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Original Research Article

Profile of congenital defects in foetuses: incidence and risk factors: a prospective observational study

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ABSTRACT

Background: Perinatal outcome is one of the major indicators of evaluating health care system of a country. Congenital defects form important components of this parameter. The aim of the study was to determine the risk factors associated with congenital malformations in foetuses.
Methods: All antenatal mothers whose foetuses were detected to have congenital defects on ultrasonography irrespective of period of gestation were enrolled for the study.
Results: Eighty-six pregnant women with prenatally diagnosed fetal anomalies were enrolled for the study, out of which, 87.2% (N=75) belonged to 20-30 years age group. Majority of the subjects were educated till secondary school. Compared to primigravidae, the incidence of malformations was significantly higher in the multigravida group (69.8% vs 30.2% respectively). Thirty-eight (44.2%) mothers with malformed foetuses missed folic acid intake during early pregnancy. Only 40% mothers had prior history of abortions. Smoking was seen in 9% of subjects with malformations. Seven (8.3%) mothers had previous history of malformations and 5 (5.8%) reported a family history of malformations. Consanguineous marriage was observed in 4.7% of couples. Oligohydramnios or anhydramnios was associated with 11.6% foetuses, while polyhydramnios was seen in 53.5%. CNS malformations were seen in 57% of foetus, followed by genitourinary system malformations (9.2%).
Conclusions: Tertiary level hospitals need to be upgraded with a dedicated multidisciplinary team of foetal medicine to cater to medical, clinical, surgical, preventive and therapeutic needs of malformed foetuses.

Keywords: Congenital malformations, Birth defects, Risk factors, Counselling

INTRODUCTION

Advancements in healthcare and improved standard of living has caused a shift in the prevalence of diseases. A decline in infectious diseases and a surge in inherited disorders is visualised of which congenital malformations constitute a major section. Congenital anomalies accounts for 15% of perinatal and neonatal deaths in India.[1] The incidence of congenital malformations varies widely between developed and developing countries. Major congenital malformations occur in approximately 3 to 4 percent of livebirths, although minor anomalies are more frequent.[2]

According to March of Dimes and WHO report, 70% of birth defects are preventable provided genetic services could be introduced at the community level.[3] However, these services have not received due attention in India because of various reasons including cultural, religious, and social; apart from inadequate resources and trained manpower. Small interventions like introduction of periconceptional care and better control of medical

diseases in this crucial period can reduce the incidence of birth defects and still births.[4]

Single gene and chromosomal disorders, environmental pathogens and micronutrients depletion can cause various birth defects.[5] Syphilis and rubella infection in pregnancy, pregestational diabetes mellitus, iodine and folic acid deficiency, radiation exposure, teratogenic drugs cause significant birth defects. The common risk factors for developing birth defects in India are advanced maternal age at delivery, foetal growth restriction, low birth weight, consanguineous marriage, poor socioeconomic status and multifetal gestation.[4]

Among the structural birth defects, inborn errors of metabolism constitute a major role. These range from congenital malformations to foetal cardiomyopathy, hydrops fetalis or isolated ascites and foetal death.[6] Hydrops fetalis may be a presentation of Glycogen storage disorder IV and lysosomal storage disorders. On the other hand, metabolic errors which lead to decreased foetal energy production such as mitochondrial oxidation defects may present with cardiomyopathy, oedema, ascites, and foetal demise.[6]

In developing countries, dedicated efforts to evaluate the etiological factors specifically incorporating cytogenetic studies, syndromes, minor congenital malformations or heart lesions are lacking because of lack of consistent approach and follow up.

While studying the incidence of anencephaly in our own institute, it was felt that detailed information on unexpected foetal loss and perinatal counselling for prevention of recurrences is required. However, the study was limited to foetuses presenting with anencephaly.[7] The prerequisite for better neonatal outcomes is still lacking in medical care managements except in select institutes. Hence the present study is being planned to study the profile of congenital defects in foetuses presenting in a tertiary level hospital based on their clinical presentation. The planned study can help us identify possible risk factors in the population leading to congenital defects.

METHODS

A prospective cross-sectional observational study was carried out for a period of 18 months from January 2016 to July 2017 in the department of obstetrics and gynaecology in collaboration with department of anatomy, and radiology at a tertiary care hospital.

Inclusion criteria

All antenatal mothers whose foetuses were detected to have congenital defects on ultrasonography irrespective of period of gestation were enrolled for the study. Enrolment was started after approval by the institutional ethics committee. In these cases, after taking informed consent, detailed information on pre-conceptional counselling, intake of micronutrient, past and present history of medical disorders of pregnancy and details of treatment, any past history of previously affected pregnancy, congenital malformations and any defects in sibling or family member were collected. OMIM database was used in evaluation of foetuses with multiple malformations. Study was ethically conducted in accordance with Declaration of Helsinki.

Exclusion criteria

Couples undergoing sterilization or not planning further pregnancy, or not willing to participate in the study.

Statistical analysis

Data was analysed using Student's t test for comparing quantitative parameters in different subgroups. Normal test of proportion was used for comparison of proportion in different subgroups. Chi square test was used for testing significance of association between different attributes. Logistic regression analysis was done for investigating risk factors of multiple genetic defects/ abnormalities. A p value<0.05 was considered significant.

RESULTS

Out of 9155 pregnancies which were screened, 115 pregnancies were diagnosed fetal anomalies, citing incidence of 1.3% of congenital malformations. Eighty-six women who fulfilled the inclusion criteria were enrolled in the study. Of 86 malformed foetuses, 39 (45.3%) were in the age group 20-25 years and 33 (38.4%) between 25-30 years (Table 1). Since a large number of referrals are made to our institute from rural areas of surrounding states, only 8 (9.3%) mothers of the study group resided in urban state of Chandigarh. Forty-four (51.2%) foetuses with malformations were born to resident couples from rural Punjab, 22 (25.6%) from Haryana, and 12 (14%) from Himachal. These cohort of women were referred for further counselling to our tertiary institute. As per Kuppu-Swamy categorization, 2 (2.3%) belonged to class II, 22 (25.6%) to class III, 24 (27.9%) to class IV, and 38 (44.2%) to class V. Out of 86 mothers, 19 (22.1%) were illiterate, and 61 (70.9%) had received education till secondary standard. Out of the 86 malformed foetuses, 26 (30.2%) foetuses were born to primigravida mothers and 60 (69.8%) to multigravida.

Majority of malformations, (70, 81.4%) were detected by second trimester and 16 (18.6%) detected in late pregnancy after 28 weeks of gestation. (Table 2). In our study population, majority of mothers reported for antenatal check-up in late first trimester, 38 (44.2%) mothers with malformed foetuses missed folic acid intake during early pregnancy and this was statistically significant (p= 0.03). Of those who did not take folic acid, 26 (68.4%) had central nervous system involvement. Seven (8.3%) mothers had previous history of malformations and 5 (5.8%) reported a family history of

malformations. Both co-relations were significant statistically. Of 86, only 4 (4.7%) foetuses were born out of consanguineous marriage. Five mothers with congenital malformed babies had history of taking potentially teratogenic antiepileptic drugs and it was not statistically significant. Amongst multigravida mothers with malformed foetuses, 24 (40%) had prior history of abortions. Amongst medical disorders in the study group, 6 (7%) mothers had hypothyroidism (7%), 2 (2.3%) each with diabetes mellitus and hypertension. Out of 86 malformations, oligohydramnios or anhydramnios was associated with 10 (11.6%) foetuses out of which, 8 foetus had genitourinary malformations. Polyhydramnios was seen in 46 (53.5%) mothers with malformed foetuses out of which 36 (78.2%) had neural tube defects and 8 (17.4%) had gastrointestinal malformations.

Out of 55 foetuses with central nervous system malformations, 25 (45.4%) had anencephaly, 5 (9%) each of meningomyelocele and hydrocephalus (Table 3). Musculoskeletal system was involved in 5 foetuses. Four (80%) had skeletal dysplasia and one had distal arthrogryposis. Out of 10 foetuses with malformations of Gastrointestinal tract, 5 (50%) had omphalocele. Nine foetuses had genitourinary malformations, with 4 (44%) cases of multicystic kidneys. Cardiovascular malformations were found in 4 foetuses, out of which 3 (75%) had hypoplastic left heart. Five cases of hydrops fetalis and 4 cases of cystic hygroma were found. Out of 86 malformed foetuses, 77 (89.5%) had a single malformation and 9 (10.5%) foetuses had multiple malformations.

Table 1: Socio-demographic features of the subjects (N=86).

Characteristics	Categories	Frequency	Percentage (%)
Age (years)	<20	2	2.3
	20-25	39	45.3
	25-30	33	38.4
	>30	12	14.0
Socio-economic status (SES)	Upper middle	2	2.3
	Lower middle	22	25.6
	Upper lower	24	27.9
	Lower	38	44.2
State	Punjab	44	51.2
	Haryana	22	25.6
	Himachal	12	14.0
	Chandigarh	8	9.3
Education status of mother	Illiterate	19	22.1
	Up to XII	61	70.9
	Graduation	3	3.5
	Postgraduation	3	3.5
Gravida	Primigravida	26	30.2
	Multigravida	60	69.8

Table 2: Clinical features of the subjects (N=86).

Characteristics	Categories	Frequency	Percentage (%)
Period of gestation (weeks)	<13	2	2.3
	13-28	68	83.7
	28-34	6	7.0
	>34	10	7.0
History of intake of folic acid	Yes	48	55.8
	No	38	44.2
History of drug intake in pregnancy	Present	12	13.9
	Absent	74	86.1
History of abortion (N=60)	Present	24	40
	Absent	36	60
History of malformations (N=60)	Present	5	8.3
	Absent	55	91.6
Family history of malformations	Present	5	5.8
	Absent	81	94.2
History of smoking in mother	Present	8	9.3
	Absent	78	90.7
History of alcohol in mother	Present	04	4.6

Continued.

Characteristics	Categories	Frequency	Percentage (%)
	Absent	82	95.3
History of consanguineous marriage	Present	4	4.7
	Absent	82	94.2
Amniotic fluid	Oligohydramnios	10	11.6
	Polyhydramnios	46	53.5
	Normal	29	33.7
Medical disorders in pregnancy	Absent	74	86.0
	DM	2	2.3
	Hypothyroidism	6	7.0
	Hypertension	2	2.3
	Epilepsy	1	1.2
	Cholestasis	1	1.2

Table 3: Congenital malformations and its systemic distribution.

Characteristics	Categories	Frequency	Percentage (%)
Number of systems involved (N=86)	Single	77	89.5
	Multiple	9	10.5
CNS malformations (N=55)	Meningomyelocele	5	9.0
	Anencephaly	25	45.4
	Spina bifida	4	7.3
	Encephalocele	4	7.3
	Hydrocephalus	5	9.1
	Arnold Chiari	4	7.3
	Dandy Walker	3	5.4
	Aqueductal stenosis	1	1.8
	Hypoplastic cerebellar hemispheres	2	3.6
	Holoprosencephaly	1	1.8
Genitourinary malformations (N=9)	Vesicourethral reflux	2	22.2
	Hydronephrosis	1	11.1
	Multicystic kidneys	4	44.4
	Bladder outlet obstruction	1	11.1
	Bladder exstrophy	1	11.1
Gastrointestinal malformations (N=10)	Omphalocele	5	50
	Gastroschisis	2	20
	Bowel atresia	2	20
	Imperforate anus	1	10
Musculoskeletal malformations (N=5)	Distal arthrogryposis	1	20
	Skeletal dysplasia	4	80
Cardiovascular malformations (N=4)	Hypoplastic left heart	3	75
	Transposition of great vessels	1	25
Other malformations (N=9)	Hydrops fetalis	5	55.5
	Cystic hygroma	4	44.4

DISCUSSION

Congenital malformations are a major cause of perinatal morbidity and mortality. Ideally to bridge the gap of understanding the natural course of congenital anomaly, a multidisciplinary team of foetal medicine specialist, geneticist and paediatric surgeon is needed for counselling.

In the present study, congenital malformations were common in the age groups 20- 25 (45.3%) and 25-30 years (38.4%). This was comparable to Taksade et al and Sarkar et al.[1,8] Majority of the malformations of the central nervous system (73.4%) were encountered in the reproductive age group. Lower socioeconomic class may show indirect association with congenital anomalies as in our study which may be co-related to risk factors for malformations like deficiency of micronutrients, exposure to infection, or poor access to healthcare.[9] The present study showed that most of the subjects 68 (83%) presented between 13 to 28 weeks of gestational age. In a multicentre European study involving 3686 malformed foetuses, the overall detection rate was 56%, but 44% of the cases were diagnosed before 24 weeks.[10] However, termination was possible till term. This is of bigger challenge for us in India as termination of pregnancy was allowed only up to 20 weeks due to MTP act, therefore cases had no option but

to continue the pregnancy after 20 weeks. However, in light of late detection of congenital malformation in India, The Medical Termination Of Pregnancy (Amendment) Act, 2021 has been modified to allow termination of pregnancy till 24 weeks in special circumstances.[11] In the present study, 44.2% of mothers with malformed foetuses did not take folic acid. It was higher than that observed by Singh A from India (19.29%).[12] Periconceptional folic acid supplementation provides a major opportunity to prevent birth defects especially neural tube defects.[13] The incidence of periconceptional folic acid deficiency is higher as concept of pre-conceptional counselling is largely missing in developing countries. Unfortunately, separate data on this was not attempted in our study. The present study observed that 5.8% had previous history of abortions which was lower than that observed in other studies like Perveen et al (26.3%), Shawky et al (32.3%), and Singh et al (70.5%).[12,14,15] Predominance of central nervous system involvement was found in the foetuses of mothers who had a previous history of abortions but this was not found to be statistically significant (p=0.246). However, cytogenetic analysis of parents for chromosomal anomalies with recurrent abortions should preferably be a part of investigation for affording couples reporting for pre-conception counselling.[16] In the present study, it was observed that 8.3% subjects with malformed foetuses had already previous history of malformed foetuses. There was significant difference between subjects with prior malformed foetuses and those without such history (p=0.001). The high recurrence rate of chromosomal abnormalities warrants foetal chromosomal investigation in subsequent pregnancies.[17]

Presence of family history of congenital anomalies was observed in 5.8% of subjects similar to the study by Perveen et al (5.26%).[14] The study highlights that it may be pertinent to undertake pedigree analysis of foetal syndromes with familial inheritance to guide couples through pre-conception counselling by a geneticist for future.[18] Most of the malformations in patients with similar family history were of the central nervous system (p=0.041). Consanguineous marriage constitutes 20-50% of all marriages in North Africa and South India.[19] In this study, only 4 cases (4.7%) of consanguineous marriage were observed. There is an urgent need to address this group separately. This apparently appears to correspond to the highest rate of consanguineous marriages in this part of the country. There appears to be associated with cardiovascular and nervous system malformations, which was statistically significant (p=0.023).

Polyhydramnios was present in 54.8% of malformed foetuses which was higher than that observed in the study conducted by Perveen et al (22.9%) and Shawky et al (10.7%).[14,15] Our study revealed statistically significant association between polyhydramnios and the malformations of central nervous system and gastrointestinal system (p<0.001). On the other hand, oligohydramnios was seen in 11.8% of malformed foetuses which was comparable to the study by Shawky et al (9.8%) and lower than that observed in the study by Stoll et al (32.6%).[15,20] Among those with foetal abnormalities, most cases of oligohydramnios beginning early in gestation are secondary to genitourinary anomalies. Hence, study supports a critical and detailed anomaly scan of all cases of oligohydramnios or polyhydramnios. In the present study, 2.3% mothers with malformed foetuses had pregestational diabetes.

This number was lower when compared to Perveen et al (5.26%) and Shawky et al (7.28%).[14,15] Though medical disorders, specifically diabetes mellitus significantly increases the risk of congenital malformations, for correct interpretations the total number of mothers with medical disorders presenting during the study period would be relevant. The study does suggest preconception counselling for women with medical disorders diabetes mellitus and metabolic control as preventive measures to reduce birth defects and maternal morbidity.[21] Various studies as shown above have found different systems to be the commonest system involved in their studies. The most common system involved in the present study was central nervous system which is comparable to the study conducted by Shawky et al.[15] In the study by Ronya et al, GIT was the most common system involved in the malformations (20.4%), and genitourinary in a study by Singh et al (29%).[12,22] Cardiovascular system was the most frequently system to be involved in anomalies in the studies by Taksande et al (23.17%), but only 4.1% in our study.[1] In our hospital, foetal echocardiography is not being done routinely which may be responsible for lower proportion of cardiovascular anomalies detected in the present study. Among all subjects, the mothers with congenital cardiac malformations in foetuses were >30 years of age and this association with elderly age was found to be statistically significant (p=0.002).

In the present study 9 out 86 foetuses were detected to have multiple malformations i.e.; involvement of two or more organ systems (Table 4). The possibilities are a denovo chromosomal (microscopic/sub-microscopic) syndrome or single gene multiple malformation syndrome should be born in mind. Foetal chromosomal analysis was offered to all couples with affected pregnancies less than 20 weeks. Additionally, for foetus 1 with USG suggestive of aqueductal stenosis with lissencephaly with distal arthrogryposis, possibility of Baraitser Winter syndrome or Miller Diecker lissencephaly syndrome can be kept. For confirmation of these syndromes ACTB gene sequencing and chromosomal microarray/FISH for 17p13.3 deletion can be offered. In a study by Chen et al it was concluded that in foetuses with Miller-Diecker Lissencephaly syndrome, the main abnormal ultrasound feature is central nervous system anomalies.[23] They confirmed this syndrome by Single nucleotide polymorphism analysis in two foetuses. Cystic hygroma with meningocele in foetus 2, would indicate pterygium syndrome, Knobloch syndrome and Joubert syndrome.[24] Bowel atresia was found in conjunction with hypoplastic left heart in foetus 4 and such combination points towards VACTERL

association.[25] CHARGE syndrome can be a differential although study by Sanlaville et al shows that the more constant features are external ear anomalies, arhinencephaly and semi-circular canal agenesis.[26] Clinical exome sequencing with CHD7 gene analysis can be offered in such cases. Omphalocele was seen in association with sacral agenesis, anencephaly and meningomyelocele in foetus 5, 6 and 7. Omphalocele-exstrophy-imperforate-anus-spinal defects (OEIS) complex could be suspected in such cases.[27] Omphalocele with anencephaly indicate towards thoracoabdominal syndrome.[28] An omphalocele is usually associated with other major anomalies and aneuploidy and thus mandates a complete foetal evaluation including karyotype.[29] Possibility of a lethal lysosomal storage disorder as a cause of non-immune hydrops fetalis (NIHF) as seen in foetus 8 can be kept and a cordocentesis for enzyme analysis can be offered for such cases.[30]

Table 4: Syndromic approach to congenital malformations.

Congenital malformations	Probable syndromes
Aqueductal stenosis with lissencephaly with distal arthrogryposis	Baraitser Winter syndrome 1
	Miller Diecker lissencephaly syndrome
Parietal meningocele with cystic hygroma	Pteryguim syndrome multiple lethal type
	Currarino syndrome
	Knobloch syndrome
	Arima syndrome
	Joubert syndrome
Hydrocephalus and pleural effusion	Mucopolysaccharidosis type 7
	Costello syndrome
Bowel atresia and hypoplastic left ventricle	VACTERL
	Alveolar capillary dysplasia with misalignment of pulmonary veins (ACDMPV)
	Forkhead box F1
Anencephaly with meningomyelocele with omphalocele	Omphalocele- exstrophy-imperforate anus-spinal defects (OEIS)
Anencephaly and omphalocele	Thoracoabdominal syndrome
	Brachial amelia, cleft lip and holoprosencephaly (ACLH)
	Foetal akinesia syndrome
	Hydrolethalus syndrome
	Short rib thoracic dysplasia 12
	Meckel syndrome 1
Sacral agenesis with omphalocele	OEIS complex
	Monosomy 1p36 syndrome
	Zinc finger protein of cerebellum 3
Hydrocephalus and hydrops fetalis	Cole carpenter syndrome 1
	Klippel trenaunay weber syndrome
	Myotonic dystrophy 1
	Yunis Varon syndrome
	Mucopolysaccharidosis 7

CONCLUSION

With introduction of biochemical markers and improved sensitivity of ultrasonography, the detection rates of congenital anomalies have increased considerably. Tertiary level hospitals need to be upgraded with a dedicated multidisciplinary team of foetal medicine to cater to medical, clinical, surgical preventive and therapeutic needs of foetus. Counselling of the couple for pre-conceptional care needs more devotion and attention.

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REFERENCES

1. Taksande A, Vilhekar K, Chaturvedi P, Jain M. Congenital malformations at birth in Central India: A rural medical college hospital based data. Indian J Hum Genet. 2010;16(3):159-63.

2. Bhide P, Gund P, Kar A. Prevalence of Congenital Anomalies in an Indian Maternal Cohort: Healthcare, Prevention, and Surveillance Implications. PLoS One. 2016;11(11):166408.
3. Christianson A, Howson CP, Modell B. Relationship between birth defect and maternal age, occupation, level of education. White Plains, New York: March of Dimes Foundation; 2006.
4. Institute of Medicine (US) Committee on Improving Birth Outcomes. Reducing Birth Defects: Meeting the Challenge in the Developing World. Bale JR, Stoll BJ, Lucas AO, eds. Washington: National Academies Press; 2003.
5. Iourov IY, Vorsanova SG, Yurov YB. Pathway-based classification of genetic diseases. Mol Cytogenet. 2019;12:4.
6. Saban C, Acquaviva C, Cheillan D, Frachon S, Guibaud L, Pagan C, et al. Antenatal manifestations of inborn errors of metabolism: biological diagnosis. J Inherit Metab Dis. 2016;39(5):611-24.
7. Singh J, Kapoor A, Kaur A, Kochhar S, Huria A. Incidence of Anencephaly in a tertiary care hospital in North West India. Int J Scj Res. 2015;5:17.
8. Sarkar S, Patra C, Dasgupta MK, Nayek K, Karmakar PR. Prevalence of congenital anomalies in neonates and associated risk factors in a tertiary care hospital in eastern India. J Clin Neonatol. 2013;2(3):131-4.
9. Vrijheid M, Dolk H, Stone D, Abramsky L, Alberman E, Scott JE. Socioeconomic inequalities in risk of congenital anomaly. Arch Dis Child. 2000;82(5):349-52.
10. Grandjean H, Larroque D, Levi S. The performance of routine ultrasonographic screening of pregnancies in the Eurofetus Study. Am J Obstet Gynecol. 1999;181(2):446-54.
11. Ministry of Law and Justice (legislative department). The Medical Termination Of Pregnancy (Amendment) Act, 2021, Available at: https://egazette.nic.in/WriteReadData. Accessed on 15 July 2021.
12. Singh A, Sinha S. Risk Factors of Congenital Malformations in North India: A Case–control Study. J Postgrad Med Educ Res. 2016;50:59-63.
13. Padmanabhan R. Etiology, pathogenesis and prevention of neural tube defects. Congenit Anom. 2006;46(2):55-67.
14. Perveen F, Tyyab S. Frequency and pattern of distribution of congenital anomalies in the newborn and associated maternal risk factors. J Coll Physicians Surg Pak. 2007;17(6):340-3.
15. Shawky RM, Sadik DI. Congenital malformations prevalent among Egyptian children and associated risk factors. Egypt J Med Hum Genet. 2011;12:69-78.
16. Sudhir N, Kaur T, Beri A, Kaur A. Cytogenetic analysis in couples with recurrent miscarriages: a retrospective study from Punjab, North India. J Genet. 2016;95:887-94.
17. Ryynänen M, Heinonen S, Kirkinen P. Recurrence risk of a serious, noninherited chromosomal abnormality. Fertil Steril. 1997;68:439-42.
18. Andrews LB, Fullarton JE, Holtzman NA, Motulsky AG. Assessing Genetic Risks: Implications for Health and Social Policy. Washington, DC: National Academies Press; 1994.
19. Soujanya JP, Amarnath GS. A study to assess the knowledge regarding consanguineous marriages and its genetic effects among young adults with a view to develop an information guide sheet. IOSR J Nurs Health Sci. 2013;1:24-8.
20. Stoll C, Alembik Y, Roth MP, Dott B. Study of 224 cases of oligohydramnios and congenital malformations in a series of 225,669 consecutive births. Community Genet. 1998;1:71-7.
21. Chen CP. Congenital Malformations Associated with Maternal Diabetes. Taiwan J Obstet Gynecol. 2005;44:1-7.
22. Ronya R, Gupta D, Ghosh SK, Narang R, Jain KB. Spectrum of congenital surgical malformations in newborns. J Indian Med Assoc. 2002;100:565-6.
23. Chen CP, Chien SC. Prenatal Sonographic Features of Miller-Dieker Syndrome. J Med Ultrasound. 2010;18:147-52.
24. Joshi T, Noor NN, Kural M, Tripathi A. Lethal multiple pterygium syndrome. J Fam Med Prim Care. 2016;5:477-8.
25. Martin V, Smith C. Review of genetic factors in intestinal malrotation. Pediatr Surg Int. 2010;26:769-81.
26. Sanlaville D, Etchevers HC, Gonzales M, Martinovic J, Ziza M, Delezoide AL, et al. Phenotypic spectrum of CHARGE syndrome in fetuses with CHD7 truncating mutations correlates with expression during human development. J Med Genet. 2006;43:211-7.
27. Mallmann MR, Reutter H, Müller AM, Geipel A, Berg C, Gembruch U. Omphalocele-Exstrophy-Imperforate Anus-Spinal Defects Complex: Associated Malformations in 12 New Cases. Fetal Diagn Ther. 2017;41:66-70.
28. Chen CP. Syndromes and Disorders Associated with Omphalocele (III): Single Gene Disorders, Neural Tube Defects, Diaphragmatic Defects and Others. Taiwan J Obstet Gynecol. 2007;46:111-20.
29. Poaty H, Pelluard F, Diallo MS, Ondima IPL, André G, Massamba JF. Omphalocele: a review of common genetic etiologies. Egypt J Med Hum Genet. 2019;20:37.
30. Sheth J, Mistri M, Shah K, Chaudhary M, Godbole K, Sheth F. Lysosomal Storage Disorders in Nonimmune Hydrops Fetalis (NIHF): An Indian Experience. JIMD Rep. 2016;35:47-52.

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