Journal of Cardiovascular Disease Research

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

Original research article

Congenital anomalies in fetal autopsy: An institutional experience

[1]Dr. K. Grace Madhuri, [2]Dr. Vamsi Krishna Undavalli

[1]Assistant Professor, Department of Pathology, Siddhartha Medical College, Vijayawada, Andhra Pradesh, India

[2]Assistant Professor, Department of Community Medicine, Siddhartha Medical College, Vijayawada, Andhra Pradesh, India

Corresponding Author:
Dr. K. Grace Madhuri

Abstract

Background: Congenital anomalies diagnosed on Ultrasound scan, autopsy plays a vital role in confirming the diagnosis and many times gives information regarding additional malformations. Autopsy on dead fetuses/infants helps the parents by giving information regarding the recurrence risk of fetal anomaly. This study confirms the utility of fetal autopsy in identifying the cause of fetal loss which will indicate the need in genetic counseling of the couple.

Aim: The study is done to record the incidence of congenital malformations in Fetal Autopsy. Details are collected from the department of Obstetrics and Gynecology.

Methodology: A total of 98 fetal autopsies were done in the department of Pathology in a tertiary care teaching hospital, South India from the period of June 2015 to May 2020.

Results: In 98 autopsies performed, 90 were fetal deaths and 8 neonatal deaths. Out of 62 autopsies on male fetuses, 22 had congenital malformations and of 36 autopsies on female fetuses, 14 had congenital malformations. Congenital anomalies were commonest in the birth weight group of <1000 gms, accounting for 28 cases. Most of the fetal deaths occurred in mothers with age group of 21-30 accounting to 27 cases out of 72 autopsies. Incidence of congenital anomalies was highest in primigravida. Congenital malformations were seen in 36 cases which accounted for 36.7% of fetal and early neonatal deaths. Malformations of the central nervous system (33.3%) were the most common. Neural tube defects like anencephaly and spina bifida were seen in 8 cases. The second most common anomalies were encountered in Gastrointestinal system (19.4%), followed by genito-urinary system (13.8%) and cardiovascular system (8.3%). Tracheo esophageal fistula was the only case seen involving the respiratory system. Rare cases like Prune belly syndrome, Jarcho Levin syndrome were observed. Two cases of cystic hygroma and one case of Phocomelia with a history of Thalidomide intake by the mother were seen.

Conclusion: Due to financial constraints only karyotyping was performed in the present study. Further studies including molecular biology should be carried out to identify more cases with congenital anomalies so that proper genetic counseling can be given to the parents to avoid subsequent anomalous births.

Keywords: Karyotyping, congenital anomalies, spina bifida, autopsies

Introduction

Autopsy has contributed to the medical care since the advent of modern medicine. Autopsy has the potential to provide the last and most definite summary of a life unfortunately shortened. When the autopsy succeeds, a host of individuals benefit, especially parents, other family members, clinical care providers, and at times society at large. Autopsy can provide valuable explanations and sometimes put these issues to rest. The benefits are maximal when collaboration between pathologist and clinician occurs before and after the autopsy, and when findings are relayed to appropriate individuals in an accurate and timely manner.

The major objectives of the autopsy are to evaluate pregnancy and birth, determine gestational age, document growth and development, detect underlying abnormalities (anomaly, infection, metabolic defect, other), evaluate diagnoses and therapy, and determine cause of death [1, 2]. In addition, autopsy has been a useful tool in clinical education, research, and quality monitoring of patient care.

Autopsy findings in confirming or altering clinical diagnoses made prior to death is particularly valuable in the neonatal period, since not only is the cause of death significant, but also at least of equal importance is the presence of disorders or diseases that may recur [3] in subsequent pregnancies.

Pathologists must ensure that their work falls within the scope of the autopsy permit, and that all

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

medicolegal requirements are met before an autopsy is conducted. Laws specific to fetal autopsy may vary by state or country, with some requiring permits on fetuses exceeding a given gestational age (e.g. 20weeks) or body weight (e.g. 350 or 500 g). The prosector needs to understand pertinent regulations and/or adopt a policy of obtaining permission on every autopsy performed, regardless of gestational age or body weight.

Perinatal losses are common in routine obstetric practice. They may be unexplained intrauterine deaths or related to or caused by fetal abnormalities, spontaneous preterm labor or maternal disease. The value of the perinatal autopsy has been demonstrated in a number of studies [3-6]. Workers have made important contributions to technical aspects of the perinatal autopsy [7] and created practice guidelines for both pathologists and clinicians [8].

Congenital anomalies contribute a significant proportion of infant morbidity and mortality, as well as fetal mortality. They account for 8-15% of perinatal deaths and 13-16% of neonatal deaths in India [23]. Unlike the situations in developed countries, where congenital malformations are leading cause of infant mortality, in India low birth weight, prematurity, sepsis and infections are still the leading causes.

Autopsy also aids in assessing the level of tissue maturity, to correlate or establish it as the cause of death. To achieve this, a detailed study of the age of the fetus and maturity of various organs is taken up so that the organ which stops maturing is taken as an indicator of initiating the fetal death and future studies may be directed towards the causes of arrest of maturation of various organs.

Aims and Objectives

1. To identify and record gross congenital anomalies in the fetus/neonate.
2. To study the various organs and tissues of body histologically and to correlate with the available literature in assessing the gestational age of the tissue.
3. To correlate the gestational age of each tissue with the gestational age of the fetus.
4. The study also includes special serological markers and chromosomal analysis where necessary.

Materials and Methods

The study is done to record the incidence of congenital malformations at a tertiary care teaching hospital, South India from the period of June 2015 to May 2020. Details are collected from the department of Obstetrics and Gynecology.

Out of 88 fetal deaths, 85 were still born and only 3 were early neonatal deaths. In each case, clinical cause of the deaths and clinicopathological correlation was done after a detailed postmortem and histopathological study.

Clinical data

Proforma consists of two parts which include clinical data of mother and fetus.

First Part: Maternal data

The first part is maternal data which consists of age, parity, consanguinity, history of present and past pregnancies (duration, USG report), antenatal history, and obstetric history.

Second Part: Newborn and still born data

Birth weight, crown-rump length, head circumference, chest circumference and abdominal circumference, external anomalies were recorded in all cases. Details of APGAR score**,** physical examination (birth injuries, cyanosis, jaundice, CVS, RS, abdomen, CNS, and other clinical feature) and the clinical cause of death were obtained from the concerned clinicians in neonatal deaths. Histopathological results were recorded.

Results

In 98 fetal autopsies performed, 87 were fetal deaths and 11 were neonatal deaths.

Table 1: Incidence of Fetal Deaths and Neonatal Deaths

	No. of cases	**Percentage (%)**
Intra uterine deaths	50	51%
Terminations	37	37.7%
Neonatal deaths	11	11.2%
Total	98	100

Out of 98 autopsies, 50 were intrauterine deaths, 37 were terminated pregnancies and 11 were neonatal deaths.

Intrauterine deaths accounted for 51% and congenital anomalies were observed in 20% of IUD cases. 56% of terminations were done for antenatally diagnosed congenital anomalies and the remaining for other causes like eclampsia, severe oligohydramnios and unwanted pregnancies.

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

Neonatal deaths accounted for 11.2% of which congenital anomalies were observed in 45% of cases.

Table 2: Congenital Anomalies in Relation to Birth Weight

	Total cases	Anomaly present
<1000	74	28
1001-2000	15	5
2001-3000	7	3
>3000	2	0
Total	98	36

Highest incidence of congenital anomalies was seen in the birth weight group of <1000 gms.

Table 3: Congenital Anomalies in Relation to Sex

Anomaly	Sex		Total
	M	F	
Absent(N)	40	22	62
Present(Y)	22	14	36
Total cases	62	36	98

There were 62 male babies and 36 female babies. Congenital anomalies were most common in male babies than female babies with a M:F ratio of 1.5:1. Most of the fetal deaths were seen in mothers with age group of 21-30 years. (27 cases out of 72 autopsies)

Table IV: Congenital Anomalies Encountered in Autopsies as Per Maternal Age

Maternal Age	Anomaly		
	Absent (N)	Present (Y)	Total
<20	16	7	23
21-30	45	27	72
>30	1	2	3
Total	62	36	98

Table V: Congenital Anomalies Encountered in Autopsies as Per Gravida

Gravida	Absent(N)	Present(Y)	Total
PRIMI	49	29	78
Second	7	5	12
Third	4	1	5
Fourth	1	0	1
Fifth	1	1	2
Total	62	36	98

Incidence of congenital anomalies was highest in primigravida. In a total of 78 cases of primigravida, 29 had congenital anomalies.

Table VI: System Wise Distribution of Congenital Anomalies

S. No.	Type of Anomaly	No.	Percentage (%)
1.	Alimentary	7	19.4
2.	Genitourinary	5	13.8
3.	Central nervous system	12	33.3
4.	Respiratory system	1	2.7
5.	Cardiovascular system	3	8.3
6.	Miscellaneous	8	22.2
Total		36	100

Congenital anomalies were seen in 36 cases which accounted for 36.7% of fetal autopsies. Most common anomalies were that of the Central nervous system (12, 33.3%) followed by Alimentary system (7, 19.4%), Genitourinary (5, 13.8%), cardiovascular (3, 8.3%) and respiratory system (1, 2.7%).
In the miscellaneous group (8, 22.2%) there were 6 cases of Single umbilical artery, and one each of Jarcho Levin syndrome, cystic hygroma, phocomelia.
Out of 36 cases of congenital anomalies 5 cases showed more than one anomaly. Congenital Talipes Equina Varus is associated with 2 cases (one Exomphalos and one Bilateral Renal agenesis). Anencephaly was associated with Omphalocele in one autopsy and in one case associated with Single umbilical artery.

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

Table VII: Anomalies of Central nervous system

Type	No.
Anencephaly	6
Meningoencephalocele	1
Hydrocephaly	1
Spina bifida	2
Myelomeningocele	1
Agyria	1
Holoprosencephaly	1

Congenital anomalies of central nervous system accounted for 12 cases (33.3%). There were 6 cases of Anencephalic fetuses seen in the maternal age group of 20-29 yrs. Of them 4 cases were from primi gravidae. There were 2 cases of spina bifida of which one was seen associated with anencephaly in a 30 weeks fetus. Antenatal alpha feto protein (AFP) levels were raised in all cases of anencephaly and spina bifida. Occipital Encephalocele was observed in a 30 weeks female fetus died in utero with normal karyotype.

Fig 1: Fetus with Hypoplasia & Synostosis of Frontal Bone, Arrhinia, cleft Palate, central hare lip

Fig 2: Fetus with Agyria

Holoprosencephaly (Fig 1) was noticed in a full-term female child who died shortly after birth associated with Trisomy 18. This fetus had multiple cranio facial anomalies.
A 32 weeks male fetus was terminated for Lissencephaly which was diagnosed antenatally by Ultrasound (Fig 2). The child survived for 2 days and died of seizures. Karyotyping was done which revealed no abnormality. One each of Hydrocephaly and Myelomeningocele were observed in intrauterine deaths at 16 weeks and 17 weeks respectively.

Table VIII: Anomalies of Gastrointestinal tract

Type	No
Cleft palate	2
Cleft lip	2
Omphalocele	2
Gastroschisis	2

One case of above had both cleft lip and cleft palate. Thus anomalies of gastrointestinal tract accounted for 7 (19.4%) cases. Two each of Cleft lip, Cleft palate, Omphalocele and Gastroschisis were noted. Omphalocele was seen in a 32 weeks terminated male fetus with associated anencephaly and spina bifida

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

(Figure 3). Gastroschisis was seen in two fetuses which were terminated at 20 and 23 weeks of gestation. One of the fetuses had associated cleft lip and cleft palate.

Fig 3: Anencephaly associated with omphalocele, spina bifida, short umbilical cord

Table IX: Anomalies of Genito urinary system

	No
B/L Renal agenesis	1
B/L Cystic renal dysplasia with prune belly syndrome	1
Renal aplasia	1
Absent kidneys and bladder	1
Hypospadiasis	1
Total	5

Anomalies of the genitourinary system accounted for 13.8% of the cases. Bilateral Renal agenesis was observed in a 18 weeks male fetus with associated CTEV.

Bilateral Cystic renal dysplasia with prune belly syndrome was seen in a 24 weeks male fetus who presented with distended abdomen. There was deficient development of abdominal muscles and defective insertion of umbilical cord in the anterior abdomen. On opening the abdomen, bladder measured 8 cms in diameter and was filled with straw coloured urine. Left kidney was hypoplastic and right kidney was polycystic (Figures 10,11). Trisomy 18 was the abnormal karyotype seen in this case.

A 24 weeks male fetus was terminated due to severe oligohydramnios. Mother had a history of third degree consanguinity. Autopsy revealed absent kidneys and bladder in the fetus associated with CTEV. Renal aplasia was observed in an 18 weeks male fetus. Hypospadiasis was seen in a premature newborn male child who died 2 days after birth due to asphyxia. Karyotyping was done which was normal.

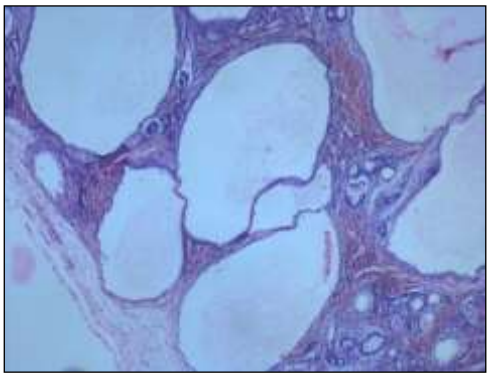

Fig 4: Right polycystic kidney. (H&E 40x10X)

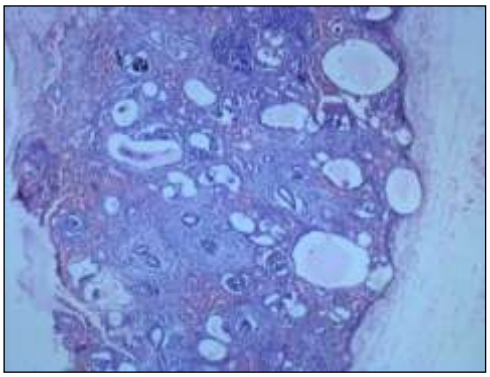

Fig 5: Left hypoplastic kidneys with features of renal dysplasia. (H&E 40x10X)

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

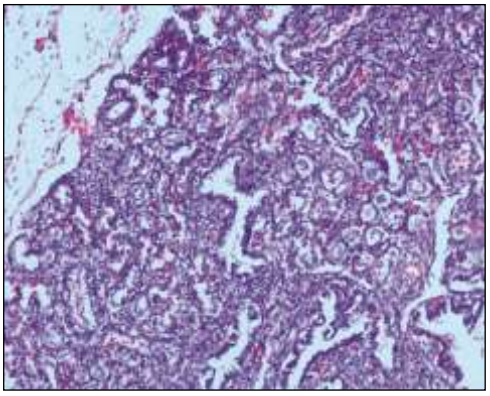

Fig 6: Pulmonary hypoplasia. H&E 40x10x

Table XI: Anomalies of cardiovascular system

	No
Hypoplastic left heart syndrome	1
Cardiomegaly	2
Total	3

Anomalies of cardiovascular system comprises 8.3% of the cases. Two cases of cardiomegaly, the birth weight of the autopsy babies being 206 and 550 gms, the hearts of these cases weighed 3.2gms and 6 gms respectively which was more than expected for the gestational age.
Hypoplastic left heart syndrome was seen in a full term newborn male child who died within 5 minutes of birth due to hypoxia.
There was only one anomalous case of respiratory system i.e., Tracheoesophageal fistula seen in a full term newborn male child who died after 3 minutes.

Table XII: Miscellaneous anomalies

	No
Single umblical artery	6
Cystic hygroma	1
Phocomelia	1
Jarcholevin syndrome	1
CTEV	2

Among the Miscellaneous anomalies there were 6 cases of single umbilical artery, one of these was associated with Anencephaly.
A 24 weeks male fetus presented with cystic hygroma, bilateral pleural effusion, bilateral pulmonary hypoplasia and ascites [Figure 6]. Umblical cord showed a single umbilical artery.
Phocomelia was diagnosed by ultrasound in a 24 weeks male fetus and was terminated. There was a history of Thalidomide intake by mother for seizures since 2 years prior to the termination. Fetus presented with short upper and lower limbs.
A 24 weeks fetus was terminated due to multiple skeletal anomalies. Autopsy revealed craniosynostosis, multiple level segmental defects of entire vertebrae and sacral agenesis - Jarcho Levin Syndrome. Karyotyping revealed trisomy 18.
CTEV was seen associated with bilateral renal agenesis in one case and with renal aplasia in another case.
Tissue maturity versus gestational age was also studied. Out of 98 fetal autopsies, 17 cases showed immaturity in weight as well as in histology in 26 organs.
Immaturity of lung is seen in 7 cases, immature kidneys and brain in 5 cases each, immature testis in 4 cases, immature adrenals in 3 cases, immature spleen in two cases. 2 cases of immature adrenals were seen in anencephalic fetuses in the present study.

Discussion

Congenital anomalies are important causes of stillbirths and infant mortality. The detection of birth defects is increasing due to antenatal ultrasonography. In the present study of 98 autopsies, 36 (36.7%) cases of congenital anomalies were encountered. The incidence matches with the study by Harsh Mohan [10] where it was 38.7% and Kasturilal and Jamilal [11] (32%) and Sunethri *et al.* [12] (27%). Most anomalies were seen in male fetuses with M:F ratio of 1.5:1. Similar ratios were reported in other studies done in India. Sunethri *et al.* [13] reported a ratio of 1.7:1 and a ratio of 1.6:1 is observed by Taksande *et al.* [14].

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

Congenital anomalies were significantly higher in fetuses with birth weight <1000 gms in the present study. This finding correlated with a study by Uma *et al.* [64] who also reported a higher incidence in this birth weight group. This study has shown that mothers, above 30 yrs of age stand at a higher risk of producing malformed babies. Sugunabai [16] reported a higher incidence of anomalies in mothers over 35 yrs of age whereas Datta *et al.* [17] documented insignificant association of increased maternal age and congenital anomalies. Mohanty *et al.* [67] in their study on 10,874 cases reported significantly higher incidence of anomalies among mothers of gravida 4 and above which was consistent with the present study where higher incidence is seen in gravida 4 and above.

The most common defects were of Central Nervous System, seen in 12 cases (33.3%) which correlates with the study of Swain *et al.* [18] where 39.5% of cases were contributed by CNS malformations. Whereas Sugunabai *et al.* [16] reported gastrointestinal anomalies to rank the highest. Mathur *et al.* [19] reported that the musculoskeletal abnormalities were the commonest. The most common anomaly was Anencephaly with 6 cases (50%), which was accurately diagnosed with ultrasonography. Antenatal AFP levels were raised in all the 6 cases. In 2 out of 6 (33.3%) cases of anencephaly associated anomalies were seen. Spina bifida was the most common associated anomaly seen in 2 cases which correlates with the study of Panduranga *et al.* [20] where spina bifida was the most common associated anomaly seen in 11(26.8%) out of 41 cases. Other associated anomalies observed in the present study were Omphalocele, single umbilical artery which were also observed in studies by which were also observed in various studies done by Tan *et al.* [21].

Panduranga *et al.* [69] in their study on 41 cases of Anencephaly reported a female preponderance, however in the present study we could not observe any sex predilection as male to female ratio was 1:1.There was a higher incidence of anencephalic pregnancy among primigravidae(66.6%) similar to the study of Tan *et al.* [22] in Singapore.

Wenghoefer *et al.* [23] in his study on 51 cases of holoprosencephaly reported higher incidence of anomaly in female fetuses. Cleft lip, cleft palate, cyclopia, maxillofacial malformations were the most common associated anomalies. In 63%, the diagnosis of holoprosencephaly led to a termination of pregnancy. Ten percent of the fetuses were born alive. One case of alobar type of holoprosencephaly was seen in a full-term female child in the present study who died shortly after birth. There were numerous associated craniofacial anomalies like Hypoplasia & Synostosis of Frontal Bone (Single hypoplastic Frontal Bone with absence of metotic sutures), Anophthalmia (Eye balls replaced by rudimentary soft tissue mass), Hypoplasia of Maxillae, Arrhinia, Cleft Palate, Central Hare Lip, Hypotelorism (Figure 1). Karyotyping revealed trisomy 18. In a case report by coleta *et al.* [24] a low birth weight male newborn presented with holoprosencephaly, microcephaly, midline cleft.

Occipital Encephalocele was observed in a 30 weeks female fetus died in utero and there were no associated anomalies observed. Karyotying was normal Caviness *et al.* [25] reported a case of newborn female fetus with occipital encephalocele who died on the fourth postnatal day.

Lissencephaly is associated with Miller-Deikersyndrome and chromosomal deletions in a study by Fong *et al.* [26]. However in the present study Lissencephaly of type 1 was seen in a 32 wks male fetus. It was diagnosed antenatally by Ultrasound and there were no associated anomalies. Karyotyping was done which revealed no abnormality. Greco *et al.* [27] observed a female fetus with lissencephaly who was delivered in 39th week of gestation. The child survived for 2 days and died of seizures.

The next common anomalies were of Gastrointestinal system accounting for 7(19.4%) cases which included Omphalocele, Gastroschisis, Cleft lip, Cleft palate, umbilical hernia. The finding is also supported by Sunethri *et al.* [12]where Gastrointestinal tract malformations constituted the second most common group of anomalies. Omphalocele was seen in a 32 weeks terminated male fetus with associated anencephaly and spina bifida. Congenital Talipes Equino Varus was the most common associated musculoskeletal anomaly observed in the present study.

Among anomalies of Genitourinary system (13.8%), bilateral renal agenesis along with absent urinary bladder was seen in a case where there was a positive history of third degree consanguinity. The pregnancy was terminated in view of severe oligohydramnios. Dubbins *et al.* [80] reported 3 cases of renal agenesis, all three with severe oligohydramnios with absent urinary bladder similar to that observed in the present study.

In the present study, a male fetus presented with distended abdomen. There was deficient development of abdominal muscles and defective insertion of umbilical cord in the anterior abdomen. On opening the abdomen, bladder measured 8 cms in diameter and was filled with straw coloured urine. Left kidney is hypoplastic and right kidney is polycystic. Trisomy 18 was the abnormal karyotype seen in this case.

Anomalies of cardiovascular system accounted for 8.3% of cases, most common anomaly observed was cardiomegaly seen in two cases. Taksande *et al.* [14] reported 19.2% of cases and ventricular septal defect was the most common anomaly. Chaturvedi *et al.* reported 6.4%, Datta *et al.* [17] reported 4.1%. There were no other associated cardiac or extracardiac anomalies.

Tracheoesophageal fistula was observed in one of the twins of a full-term male child died shortly after birth. There were no esophageal atresia or other associated anomalies as observed by Van dooren and Torfs [28] who reported esophageal atresia, congenital diaphragmatic hernia and lung hypoplasia as

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

common associated anomalies.
This correlates with the male fetus with phocomelia observed in the present study. This fetus was terminated at 24 weeks of gestation. There was a positive history of thalidomide intake by the mother for treatment of seizures since 2 years prior to the termination.

Table XIII: Comparision of distribution of congenital anomalies with previous studies

System involved	Sunethri *et al.* [12]	Datta *et al.* [17]	Present study
Central nervous system	12	5	12
Gastrointestinal	8	8	7
Genitourinary	7	3	4
Cardiovascular	1	2	3
Respiratory tract	0	0	1
Syndromes	0	3	2
Miscellaneous	0	27	7
Total	28	48	36

Kulkarni *et al*. [29] reported 2 neonates of Jarcho Levin syndrome. One neonate had associated anomalies like hydrocephalus, hydroureteronephrosis and meningomyelocoele while the other had no additional anomalies. One case of Jarcho Levin syndrome in the present study was diagnosed antenatally at 24 weeks of gestation with Craniosynostosis, multiple level segmental defects of entire vertebrae and sacral agenesis. There were no other associated anomalies observed. Karyotyping revealed trisomy 18.
Among the miscellaneous anomalies single umbilical artery was seen in 6 cases, one of these was associated with Anencephaly.
Out of 98 autopsies 17 cases showed immaturity in weight as well as in histology in 26 organs. Immaturity of lung is seen in 7 cases, immature kidneys and brain in 5 cases each, immature testis in 4 cases, immature adrenals in 3 cases, immature spleen in two cases.

Conclusion

In the present study finally we concluded that, there is a need to create certain awareness programmes to encourage fetal autopsies and genetic studies by Gynaecologists, Radiologists and Pathologists as a team work. Due to financial constraints only karyotyping was performed in the present study. Further studies including molecular biology should be carried out to identify more cases with congenital anomalies so that proper genetic counseling can be given to the parents to avoid subsequent anomalous births. Support of institutes to carry out more sophisticated studies are indicated for better diagnosis and prevention of anomalous births.

Conflict of interest: None.

Funding support: Nil.

References

1. Macpherson TA, Valdes-Dapena M. The perinatal autopsy. In: Wiggleswrth JS, Singer D, eds. Perinatal pathology. Philadelphia: WB Saunders, 1988, 93-122.
2. Ochs R, Carr RF, Griffin TD, *et al*. Perinatal autopsies: a challenge for the nonpediatric pathologist. Path Ann. 1988;23:235-255.
3. McHaffie HE, Laing IA, Lloyd DJ. Follow up care of bereaved parents after treatment withdrawal of newborns. Arch Dis Child Fetal Neonatal Ed. 2001;84(2):125-8.
4. Bove KE. Practice guidelines for autopsy pathology: the perinatal and pediatric autopsy. Autopsy Committee of the College of American Pathologists. Arch Pathol Lab Med. 1997;121:368-376.
5. Boyd PA, Tondi F, Hicks NR, *et al*. Autopsy after termination of pregnancy for fetal anomaly: retrospective cohort study. Brit Med J. 2004;328:131-144.
6. Brodlie M, Laing IA, Keeling JW, *et al*. Ten years of neonatal autopsies in tertiary referral centre: retrospective study. Br Med J. 2002;324:761-763.
7. Faye-Peterson OM, Guinn DA, Wenstrom KD. Value of Perinatal Autopsy. Obstet Gynecol. 1999;94:915-920.
8. Valdes-Dapena M, Huff D. Perinatal autopsy manual. Washington; Armed Forces Institute of Pathology, 1983.
9. Bhat BV, Ravikumar M. Perinatal mortality in India-Need for introspection. Indian J Matern Child Health. 1996;7:31-3.
10. Mohan H, Bhardwaj S, Bal A. Congenital visceral malformations- Role of perinatal autopsy in diagnosis. Fetal Diagnosis and Therapy. 2004;19:131-133.
11. Kasturilal, Jamilal JH. Factors associated with perinatal mortality. Indian Pediatr. 1974;11:743-747.
12. Sunethri Padma, Ramakrishna D, Jijiya Bai P. Pattern of distribution of congenital anomalies in

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 07, 2023

stillborn: A hospital based prospective study. International a journal of Pharma and Biosciences. 2011 Apr-Jun;2(2):604-610.
13. Kumar P, Denise B, Taxy J. Neonatal Autopsies-A 10 year experiences. Arch Pediatr Med. 2000;154:38-42.
14. Amar Taksande, Krishna Vilhekar, *et al*. Congenital malformations at birth in Central India: A rural medical college hospital-based data. Indian journal of Human Genetics. 2010 Sep-Dec;16(3):159-163.
15. Uma S Andola, Anita AM, Mukta Ahuja, Sainath K Andola. Malformations in Perinatal Autopsies-A Study of 100 Cases. Journal of Clinical and Diagnostic Research. 2012 Dec;6(10):1726-1730.
16. Sugunabai NS, Mascarane M, Syamala K, Nair PM. An etiological study of congenital malformations in new born. Indian Pediatr. 1982;19:1003-7.
17. Datta V, Chaturvedi P. Congenital malformations in rural Maharashtra. Indian Pediatr. 2000;37:998-1001.
18. Swain AA, Bhatia BD. Congenital malformations at birth. Indian Pediatr. 1994;31:1187-90.
19. Mathur BC, Karan S, Vijaya Devi KK. Congenital malformations in the newborn. Indian Pediatr. 1975;12:179-83.
20. Panduranga C, Kangle R, Suranagi W, Pilli GS, Patil PV. Anencephaly: A pathological study of 41 cases. J Sci Soc. 2012;39:81-4.
21. Tan KB, Tan SH, Tan KH, Yeo GS. Anencephaly in Singapore: a ten year series. Singapore Med J. 1993-2002;48:12-5.
22. Tan KC, Ratnam SS, Kottegoda SR, Karim SM. Anencephaly: a retrospective analysis in Singapore, 1976-1980. J Med Genet. 1984;21:350-354.
23. Wenghoefer M, Etterna AM, Sina F, Geipel A. Prenatal ultrasound diagnosis in 51 cases of holoprosencephaly: craniofascial anatomy, associated malformations and genetics. The cleft palate-craniofascial Journal. 2010 Jan;47(1):15-21.
24. Coleta E, Siminel M, Gheonea M. Holoprosencephaly sequence. Rom J Morphol Embryol. 2011;52(2):725-8.
25. Caviness VS, Ervard P. Occipital encephalocele. A pathologic and anatomic analysis. Acta Neuropathologic. 1975;32:245-255.
26. Fong KW, Ghai S, Toi A, Blaser S. Prenatal ultrasound findings of lissencephaly associated with Miller-Deiker syndrome and comparison with pre and postnatal magnetic resonance imaging. Ultrasound Obstet Gynecol. 2004;24:716-723.
27. Dr. P. Greco, Resta M, Vimercati A. Antenatal diagnosis of isolated lissencephaly by ultrasound and magnetic resonance imaging. Ultrasound Obstet. Gynecol. 1998;12:276-279.
28. Van Dooren M, Tibboel D, Torfs C. The occurrence of congenital diaphragmatic hernia, esophageal atresia and lung hypoplasia. Birth Defects Res A Clin Mol Teratol. 2005 Jan;73(1):53-7.
29. Kulkarni ML, Sarfaraz Navaz R, Vani HN, Manjunath KS. Jarcho Levin Syndrome. Indian J Pediatr 2006;73(3):245-247.