FOETAL ULTRASOUND - NEUROECTODERMAL ANOMALIES IN RURAL PREGNANT WOMEN

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ABSTRACT

BACKGROUND

A prospective clinical study to know the various types of congenital Neuroectodermal Anomalies on obstetric Ultrasound, in rural pregnant women. To reduce the maternal morbidity and mortality by early detection of these Congenital Neuroectodermal Anomalies. To calculate the incidence and prevalence of different types of Congenital Neuroectodermal Anomalies, in these rural pregnant women. To assist the obstetrician in taking decisions regarding the termination or continuation of the pregnancy in relation to the type of malformation and its prognosis.

METHODS

A prospective clinical study of Congenital Neuroectodermal Anomalies in 22,000 rural pregnant women coming to the Santhiram Medical College, Radiology Department for a routine obstetric scan. 44 cases of neuroectodermal anomalies were detected out of the 22000 cases, within an incidence of 2 per 1000 cases. Approximately 1 in every 500 cases showed an anomaly.

RESULTS

The most common lesions detected were hydrocephalus, and spina bifida followed by anencephaly. Association of these lesions with consanguinity, previous history of similar anomaly and intake of iron and folic acid tablets was noted.

CONCLUSION

Ultrasound is an excellent modality for the diagnosis and characterisation of the neuroectodermal anomalies. Its multiplanar imaging property along with real time image visualisation make it an excellent tool for the diagnosis and characterisation of these anomalies.

KEYWORDS

Congenital Neuroectodermal Anomalies, Spina Bifida, Hydrocephalus, Anencephaly, Agenesis of Corpus Callosum, Morbidity and Mortality.

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INTRODUCTION: The three primary germ cell layers of the embryo are Ectoderm, Mesoderm and Endoderm. The Ectoderm is again divided into Surface ectoderm and Neural Ectoderm. This Neural ectoderm is again of 2 varieties, one is the Neural crest and another is the Neural tube.[1-4] The derivatives of the Neural tube are brain (rhombencephalon, mesencephalon and prosencephalon), spinal cord and motor neurons, retina and posterior pituitary. Congenital Neuroectodermal Anomalies are one of the most common anomalies occurring in the foetus. These anomalies are most often derived from the neural tube, rather than neural crest[5]. These anomalies have been classified as follows by (ICD-10) International Statistical Classification[6] of Diseases and Related Health Problems:

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(Q00-Q07) Classification of Congenital Neuroectodermal Anomalies:

- (Q00) Anencephaly and similar malformations.
- (Q00.0) Anencephaly.
- Acrania.
- (Q00.2) Iniencephaly.
- (Q01) Encephalocoele.
- (Q02) Microcephaly.
- (Q03) Congenital hydrocephalus.
- (Q03.0) Malformations of aqueduct of Sylvius.
- (Q03.1) Atresia of foramina of Magendie and Luschka.
- Dandy-Walker syndrome.
- (Q04) Other congenital malformations of brain.
- (Q04.0) Congenital malformations of corpus callosum.
- (Q04.2) Holoprosencephaly.
- (Q04.3) Other reduction deformities of brain.
- Agyria and Lissencephaly.
- Microgyria and Pachygyria.
- Hydranencephaly.
- (Q04.4) Septo-optic dysplasia.

- (Q04.5) Megalencephaly.
- (Q04.8) Other specified congenital malformations of brain.
- (Q04.9) Congenital malformation of brain, unspecified.
- (Q05) Spina bifida.
- Hydromeningocoele (spinal).
- Meningocoele (spinal).
- Meningomyelocoele.
- Myelocoele.

Of these anomalies, the most common anomalies are spina bifida, anencephaly, and hydrocephalus.

AIMS AND OBJECTIVES:

Primary: To study various types of congenital Neuroectodermal Anomalies on obstetric Ultrasound in rural pregnant women.

To calculate the incidence and prevalence of different types of Congenital Neuroectodermal Anomalies in these rural pregnant women.

Secondary: To reduce the maternal morbidity and mortality by early detection of these Congenital Neuroectodermal Anomalies in Rural pregnant women.

MATERIALS AND METHODS: This cross-sectional study of Congenital Neuroectodermal Anomalies on Antenatal Ultrasound comprised a total of 22000 pregnant women who came for routine antenatal scans to the inpatient and outpatient departments of Santhiram General Hospital, Nandyal.

The study was conducted from October 2011 to December 2015. Pregnant women underwent routine antenatal ultrasound in the department of Radio-diagnosis.

Inclusion Criteria: All pregnant women with intrauterine pregnancy of gestational age ranging from 11 weeks to Post-term cases.

Exclusion Criteria:

1. Pregnant women with gestational age less than 11 weeks.
2. Extrauterine pregnancies.
3. Woman from urban background.

RESULTS: The present study was done for a period of 51 months starting from October 1st 2011 till December 2015. Approximately, 22000 antenatal scans were performed during the above-mentioned period of study.

A total of 44 cases out of the 22000 antenatal scans showed CNS anomalies.

Approximately, 0.20% of the total cases showed CNS anomalies.

Percentage of Total Anomalies: 1 in approximately every 500 cases showed an anomaly.

The anomalies that were diagnosed were Agenesis of Corpus Callosum, Anencephaly, Encephalocoele, Spina bifida associated with meningocoeles and myelomeningocoeles, Hydrocephalus both solitary and associated with spina bifida, Iniencephaly, Microcephaly and Spina bifida.

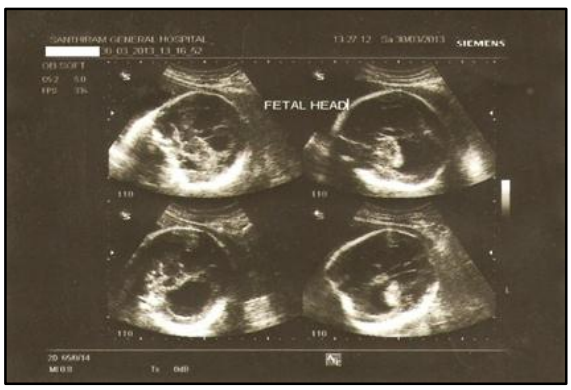

Figure 1: Hydrocephalus in a 26wk old fetus

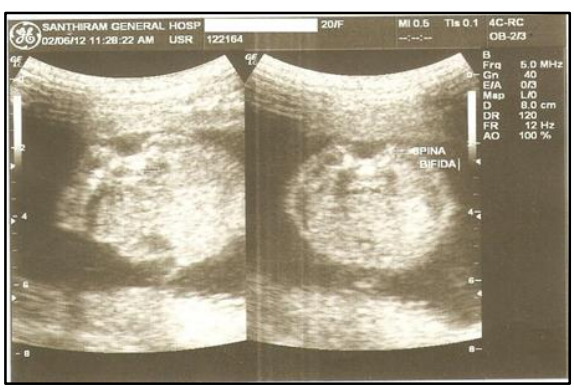

Figure 2: Spina bifida in a 21 wk old fetus

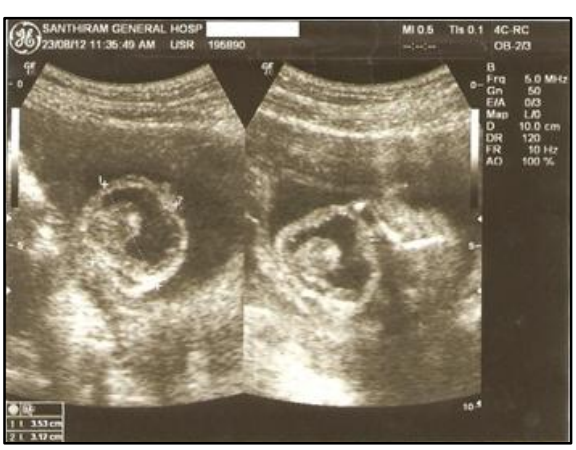

Figure 3: Meningomyelocele in a 24 wks old fetus

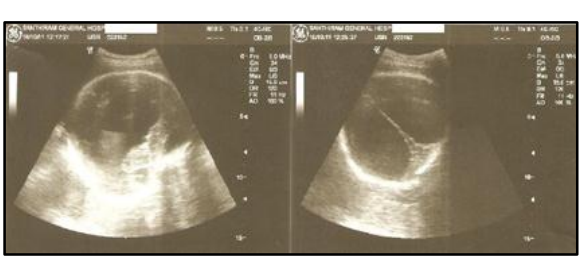

Figure 4: Hydranencephaly in a 28 wks old fetus

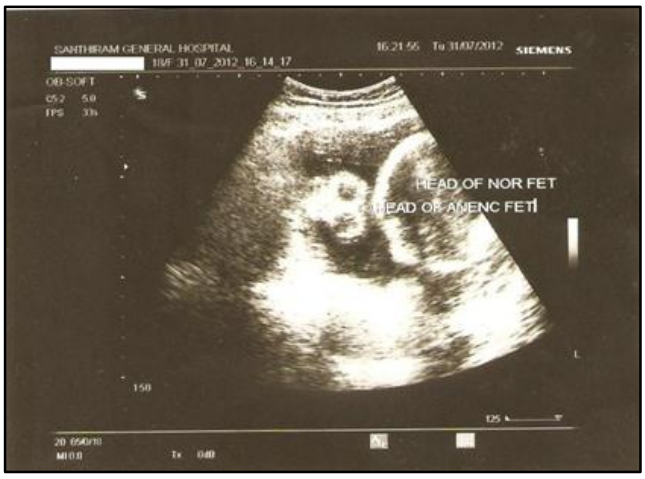

Figure 5: A case of twins, with one fetus having a normal head and another showing anencephaly

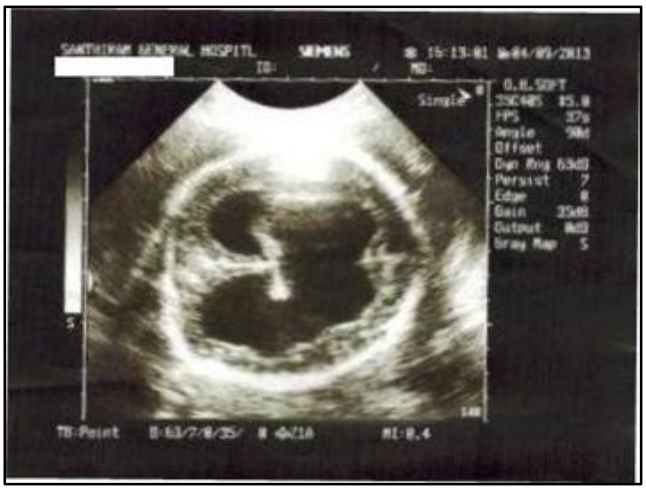

Figure 8: Fetus showing severe Hydrocephalus

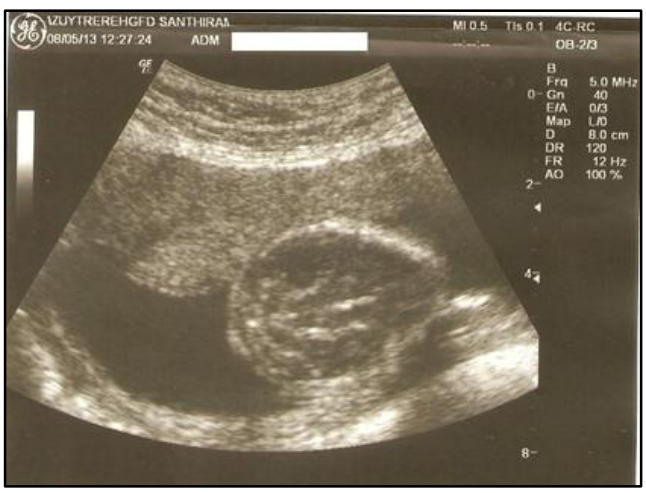

Figure 6: A 30 wk fetus with spina bifida showing the banana sign

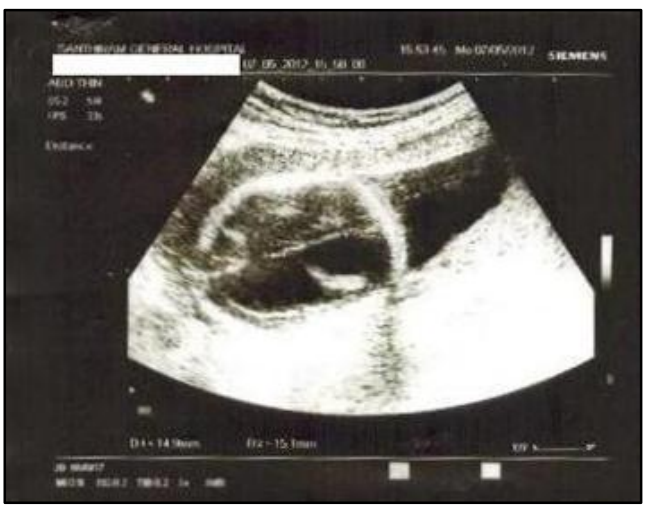

Figure 9: Another Fetus showing Hydrocephalus with Dangling Choroid Sign

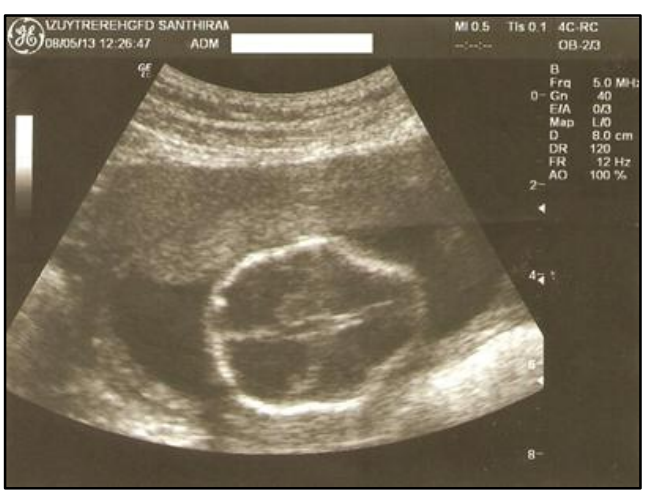

Figure 7: Lemon sign in the same fetus shown above

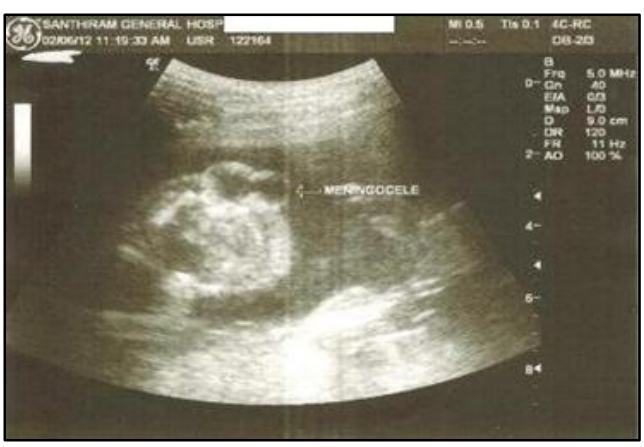

Figure 10: Fetus showing Meningocele

The 44 diagnosed anomalies were distributed as follows:

Anencephaly	14 cases
Hydrocephalus+spinabifida+meningocoele/ myelomeningocoele	14 cases
Solitary hydrocephalus	5 cases
Spina bifida + meningocoele/ myelomeningocoele	3 cases
Spina bifida without {any complication] any meningocoele/myelomeningocoele	2 cases
ACC (agenesis of corpus callosum)	2 cases
Encephalocoele	1 cases
Hydranencephaly	1 case
Iniencephaly	1 case
Microcephaly	1 case
Name of the Anomaly No. of Cases	

Out of the 44 cases, 14 anencephaly foetuses seen, only 1 case that is of an anencephaly was diagnosed in the first trimester at 11 weeks 3 days of gestational age.

Among these 19 cases, there were 5 cases (27%) of solitary hydrocephalus which had no other associated abnormality involving either the CNS or any other system. The liquor was also normal in these 4 cases, with no case showing polyhydramnios or oligohydramnios.

Out of the 19 cases of hydrocephalus, the remaining 14 cases (77%) showed various associated features. Of these 14 cases, 12 cases showed spina bifida in the lower lumbar region associated with a meningocoele or myelomeningocoele, and 2 cases showed a thoracic meningocoele and two cases showed spina bifida in the thoracolumbar region without any associated meningocoele or meningomyelocoele.

The case with the thoracic meningocoele showed associated polyhydramnios, abnormally thin placenta and single umbilical artery.

Hydrocephalus associated with spina bifida in 4 cases showed the characteristic lemon shaped skull and banana sign of cerebellum.

The spina bifida was noted at various levels. 2 cases showed spina bifida at the thoracolumbar region, 1 case showed spina bifida at the mid thoracic region and the rest of the 13 cases showed defect in the lower lumbar region.

Of the 19 cases of spina bifida, 4 cases did not show any associated meningocoeles or myelomeningocoeles, 4 cases showed myelomeningocoeles and 8 cases showed meningocoeles.

Out of the 19 cases of spina bifida, 6 cases were associated with polyhydramnios, 4 cases showed typical lemon shaped skull, 5 cases showed banana sign of cerebellum, 14 cases showed hydrocephalus, 1 case showed single umbilical artery and 17 cases showed associated meningocoeles/myelomeningocoeles.

Out of 44 cases, 14 cases (32%) showed anencephaly. Of these cases, three cases were associated with polyhydramnios. One case with polyhydramnios was an interesting case of Twins with one normal foetus and another foetus showing no foetal head. [Anencephaly]

Out of 44 cases, 2 foetuses with Agenesis of Corpus Callosum, Encephalocoele, Hydranencephaly, Iniencephaly and Microcephaly were seen one in each case.

Of the 44 cases with anomalies, 14 cases had history of consanguinity (30% of cases).

Of the 44 cases, 22 cases (50%) had history of intake of Iron and Folic acid tablets. In the rest of the 22 cases, 11 cases (25%) had no history of intake of Iron and Folic acid tablets. Others were not willing to communicate regarding the drugs intake.

Out of 44 cases, the age group of the mother was less than 20 years in 2 cases (Both showing spina bifida with hydrocephalus) and more than 30 years in 1 case which showed severe hydrocephalus. The rest of 41 cases belonged to age group between 20-30 years.

Age group	Number of Anomalies	Percentage
Less than 20 years	2	5%
Between 20-30 years	41	93%
More than 30 years	1	2%

Of the 44 cases, 23 cases (52%) were primi cases and the remaining 21 cases (48%) were multigravida cases.

Thus, more number of cases were noted in primi cases rather than multigravida women.

Of all the 44 cases, 10 cases showed polyhydramnios. Oligohydramnios was observed in 2 of the 44 cases.

DISCUSSION: Ultrasound is an excellent modality to diagnose and characterise foetal anomalies more so neuroectodermal anomalies. The use of Doppler to detect flow enhances its application even more. Use of 3D and 4D imaging helps further. It is cost effective. Ultrasound, the imaging modality of choice for antenatal ultrasound.[7-9]

In this study of 22000 cases of antenatal ultrasound at gestational ages ranging from 11 weeks to post-term pregnancies, 44 foetuses with neuroectodermal anomalies were detected.

The incidence was calculated to be 2 per 1000 cases or 1 for every 500 cases.

42 (95%) of the detected women were in between the ages of 18 and 30 years, with only one noted in woman aged more than 30 years. Congenital neuroectodermal anomalies are more common in women whose age is more than 30-35 years that is not reflected in this present study because most of the pregnant women who took part in the study were between 20-30 years. This is due to the fact that most of these rural women get married very early.

Out of the 44 anomalies identified, the most common anomalies detected were hydrocephalus and spina bifida, seen in 19 cases (35%) each (1 per 1200 cases).

Out of these 19 cases of hydrocephalus, 5 cases were cases of solitary hydrocephalus with no other associated CNS

anomaly or anomaly of other systems. Of these, 4 cases showed severe hydrocephalus with communication between both lateral ventricles and dangling choroid sign. The other 16 cases showed lateral ventricular diameter 15 and 16 mm.[10]

The degree of hydrocephalus in these cases was less when compared to the solitary hydrocephalus cases, with the diameters ranging between 15 and 16 mm.

The second most common anomaly detected was anencephaly, 14 out of 44 cases (30%). Out of these 14 cases, 1 case was detected as early as 11 weeks 3 days, which had the uncovered brain tissue projecting into the amniotic fluid.[11,12] Of all the 44 cases, this was the only case which was diagnosed in the first trimester. This reiterates the fact that anencephaly is one of the few anomalies that can be detected in the first trimester. Early diagnosis of this disorder helps in preventing many complications associated with termination of pregnancy in the second and third trimester like blood loss, infection and mental trauma to the mother.

An interesting case of twins with one foetus showing anencephaly and another foetus showing normal head was seen. This case had associated polyhydramnios. An intertwin membrane was noted, ruling out monoamniotic pregnancy.
Spina bifida was seen in 19 out of 44 cases were noted (42%). 4 cases did not show any associated meningocoeles or myelomeningocoeles, 4 cases showed myelomeningocoeles and 8 cases showed meningocoeles.

The spina bifida was noted at various levels. 2 cases showed spina bifida at the thoracolumbar region, 1 case showed spina bifida at the mid thoracic region and the rest of the 13 cases showed defect in the lower lumbar region.[13,14] This finding supports the fact that most common location for meningocoeles or meningomyelocoeles is the lower lumbar region. 4 of these cases showed the typical banana shaped cerebellum and 5 cases showed the typical lemon shaped skull.

One case of Encephalocoele was noted in the 44 cases (2.2%). Encephalocoele by definition indicates herniation of brain tissue through the skull. In this case, the encephalocoele was located in the occipital bone and contained the herniated cerebellum[15-17]. This is in tune with the fact that most common location of encephalocoeles is the occipital bone.

One case of Hydranencephaly was noted in the 44 cases (2.2%). This case had the typical finding of a fused thalamus with no rind of cerebral tissue lining the inner table of skull, supporting the diagnosis of hydranencephaly.[18] Along with absence of cerebral tissue lining the inside of skull, falx was clearly evident on the scan ruling out holoprosencephaly which usually is not associated with the presence of falx cerebri.

Single case of iniencephaly was noted among the 44 cases (2.2%). The occipital bone was attached to the upper part of the spine. During the whole period of scan, the neck could not be visualised and the movements of the head were also severely restricted.[19] The trunk was smaller than usual and there was associated pulmonary hypoplasia. Unfortunately, this could not be confirmed post-delivery because the patient wanted a second opinion from another radiologist and so was not willing to get the termination of pregnancy done at our institution.

A case of Microcephaly was diagnosed among the 44 cases (2.2%). The case presented to us at 36 weeks for delivery and the obstetrician at our centre asked for a scan to be done to rule out oligohydramnios, cord around neck and confirm the gestational age.[20] During the scan, the Femur Length (FL) was measured to be 7.03 cm corresponding to a gestational age of 36w 1d, but the Head Circumference (HC) and Biparietal Diameter (BPD) corresponded to 26wk 0d and 26wk 3d respectively. We were lucky enough to confirm these findings after termination of pregnancy that happened in our Centre. The newborn had a very small head when compared to the body. The face was normal. The baby had severe lower limb abnormalities with both hip joints showing hyperflexion and both knee joints showing genu recurvatum. The baby was alive without any signs of distress during birth and immediately after delivery. Just before delivery TORCH antibodies investigation was performed and the maternal blood was positive for Toxoplasmosis, and Cytomegalovirus (CMV) IgG antibodies.

2 cases of Agenesis of Corpus callosum (ACC) was diagnosed out of the 44 cases (4.5%). One case was diagnosed at 35 weeks of gestational age. The suspicion of agenesis of corpus callosum (ACC) arose first after looking at the prominent occipital horns of both lateral ventricles which measured between 11 and 12 mm. In 2nd case, high riding third ventricle was evident. Finding of colpocephaly in literature,[21,22] the lateral ventricles appeared more parallel to each other than usual, with loss of the normal curvature of the lateral ventricles. The cavum septum pellucidum was absent. On application of Doppler in this sagittal section of head, an observation was made of the loss of the smooth curvature of the anterior cerebral artery branches as they course anterior to the genu region of the corpus callosum which was absent. The cisterna magna measuring 14 mm in diameter 13 mm in diameter in these cases.

A total of 20 cases, 45% had history of consanguinity, 2 cases (4%) with spina bifida, meningocoele and hydrocephalus had history of consanguinity. 8 cases (40%) with anencephaly and had history of consanguinity and the case with encephalocoele (2.2%) had history of consanguinity.

8 out of the 44 cases (22%) had a history of a CNS anomaly in the previous pregnancy. 2 cases with solitary hydrocephalus had similar foetus in their previous pregnancy. The same thing was true with 3 cases of anencephaly and 2 cases of spina bifida with associated meningocoele and myelomeningocoele.

No cases of intracranial cysts, disorders of neuronal migration and vascular abnormalities were noted in this study probably because of the relatively small sample size.
In the table below, the results in this present study have been compared to a meta-analysis of 19 articles on neural tube defects prevalence and incidence in India, collected and written as an article by Bhide P, Sagoo GS, Moorthie S,

Burton H, Kar A; School of Health Sciences, University of Pune, Pune, India; called as the systematic review of birth prevalence of neural tube defects in India.

	Meta-analysis of 19 articles	**Present Study**
Total number of pregnant women included in study	308,307	22000
Number of positive cases showing anomalies	1310	44
Percentage of cases showing anomalies	0.42%	0.2%
Number of cases per 1000 births	4.1 per 1000 live births	2 in 1000 births
Most common anomaly detected	Anencephaly – 2.1 per 1000 live births, followed by spina bifida – 1.9 per 1000 births	Hydrocephalus and Spina bifida – 0.4 cases each per 1000 live births followed by Anencephaly – 0.3 per 1000

This comparative study table shows closely related numerical data and also reiterates certain facts that the Spina bifida, hydrocephalus and anencephaly are some of the most common type of CNS anomalies.

CONCLUSION: Excellent characterisation of these congenital neuroectodermal anomalies is possible with ultrasound without the need to confirm it on foetal autopsy, thereby conveying the prognosis to the Obstetrician and helping her in taking the decision whether to terminate or continue the pregnancy. Early diagnosis of these foetal anomalies can be done by using ultrasound, sometimes as early as first trimester, thereby preventing complications associated with termination of pregnancy in the second and third trimester leading to reduction in maternal morbidity and mortality.

A total of 44 anomalies were detected in the study (0.22%). All the anomalies detected in the present study were identified and characterised. The incidence of these anomalies was calculated to be 2 per 1000 cases or 1 in every 500 cases. The most common lesions detected were hydrocephalus and spina bifida followed by anencephaly.

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