, 76.3% of patients had cesarean deliveries. Immediate care was provided to 40.6% of newborns, 1.9% received care within 7 days, and 7.1% received care within one month. Postnatal care was mainly medical (27.8%) or surgical (16.1%) or palliative in 14.2% of cases. Forty-seven children (31.8%), survived after birth. Unfortunately, 7.7% were lost to follow-up, and 8.8% progressed to intrauterine fetal death (IUFD).

Neonatal mortality was 51.4%. Among the neonatal mortality, the proportion of lethal congenital defects was 31.6%. We noted that 30.2% of deaths were due to failure of resuscitation or management. Four deaths (5.3%) were linked to renal failure, while one case (1.3%) was attributed to infection. We recorded a lethality of 100% in following congenital defects: urethral atresia, epidermolysis bullosa, conotruncal heart defects, bilateral multicystic dysplastic kidney, HLHS, diaphragmatic hernia, unexplained hydrothorax, OEIS syndrome, laparoschisis, anorectal malformations, and progeria.

DISCUSSION

Main findings

We didn't calculate the incidence of malformations because the healthcare facility receives pregnancies from various regions of the country, which could lead to selection bias.

Most of the mothers were young, with an average age of 28 years.

The recurrence rate of anomalies was 7.7%, and the recurrence rate of similar anomalies was 3.9%.

The most common malformations involved the central nervous system (20.6%), the kidney and urinary tract (16.9%), and the heart (11%).

Genetic testing was rare (3.8%) due to its high cost. So genetic counselling was often impossible.

Antenatal care was possible but limited.

Neonatal mortality was very high (51.4%), with 68.4% of the deaths attributed to inadequate management.

Interpretation of our results

It is well recognized that the incidence of malformations in the population is 2-3%.[10,11] Our local law prohibits the termination of pregnancy due to fetal malformation. Therefore, the incidence of malformations at birth will be higher than in countries with different laws. According to Sitki et al, 94% of malformations occur in low- and middle-income countries.[4] This is explained by the high birth rate and the low frequency of pregnancy terminations following prenatal diagnosis of congenital anomalies.[4] According to the Centers for Disease Control and Prevention (CDC), congenital anomalies occurred in 1 in 33 babies in USA. It is crucial to organize effective screening and diagnostic systems given this high prevalence. Considering birth defects in health policies is also important due to the burden and the DALYs. The prevalence of anomalies remains stable, indicating that primary prevention is difficult. Efforts must be made by countries to improve human resources and technology in management of congenital defects.

The mean maternal age in our sample confirms that the congenital defect can occur at all ages during of reproductive period. According to Gill et al, although all types of anomalies are observed at any age during the reproductive years, there is an association between certain malformations and maternal age.[10] They demonstrate that conotruncal heart defects, ventricular septal defects, and atrial septal defects are more frequent in women over 40 years old. Identifying risk factors specific to extreme maternal ages allows for preventive measures.[10]

The recurrence rate is between 2% and 4%, according to various authors.[12,13] According to Glinianaia et al, for similar anomalies, the relative risk (RR) was 23.8 (95% CI 19.6-27.9, p<0.0001), while for non-similar anomalies, the RR was 1.4 (95% CI 1.2-1.6, p=0.001).[13] In our study, similar recurrence involved Zellweger syndrome, epidermolysis bullosa, congenital adrenal hyperplasia, HLHS, multicystic dysplastic kidney, and microcephaly. Genetic testing was only performed for the Zellweger syndrome case, due to insufficient technical resources. Some authors note that anomalies with the highest recurrence rates include chromosomal anomalies, microdeletions, cleft palates, cardiac anomalies, central nervous system anomalies, urinary anomalies, skeletal anomalies, and microcephaly. The availability of genetic testing is essential for genetic counselling.[13,14]

CNS, heart, and urinary tract defects were the most frequent. In Brazil, Oliveira-Brancati et al report prevalences of 11.2% for cardiac anomalies, 8.9% for central nervous system anomalies, and 7.7% for urinary tract anomalies among all congenital anomalies.[12] Similarly, Glinianaia et al document prevalences of 2.7/1000 for CNS anomalies, 8.5/1000 for heart defects, and 2.8/1000 for urinary tract defects in the general population. According to these authors, cardiac malformations rank first, followed by CNS malformations. Compared to our results, we conclude that there was a deficiency in the prenatal screening of congenital heart anomalies in our context. Despite advancements in fetal cardiac imaging, the prenatal detection rates of congenital heart defects remain highly variable. According to Parikh et al, the prenatal detection rate, apart from HLHS, ranges from 0% to 50% depending on the pathology.[15] Similarly, Sun et al in USA report detection rates ranging from 9% to 60% depending on the anomalies.[16] Screening tools such as artificial intelligence should be developed to improve detection rates of cardiac anomalies.

Management remains particularly challenging in low-income countries. The availability of genetic testing techniques and significant progress in imaging have fundamentally changed the practice of fetal medicine.[17] In our series, the lack of genetic testing remains a barrier to genetic counselling.

High neonatal mortality is due to several factors, including the lack of an integrated center for managing malformations, the absence of prenatal surgery, deficiencies in neonatal intensive care and emergency neonatal surgery. Sitkin et al. also blame delays in referral to surgical centers and financial inaccessibility in low-resource countries.[4]

Recently, there has been a trend towards centralization of perinatal care services involved in diagnosing and treating fetal malformations. These centers offer highly specialized invasive procedures that can treat fetal life-threatening anomalies, modify the disease's natural evolution, or improve the newborn's condition.[7,8] This model ensures high-quality care and the survival of children with treatable malformations.

Studies have shown a significant reduction in the economic burden of disease through surgery. Indeed, studies demonstrate that pediatric surgery prevents more than two-thirds of the DALYs associated with congenital malformations.[18-20]

Implications for care and research

The implementation of specialized centers for managing malformations should be a priority for low-resource countries. Research priorities should focus on the impact of various prenatal and postnatal therapeutic interventions.

CONCLUSION

Although congenital defects are not always considered a major public health issue, they represent a growing challenge due to the significant impact on families and society. The occurrence of congenital anomalies remains stable worldwide over the years, making prevention difficult. After prenatal diagnosis, management requires technical, financial, and organizational resources. When effectively implemented, these resources significantly reduce the burden of these anomalies.

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