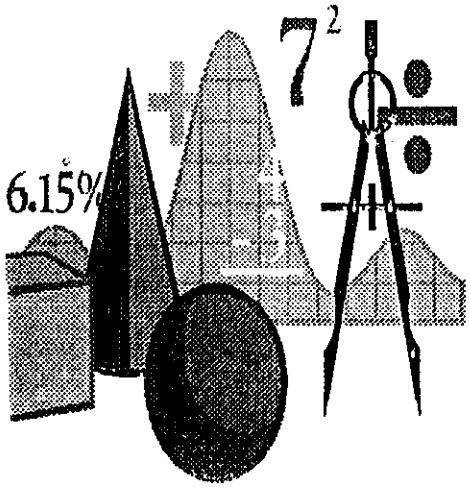
# RESULTS



# RESULTS

* The abnormalities detected in the examined 65 cases were classified according to the final diagnosis into 7 groups (Table 14).

**Table (14):** Classification of detected lesions.

| *Group* | *Lesions* | *No.* |
|---|---|---|
| *I* | Congenital brain malformation. | 29 |
| *II* | Hydrocephalus. | 38 |
| *III* | Cystic brain lesions. | 21 |
| *IV* | Intracranial infection. | 13 |
| *V* | Intracranial hemorrhage. | 11 |
| *VI* | Cerebral atrophic changes. | 3 |
| *VII* | Intracranial neoplasm. | 1 |

- **N.B:** Most of the cases showed more than one abnormality, so the total number exceeds the number of cases encountered in this study.

## *Group I : Congenital brain malformation*

* **Table (15):** Showing types of detected (29) congenital brain malformation.

| *Congenital lesion* | *No.* |
|---|---|
| * *Arnold chiari malformation.* | 10 |
| * *Chiari III malformation.* | 2 |
| * *Encephalocele.* | 4 |
| * *Dandy walker cyst.* | 2 |
| * *Dandy walker variant.* | 4 |
| * *Holoproscencephaly.* | 2 |
| * *Agenesis of corpus callosum.* | 3 |
| * *Schizencephaly.* | 1 |
| * *Sturge weber syndrome.* | 1 |
| *Total* | 29 |

**Table (16):** Clinical presentation and final diagnosis of (10 cases) of Arnold chiari malformation.

| *No.* | *Maturity* | *Clinical presentation* | *Cranial US* | *CT brain* | *Plain LS spine* | *US for lumbar sac* | *Pelvi-abdo-minal US* | *Final diagnosis* |
|---|---|---|---|---|---|---|---|---|
| 1 | FT | Swelling at the back | + | + | + | + | - | Arnold chiari malformation |
| 2 | FT | " | + | + | + | - | - | " |
| 3 | PT | " | + | - | + | - | - | " |
| 4 | FT | " | + | + | - | - | - | " |
| 5 | PT | " | + | + | - | - | - | " |
| 6 | PT | " | + | + | - | + | - | " |
| 7 | FT | " | + | - | - | - | - | " |
| 8 | PT | " | + | + | - | + | - | " |
| 9 | FT | Swelling at the back with increase intra-cranial tension | + | + | - | + | - | Arnold chiari malformation with ventri-culitis |
| 10 | FT | Follow up after shunt operation and repair of lumbar meningocele | + | - | - | - | + | Arnold chiari malformation with successful shunt operation |

FT = Full-term. PT = Pre-term.

* Ten cases of Arnold chiari malformation were examined (6 full term infants and 4 pre-term infants). Nine cases presented with swelling at the back, one of them presented also with signs of increased intracranial tension in the form of increased occipitofrontal diameter of the head with bulging tense anterior fontanelle and projectile vomiting. One case presented to assess the shunt tube function after ventriculo-peritoneal shunt and lumbar meningocele repair.

- Cranial sonography of all cases were characteristic, these include dilatation of the lateral and third ventricles with batwing or pointed frontal horns. Occipital horns were much larger than frontal horns. Large massa intermedia filling most of the dilated third ventricle. Displaced cerebellum into foramen magnum with non-visualized fourth ventricle. One case showed superadded ventriculitis detected by cranial US and confirmed by CT examination. Another one case showed proximal end of the shunt tube within Rt. lateral ventricle with mild supratentorial ventriculomegaly and no midline shift. Pelvi-abdominal US examination of this case showed bilateral hydronephrosis with distended urinary bladder and huge amount of residual urine suggesting neurogenic bladder and no pelvi-abdominal collection around distal end of the shunt tube.

- The same sonographic changes were confirmed by CT brain examination of 7 cases.
- Four cases were examined by applying 5 MHz linear transducer over the lumbar swelling. They showed a cystic mass with echogenic tissue inside (cord) i.e meningomyelocele. It's site of communication with the lumbar subarachnoid space were evident.
- Plain x-ray of the lumbar spine of 3 cases showed evidence of spina bifida with widening of interpedicular distances and soft tissue swelling at high lumbar region posteriorly.
- Final diagnosis of (10 cases) were :

  (8) cases of Arnold chiari malformation.

  (1) case of Arnold chiari malformation with ventriculitis.

  (1) case of Arnold chiari malformation with successful shunt operation and neurogenic bladder.

**Table (17):** Final diagnosis of (4 cases) of encephalocele.

| *No.* | *Cranial US* | *CT brain* | *Plain skull* | *Final diagnosis* |
|---|---|---|---|---|
| *1* | + | + | - | **Occipital meningoenchalocele with chiari III malformation.** |
| *2* | + | + | + | **Occipital meningoenchalocele with chiari III malformation.** |
| *3* | + | + | + | **Left fronto-parietal meningo-encephalocele with Dandy Walker variant.** |
| *4* | + | - | + | **High parieto-occipital meningo-cele with alobar holoproscen-cephaly.** |

* Four cases of clinically diagnosed encephalocele were examined by cranial sonography. The contents of the encephalocele were CSF and brain tissue in (3 cases) i.e. meningoencephalocele and CSF only in one case i.e. meningocele. CT brain was done for (3 cases). Both US and CT were able to define the contents of the encephalocele but CT was superior to US in detection of skull bone defects.

- Two cases of occipital meningoencephalocele showed characteristic appearance of chiari malformation by both US and CT examinations. The first case showed supratentorial ventriculomegaly with pointed frontal horns, occipital horns were more dilated than frontal horns and massa intermedia was prominent within dilated third ventricle. The fourth ventricle was

not visualized. In the second case the supratentorial ventricles were not dilated with non-visualized fourth ventricle, this case was preterm (31 weeks), one day age at examinaton. The diagnosis of chiari III malformation was confirmed by CT examination.

- One case of high parieto-occipital meningocele showed characteristic findings of alobar holoproscencephaly by US. Another one case showed associated Dandy Walker varient with the left fronto-parietal meningoencephalocele by both US and CT examinations.
- Plain x-ray of the skull was done for (3 cases) showed bony cranial defect with extracranial soft tissue swelling.

**Table (18):** Final diagnosis of (3 cases) clinically presented with extracranial head swelling.

| *No.* | *Cranial US* | *Plain skull* | *CT brain* | *Others* | *Others* |
|---|---|---|---|---|---|
| *1* | + | + | - | - | **Cephalhematoma** |
| *2* | + | + | - | **Follow up after 11/2 month** | " |
| *3* | + | + | + | **Excision biopsy** | **Occipital dermoid cyst** |

* During our study we came across (3 cases) presented clinically with extracranial head swelling (Table 18). Sonographic examination proved to be valuable in differentiating the previously described cases of encephalocele from cephalhematoma (2 cases) and midline occipital dermoid cyst (1 case).

- Two cases of cephalhematoma were presented with history of head trauma and soft extracranial head swelling. Sonographic findings of cephalhematoma were echofree collection between the elevated periosteum and skull bones with no bony defects and normal intracranial structures. Follow up of one case revealed complete resolution of the hematoma over a period of 1.5 months.
- Plain x-ray of skull for (2 cases) of cehalhematoma proved that, there were no cranial bony defects.

- One case of mid-line occipital dermoid cyst could be suspected by sonographic examination of the cyst but bony defect could not be detected sonographically. CT examination and plain x-ray skull could detect this bony defect. Excision biopsy confirmed diagnosis of occipital dermoid cyst.

**Table (19):** Clinical presentation and final diagnosis of (6 cases) of Dandy walker malformation.

| *No.* | *Clinical presentation* | *Cranial US* | *CT brain* | *Plain skull* | *Final diagnosis* |
|---|---|---|---|---|---|
| *1* | **Large head and increase ICT** | + | + | - | **Dandy walker cyst** |
| *2* | " | + | + | - | " |
| *3* | **Failure to thrive** | + | + | - | **Dandy walker variant with Rt. temporal arachnoid cyst** |
| *4* | **Extracranial head swelling (encephalocele).** | + | + | + | **Dandy walker variant with left frontoparietal meningoencephalocele** |
| *5* | **Large head and increase ICT.** | + | + | - | **Dandy walker variant with communicated hydrocephalus** |
| *6* | **Large head & MR** | + | + | - | **Dandy walker variant with schizencephaly** |

* Two cases of Dandy walker cyst associated with moderate supratentorial hydrocephalic changes were presented clinically by large head with signs of increased intracranial tension. Provisional diagnosis of both cases were hydrocephalus.

Cranial sonography and CT brain examinations were done for the two cases. The two modalities showed equally the posterior fossa cyst with absent or hypoplastic vermis and cerebellar

hemispheres as well as elevated tentorium and supratentorial moderate hydrocephalic changes. The fourth ventricle could not be separated from the posterior fossa cyst.

- Four cases of Dandy walker variant were detected by both US and CT equally as retrocerebellar small posterior fossa cyst communicated with moderately dilated fourth ventricle through wide valleculae and hypoplastic inferior vermis and normal cerebellar hemispheres. All (4) cases of Dandy walker variant were associated with schizencephaly (one case), communicated hydrocephalus (one case), left frontoparietal meningo-encephalocele (one case) and small Rt. temporal arachnoid cyst (one case). Cranial sonography could detect all these associations except the small arachnoid cyst which detected by CT only. CT examination confirmed these diagnostic data.

**Table (20):** Clinical presentation and final diagnosis of (2 cases) of holoproscencephaly.

| *No.* | *Maturity* | *Age* | *Clinical picture* | *Provisional diagnosis* | *US* | *CT* | *Plain skull* | *Final diagnosis* |
|---|---|---|---|---|---|---|---|---|
| 1 | PT (35 wks) | **1 month** | **Extracranial head swelling** | **Encephalocele** | + | - | + | **Alobar holoproscen-cephaly with parieto-occipital meningocele** |
| 2 | FT | **12 months** | **Delayed mile-stone develop-ment & large head** | **Hydrocepha-lus** | + | + | - | **Lobar holoproscen-cephaly with agenesis of corpus callosum** |

FT = Full-term. PT = Pre-term.

* Two cases of holoproscencephaly were detected. The first case was preterm (35 weeks gestation) presented with extracranial head swelling and provisionally diagnosed as encephalocele. Cranial sonography showed common ventricle with no lateral ventricles or third ventricle division. Absent falx cerebi, interhemispheric fissure and septum pellucidium were noted as well as fused thalami. Picture is characteristic of alobar holoproscencephaly.
- The second case was full term infant (12 months age) presented clinically with large head and delayed milestone development. Provisional diagnosis was hydrocephalus. Cranial sonography and CT examination were done and showed absent septum pellucidium and corpus callosum with rudimentary anterior falx and interhemispheric fissure. There were marked separation of frontal horns fused with superiorly extended and dilated third ventricle. Picture is characteristic of lobar holoproscencephaly with agenesis of the corpus callosum.

**Table (21):** Final diagnosis of 3 cases of agenesis of corpus callosum.

| *No.* | *Clinical presentation* | *Cranial US* | *CT brain* | *Final diagnosis* |
|---|---|---|---|---|
| *1* | **Large head and increase ICT** | + | + | **Agenesis of corpus callosum with communicating hydrocephalus** |
| *2* | **Large head and delayed milestone development.** | + | + | **Agenesis of corpus callosum with lobar holoproscencephaly** |
| *3* | **Microcephaly.** | + | + | **Agenesis of corpus callosum** |

* Three cases of agenesis of the corpus callosum were detected by CT brain and cranial sonography. Cranial sonography easily detected the absent corpus callosum in sagittal planes. In coronal views, separation of frontal horns with concave medial horders as well as superiorly extended third ventricle inbetween lateral ventricles were also detected. Elongation of foramen of Monro with radial arrangement of the medial cerebral sulci arround roof of third ventricle were also seen.

- One case of agenesis corpus collosum was associated with lobar holoproscencephaly and another case was associated with communicating hydrocephalus.
- Cranial sonographic findings were confirmd by CT findings in all three cases.

* One case of schizencephaly associated with Dandy walker variant was detected. This case was full term male infant (8 months age) presented clinically with large head and mental retardation. The provisional diagnosis was hydrocephalus. Brain CT and cranial sonography examination were done. Both detected the bilateral symmetrical hemispheric schizencephalic clefts extending from subependyma of temporal horns and lateral ventricles to subarachnoid spaces at cortical bone.

* One case of sturge weber syndrome (8 months age) was presented clinically with convulsions, mental retardation and port-wine facial naveus. Cranial sonography was normal but post-contrast CT brain could detect Rt occipital gyral enhancement following its cortical envolution and no evidence of calcifications.

## *Group II : Hydrocephalus*

* During our study we detected 38 cases of obstructive hydrocephalus. Out of the examined 38 hydrocephalic infants, 9 were preterm and 29 were full term.

* **Table (22):** Shows the provisional diagnosis of the hydrocephalic 38 infants.

| *Provisional diagnosis* | *No.* |
|---|---|
| *- Hydrocephalus.* | 23 |
| *- Arnold chiari malformation.* | 10 |
| *- Intracranial hemorrhage.* | 2 |
| *- Neurologically free (high risk infant).* | 2 |
| *- Encephalocele.* | 1 |
| *Total* | 38 |

* Cranial sonography was done for all (38) hydrocephalic infants and can detect type, level and cause of the hydrocephalus. Through anterior fontanelle (coronal 2 & 3 levels). Estimation of both frontal horns and bodies of lateral ventricles width (combined coronal ventricular width) was done in all 38 cases associated with measuring of the cerebral mantle thickness at the same planes. These measurements were used to assess degree of hydrocephalus.

- CT examination of the brain was done for 24 cases and CT findings were consistant with the sonographic findings in all these cases with no additional information.
- Plain x-ray of the skull was done for 5 cases and showed signs of increased intracranial tension in the form of suture diastasis, bulging fontanelles and craniomegaly.
- Doppler study through anterior fontanelle for both ACA and MCA were done for 9 cases and showed elevated RI (85-91%) in 8 cases and normal RI (69-74%) in one case of mild degree EVOH.

* **Table (23):** Shows type and level of obstruction in the hydrocephalic infants.

| *Type* | *Level* | *No.* | *%* |
|---|---|---|---|
| *EVOH* | - | 14 | 36.9 |
| *IVOH* | At foramen of Monro level | 3 | 7.9 |
| | At aqueduct level | 19 | 50 |
| | At exit foramina of fourth ventricle | 2 | 5.2 |
| *Total* | | 38 | 100 |

EVOH = Extraventricular obstructive hydrocephalus.

IVOH = Intraventricular obstructive hydrocephalus.

*** Table (24):** Shows cause of obstruction at (38) hydrocephalic infants.

| *Type & level* | *Cause* | *No.* |
|---|---|---|
| *EVOH* | • Post-infective. | 6 |
| | • Post-hemorrhagic. | 4 |
| | • No apparent cause. | 4 |
| *IVOH at foramen of Monro level.* | • Porencephalic cyst. | 1 |
| | • Ventriculitis. | 1 |
| | • No apparant cause. | 1 |
| *IVOH at aqueduct level.* | • Aqueduct stenosis. | 7 |
| | • Chiari malformation II & III. | 11 |
| | • Arachnoid cyst. | 1 |
| *IVOH at exit foramina of fourth ventricle.* | • Dandy walker cyst. | 2 |
| *Total* | | 38 |

*** Table (25):** Shows correlation between combined coronal ventricular width (CCVW)-cerebral mantle thickness (CM) and degree of hydrocephalus.

| *Degree of hydrocephalus* | *CCVW (mm)* | *CM (mm)* | *No.* | *%* |
|---|---|---|---|---|
| *Slight* | 8-12 | 46-48 | 5 | 13.1 |
| *Mild* | 20-30 | 45-38 | 6 | 15.8 |
| *Moderate* | 30-40 | 27-40 | 17 | 44.8 |
| *Severe* | > 40 | 4 : 26 | 10 | 26.3 |
| *Total* | | | 38 | 100 |

* Follow up after shunt operation was performed for (4 cases) to detect any postoperative complication. Table (26) shows the results of cranial sonography (4 cases), CT brain (3 cases), abdominal sonography (2 cases) and plain film for shunt tube (babygram) for one case.

**Table (26):** Shows results of shunt operations.

| *Result* | *No.* |
|---|---|
| • *Successful shunt operation.* | 1 |
| • *Obstructed proximal end of the tube by adherent choroid plexus.* | 2 |
| • *Bilateral subdural empyema with slit ventricles syndrome (SVS).* | 1 |
| *Total* | 4 |

• Tapping from anterior fontanelle and left subtemporal craniectomy was done for the case of subdural empyema and SVS.

## *Group III : Cystic brain lesions*

* Intracranial cystic lesions were encountered in 21 cases as shown in table (27).

**Table (27):** Shows intracranial cystic lesions.

| *Lesion* | *No.* |
|---|---|
| • *Porencephalic cyst.* | 4 |
| • *Arachnoid cyst.* | 4 |
| • *Dandy walker cyst.* | 2 |
| • *Dandy walker variant.* | 4 |
| • *Holoprosencephaly.* | 2 |
| • *Agenesis of corpus callosum.* | 2 |
| • *Cavum septum pellucidium.* | 2 |
| • *Schizencephaly.* | 1 |
| *Total* | 21 |

**Table (28):** Shows final diagnosis of (4 cases) of porencephalic cysts.

| *No.* | *Cranial US* | *Doppler US* | *CT brain* | *Final diagnosis* |
|---|---|---|---|---|
| 1 | + | - | + | Single porencephalic cyst communicating with Rt lateral ventricle. Associated IVOH at foramen of Monro level. |
| 2 | + | RI=89% | - | Rt fronto-parietal non-communicating single porencephalic cyst associated with grade III SE-IV hemorrhage. |
| 3 | + | - | + | Single porencephalic cyst communicating with left lateral ventricle associated with blocked shunt tube proximally. |
| 4 | + | RI=75% | + | Multiple non-communicating Rt frontal porencephalic cysts associated with cerebral atrophy and superior sagittal sinus thrombosis. |

* Porencephalic cysts were encountered in 4 cases. Multiple cysts were found in one infant and single cyst in 3 cases. Communication of the cyst with the ventricular system was demonstrated in 2 cases.

• Sonographic findings showed the CSF cavity of the intra-axial cystic lesion and site of communication with the ventricular

system (if present). CT examination for (3) cases confirmed the sonographic diagnosis.

- All four cases were associated with ventriculomegaly, Doppler study for (2 cases) showed elevated RI (89%) in one case due to associated grade III bilateral SE-IV hemorrhage. Another case showed normal RI (75%) due to associated cortical and centeral cerebral atrophy with superior sagittal sinus thrombosis detected by post-contrast CT brain (positive Delta sign) but not detected by cranial sonography.

**Table (29):** Shows final diagnosis of 4 cases of Arachnoid cysts.

| *No.* | *Cranial US* | *CT brain* | *Final diagnosis* |
|---|---|---|---|
| *1* | + | + | Tempro-parietal arachnoid cyst with aqueduct stenosis. |
| *2* | + | + | Temporal arachnoid cyst with Dandy walker variant. |
| *3* | + | - | Temporal arachnoid cyst with aqueduct stenosis. |
| *4* | + | + | Tempro-parietal arachnoid cyst with aqueduct stenosis. |

* Arachnoid cysts were found in 4 cases. 3 cases could be detected by cranial sonography as extra-axial CSF cystic lesion confirmed by CT examination for 2 cases. One case failed to be visualized by cranial sonography and detected by CT examination. This case presented with failure to thrive and sonography detected associated Dandy walker variant, CT added small extra-axial temporal arachnoid cyst.
* Cavum septum pellucidium was detected in 2 cases. Both of them showed mid-line cystic structure above third ventricle and anterior to foramen of Monro interposed between frontal horns by cranial sonography and CT brain equally.

* Other encountered congenital cystic lesions : Dandy walker cyst (2 cases), Dandy walker variant (4 cases), Holoproscencephaly (2 cases), Agenesis of corpus callosum (2 cases) and schizencephaly (one case) were demonstrated in group I of congenital lesions.

## *Group IV : Intracranial infection*

* Intracranial infections were detected in (13 cases) as shown in table (30).

**Table (30):** Shows (13 cases) of intracranial infection.

| *Lesion* | *No.* |
|---|---|
| * *Brain abscess.* | 3 |
| * *Ventriculitis.* | 7 |
| * *Meningitis.* | 1 |
| * *Subdural empyema.* | 1 |
| * *Cytomegalovirus.* | 1 |
| *Total* | 13 |

* Brain abscess was demonstrated in (3 cases). Cranial sonography showed multiple cystic lesions (2 cases) and single cystic lesion (one case). These cystic lesions were of turbid fluid contents with thick echogenic wall and perifocal increased echogenicity of oedema. Mass effect in the form of compression of ipsilateral ventricles and minimal mid-line shift to the contra-lateral side. Sonographic findings suggested the possibility of abscess formation and post-contrast CT examinations confirmed these diagnosis by marginally enhancing regular walled lesions.
* Ventriculitis was detected in (7 cases), 6 cases were associated with ventriculomegaly and sonography was easy to detect the turbid CSF contents within dilated ventricles and internal septation with fluid/fluid levels. Thick echogenic ependymal wall

was also demonstrated with increased periventricular white matter echogenicity. Four cases were referred to confirm diagnosis by CT examination which showed enhancing ependymal walls and proved the sonographic data.

One case could not be detected by US and diagnosed by post-contrast CT scanning. This case showed normal sized ventricles by cranial sonography with no signs of ventriculitis.

* Meningitis was detected in one case clinically presented with fever, neck rigidity, repeated attacks of convulsions with signs of increased intracranial tension in the form of projectile vomiting and lack of suckling. Cranial sonography showed diffuse increase of brain echogenicity obscuring anatomical landmarks with small attenuated ventricles suggesting brain oedema. The sylvian fissures were thick and echogenic with prominent echogenic cortical sulci. CT examination showed meningeal enhancement after contrast with minimal subdural effusion. Lumbar puncture was done to examine the CSF and the diagnosis of meningitis was confirmed.

* One case of subdural empyema was detected as a shunt operation was performed 3 months ago and referred to assess the shunt tube patency and detect any post-operative complications.

By cranial sonography, there was bilateral subdural collection of turbid echogenicity with fluid/fluid level and collapse ventricles except left temporal horn. CT examination confirmed the diagnosis of subdural empyema and slit-ventricle syndrome

(SVS). This patient referred to do tapping from anterior fontanelle and left subtemporal craniectomy.

* Cytomegalovirus infection (CMV) was seen in one case. Clinical presentation was delayed milestone development, fever and repeated attacks of convulsions. Sonographic examination showed moderate supratentorial ventriculomegaly with prominent cortial sulci and widening of inter-hemispheric fissure. Basal ganglia and peri-ventricular bilateral dotty calcification were seen also. CT examination confirmed these findings. Doppler study revealed normal RI (72%) denoting that ventriculomegaly was due to cerebral atrophy. Serological examination for CMV was positive.

## *Group V : Intracranial hemorrhage*

* Intracranial hemorrhagic lesions were detected in (11 cases) as shown in table (31).

**Table (31):** Shows (11 cases) of intracranial hemorrhage.

| *Lesion* | *No.* |
|---|---|
| * *Subdural hematoma.* | 3 |
| * *SE-IV hemorrhage.* | 5 |
| * *Parenchymal hemorrhage.* | 2 |
| * *Subarachnoid hemorrhage.* | 1 |
| *Total* | 11 |

* Subdural hematoma was seen in (3 cases). There was history of head injury in all cases. All infants were full term and were examined by high frequency transducer 5 MHz.

- One case had repeated attacks of convulsions with unequal pupils after head injury and sonographic finding showed an echo-free extra-axial collection of concavo-convex shape between the brain and skull bone with mass effect on the ipsilateral ventricle and mild mid-line shift to the contra-lateral side. The diagnosis of acute subdural hematoma was suspected and confirmed clinically. This infant had operated by evacuation of hematoma, 2 weeks after operation, there was no subdural collection and no mid-line shift with ventricular system returned to normal size and position.

Other two cases were sonographically normal and CT examination detected small Rt frontal subdural acute hematoma in one case, and left chronic subdural hematoma in the second case with no mid-line shift. These two cases could not be detected by cranial sonography. The case of acute small frontal subdural hematoma was operated by evacuation of hematoma after CT diagnosis.

* During our study we detected 5 cases of subependymal-intraventricular (SE-IV) hemorrhages. All these 5 infants were premature of gestaginal age ranging from 31 to 33 weeks and birth weight ranging from 1500 to 1900 grams. The clinical presentation of these 5 infants were high risk infants associated with signs of increased intra-cranial tension, large head and convulsions.

• Cranial sonography of these (5) infants revealed :

- Isolated SEH was detected in 2 cases as bright echodensity over the head of caudate nucleus and thalamo-caudate groove with no intraventricular extension, ventriculomegaly or parenchymal hemorrhage. These two cases were diagnosed as grade I-SE hemorrhage. Cranial Doppler US findings of these two infants revealed normal RI (78%) and (63 : 73%).
- One case of bilateral SE hemorrhage at both thalamo-caudate grooves with moderate ventriculomegaly and intraventricular hemorrhagic extension. No parenchymal hemorrhage detected but small Rt fronto-parietal porencephalic cyst was associated. RI by

Doppler study was elevated (89%). Findings of this case was diagnosed grade III SE-IV hemorrhage.

- Two cases of SE hemorrhage with intraventricular and intra-parenchymal hemorrhagic extension as well as moderate ventriculomegaly were detected. RI by cranial Doppler study were elevated (86 : 91%). These findings diagnosed grade IV SE-IV hemorrhages.

* Spontaneous intraparenchymal hemorrhage was detected in 2 cases. One case was premature (34 weeks gestaginal age and 1800 gm birth weight) with generalized bleeding tendency. The second case was full term, 3 months age examined after history of head injury.

Cranial sonography of two cases showed strongly echogenic area with mass effect on the ipsilateral lateral ventricle and minimal mid-line shift to the contra-lateral side. CT examination of one case confirmed the fresh blood density of this detectable lesion. RI of these two cases was elevated (75 : 88%).

* One case of subarachnoid hemorrhage was suspected sonographically by finding thick echogenic sylvian fissure and confirmed by CT examination. RI was elevated (88%).

## *Group IV : Cerebral atrophic changes*

* Diffuse cerebral atrophy was detected in (3 cases). They presented with delayed milestone development, mental retardation and microcephaly.

- Sonography showed mild to moderate ventriculomegaly with homogenous decreased cerebral hemispheres echogenicity, widening of interhemispheric fissure, prominent cortical sulci and widening of basal subarachnoid spaces.
- CT examination of two cases confirmed these findings and added superior sagittal thrombosis (Delta sign) of one case.
- RI results were normal (72-75%) of all examined 3 cases. This explained that, ventriculomegaly was due to atrophic changes not hydrocephalic changes.

## *Group VII : Intracranial neoplasm*

* Only one case of intracranial neoplasm (primitive neuroectodermal tumour) was detected. This case was presented with signs of increased intracranial tension (macrocephaly and bulging fontanelle) and Rt hemiplegia with Rt facial nerve palsy.

- Cranial US revealed soft tissue left tempro-parietal intra-axial echogenic SOL with central area of cystic degeneration and mid-line shift to the Rt.
- CT examination confirmed sonographic data and showed irregular enhancing thick wall of the SOL with enhancing nidus within the cystic central component. Post-operative biopsy showed a primitive neuroectodermal tumour of infancy.

## * Cranial Doppler findings in 15 cases

**Table (32):** Shows Doppler findings in examined 15 cases.

| No. | Diagnosis | ACA | | | MCA | | |
|---|---|---|---|---|---|---|---|
| | | Max (m/s) | Min (m/s) | RI (%) | Max (m/s) | Min. (m/s) | RI (%) |
| 1 | Grade I SEH | 59 | 16 | 73 | 91 | 34 | 63 |
| 2 | Grade I SEH | 60 | 13 | 78 | 55 | 12.65 | 77 |
| 3 | Grade III SE-IVH | 75 | 8.25 | 89 | 95 | 14.25 | 85 |
| 4 | Grade IV SE-IVH | 72 | 10.08 | 86 | 93 | 8.37 | 91 |
| 5 | Grade IV SE-IVH | 69 | 7.59 | 89 | 90 | 9 | 90 |
| 6 | Parenchymal hemorrhage | 60 | 15 | 75 | 85 | 10.2 | 88 |
| 7 | Hydrocephalus | 68 | 21 | 69 | 58 | 15 | 74 |
| 8 | Hydrocephalus | 75 | 8 | 89 | 74 | 11.8 | 84 |
| 9 | Hydrocephalus | 75 | 3.75 | 95 | 76 | 10.6 | 86 |
| 10 | Hydrocephalus | 75 | 11.25 | 85 | 88 | 10.56 | 88 |
| 11 | Hydrocephalus | 75 | 7.5 | 90 | 93 | 8.3 | 91 |
| 12 | Hydrocephalus | 70 | 8.4 | 88 | 80 | 8.8 | 89 |
| 13 | Atrophy | 57 | 14.25 | 75 | 55 | 16.5 | 70 |
| 14 | Atrophy | 60 | 15 | 75 | 58 | 15 | 74 |
| 15 | C.M.V. | 60 | 16.8 | 72 | 83 | 30.7 | 63 |

# PREPRESENTATIVE CASES

## *Case No. (1):*

A pre-term newborn 7 days old (34 wks gestaginal age-1900 gm birth wt) presented with swelling at the back. On examination there was an increase in occipito-frontal circumference of the head associated with tense bulging anterior fontanelle.The cystic swelling was seen at high lumbar region. The provisional clinical diagnosis was Arnold chiari malformation.

**Plain x-ray of the lumbosacral spine in AP view (Fig.1-A) revealed :**

Spina bifida with widening of inter-pedicular distances.

**CT cuts of the brain (Fig. 1-B) revealed :**

Shallow posterior fossa with non-visualized fourth ventricle. Enlarged sagittal diameter of the foramen magnum with petrous bones scalloping.Bilateral symmetrical moderate dilatation of lateral ventricles with predominant involvement of the occipital horns and flattening of supero-lateral angles of frontal horns. The third ventricle was mildly dilated with prominent mass intermedia and caudate nuclei giving inverted (3) sign of supratentorial ventricles.

**Cranial sonography in coronal & sagittal planes through anterior fontanelle revealed :**

Moderate bilateral symmetrical dilatation of lateral ventricles. Batwing configuration of frontal horns (Fig. 1-c). Occipital horns were more dilated than frontal horns (Fig. 1-E). Mild dilatation of third ventricle with prominent massa intermedia (Fig. 1-F). Non-visualized fourth ventricle with downward displacement of cerebellum (Fig. 1-E).

***Diagnosis :*** Arnold chiari malformation.

*Fig. (1):*

(A)

(B)

(C)

*Case No. (2):*

A fullterm newborn infant, 15 days old presented with swelling at the back, fever, large head and persistant vomiting. On examination, there was macrocephaly with tense bulging fontanelles. The lumbar swelling was cystic.

**Cranial sonography in coronal and sagittal planes through anterior fontanelle revealed :**

- Non-visualized fourth ventricle with downward displacement of cerebellum (Fig. 2-c).
- Moderate dilatation of lateral ventricles with mild third ventricle dilatation (Fig. 2-B).
- Occipital horns were more dilated than frontal horns.
- The dilated ventricles showed turbid CSF with internal echoes (Fig. 2-C & D).
- The ependymal wall of lateral ventricles was thick and echogenic (Fig. 2-D) suggesting superadded ventriculitis.

**Post-contrast CT brain revealed :**

- Shallow posterior fossa with non-visualized fourth ventricle (Fig. 2-E & F).
- Moderate lateral ventricles dilatation with mild third ventricle dilatation.
- Occipital horns were more dilated than frontal horns (Fig. 2-G & H).
- The dilated supratentorial ventricles showed enhancing ventricular wall characteristic of ventriculitis.

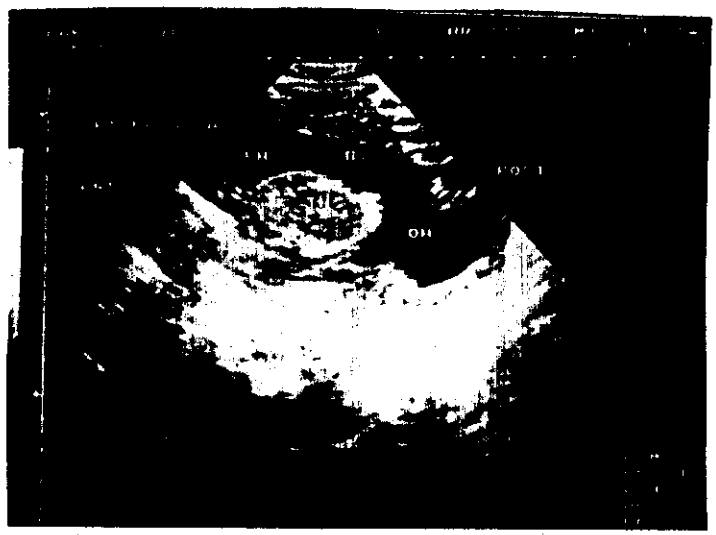
**Diagnosis :**

Arnold chiari malformation with ventriculitis.

Fig. (1)

(D)

(E)



(F)

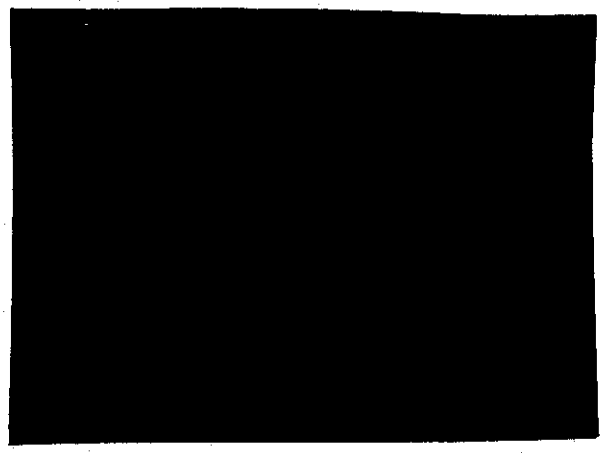
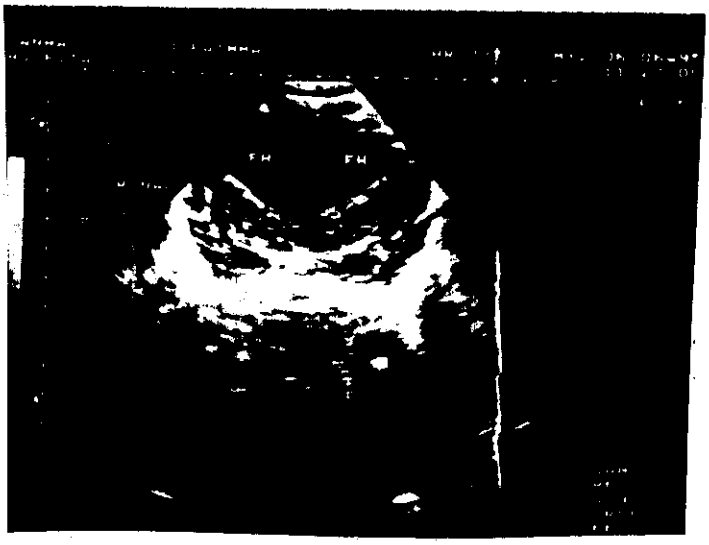


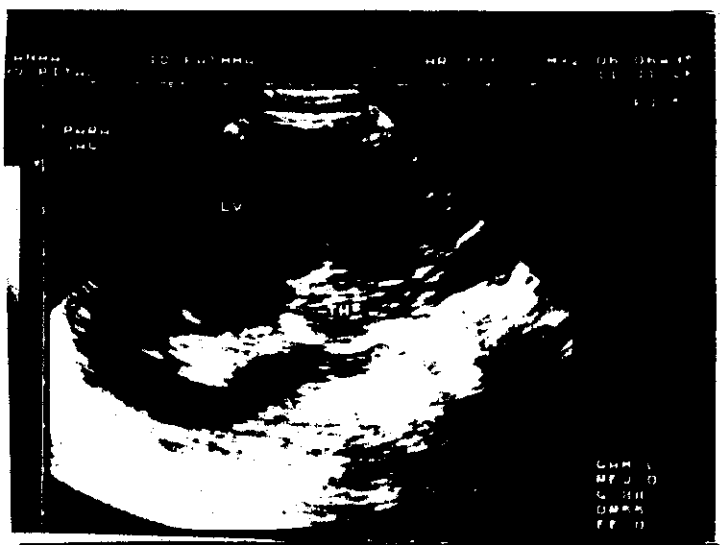
Fig. (4):

(A)



(B)

(C)



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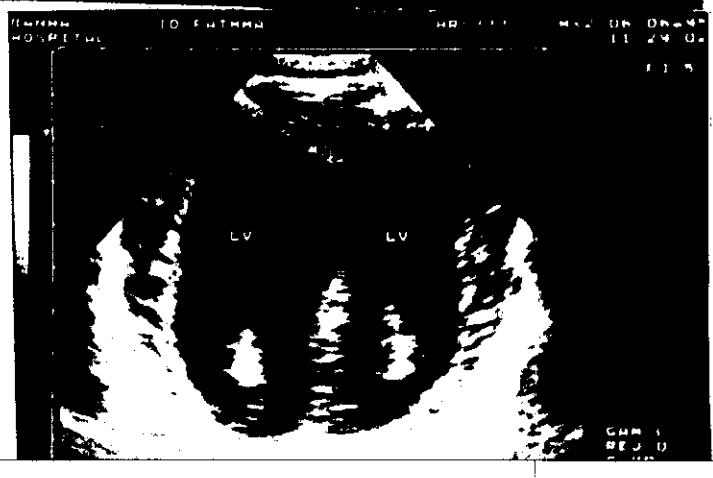
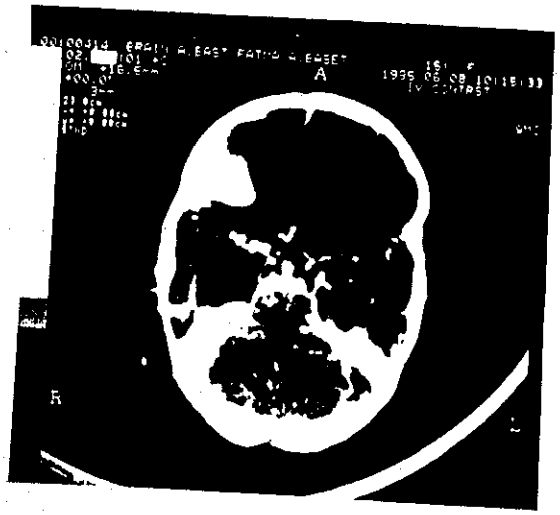
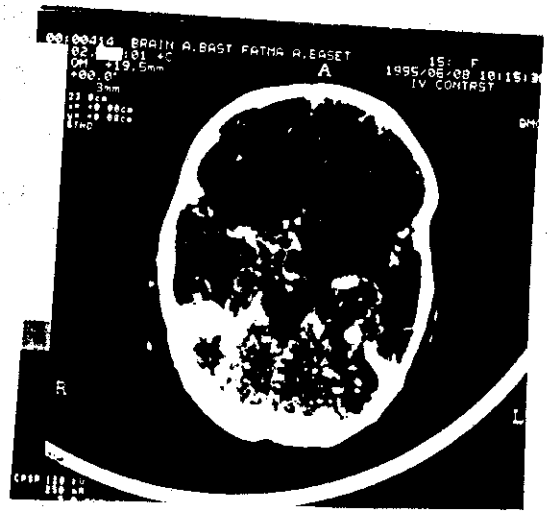


Fig.(2)

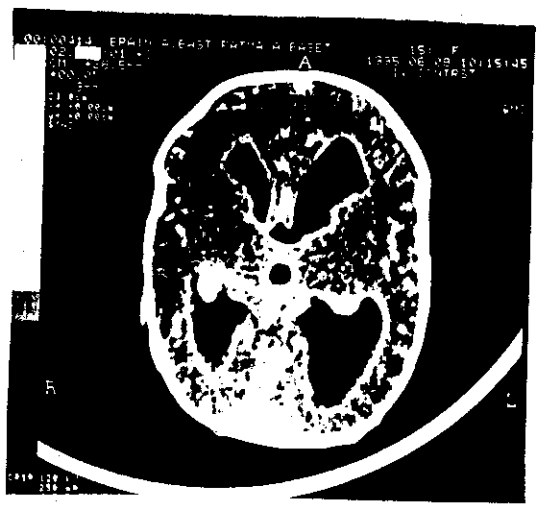
(E)



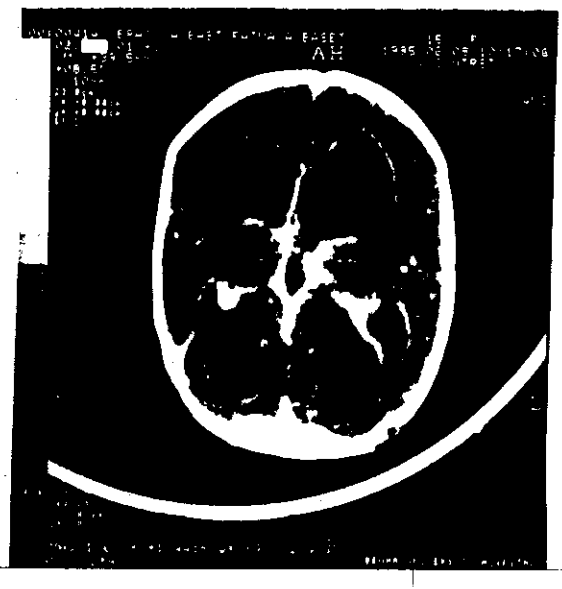
(F)



(G)



(H)



*Case No. (3):*

Full term newborn infant, 15 days old presented with large head and persistant vomiting. On examination there was macro-cephaly and tense bulging fontanelles. The provisional clinical diagnosis was hydrocephalus.

**Cranial sonography in coronal, sagittal and axial planes through anterior fontanelle and temporal bones (Fig. 3-A,B & C) revealed :**

- Large posterior fossa cyst with hypoplastic cerebellar vermis and cerebellar hemispheres.
- Elevated tentorium (Fig. 3-C).
- Moderate symmetrical dilatation of supratentorial ventricules.
- Sonographic diagnosis was Dandy walker cyst with moderate supratentorial hydrocephalus.

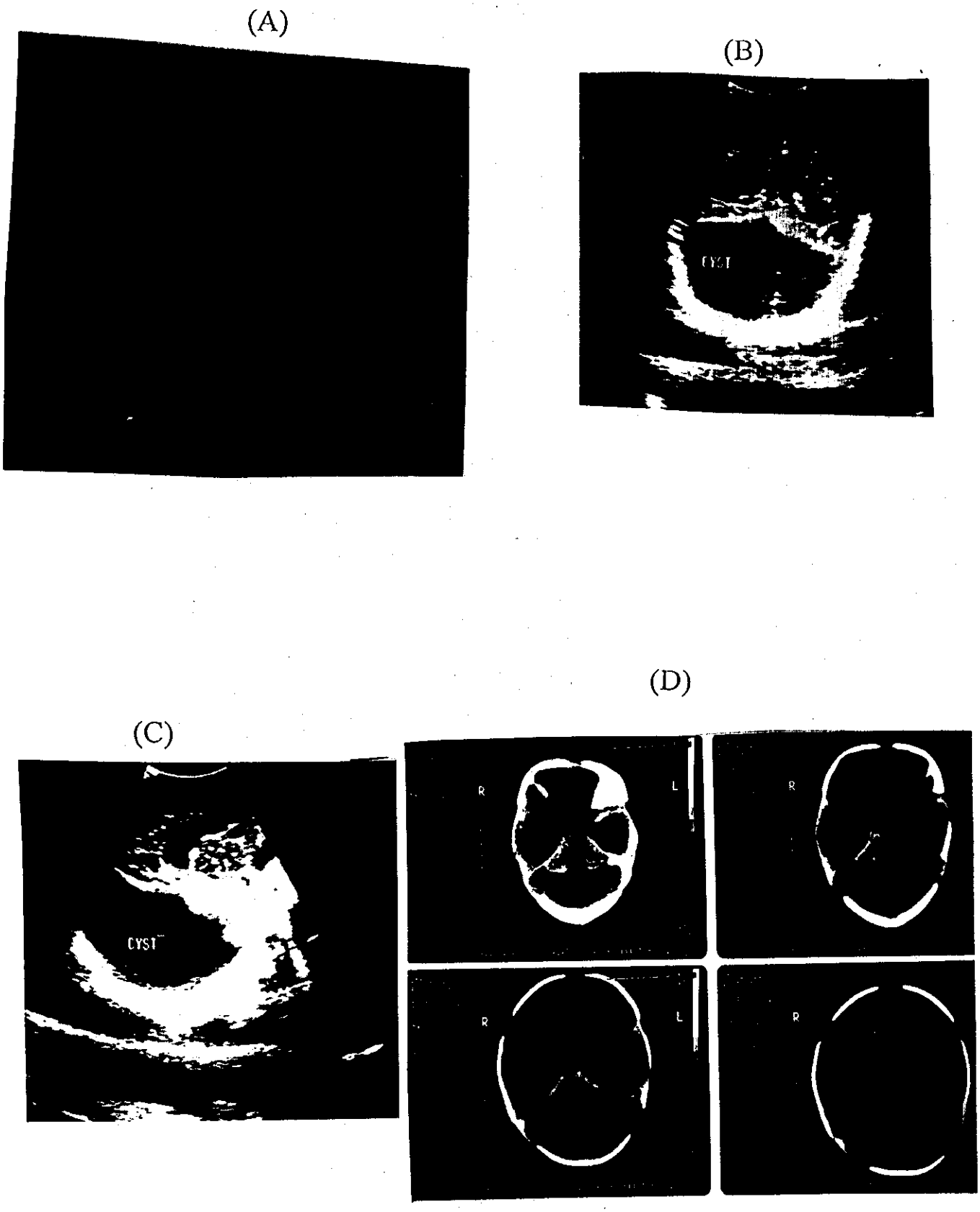
**CT examination of the brain (Fig. 3-D) :**

Confirmed the sonographic diagnosis.

**Diagnosis :**

Dandy walker cyst with supratentorial hydrocephalus.

*Fig. (3):*



*Case No. (4):*

A newborn infant 3 days old presented with extracranial head swelling. On examination there was occipital cystic swelling and palpable underlying occipital bone defect. The provisional clinical diagnosis was occipital encephalocele.

**Plain x-ray of the skull in lateral view (Fig. 4-A) :**

Showed occipital soft tissue swelling.

**Cranial sonography (Fig. 4-B) :**

Showed that the occipital swelling containing CSF with brain tissue inside (meningo-encephalocele). The occipital bony defect could not be detected by sonography. The supratentorial ventricles were mildly dilated with non visualized fourth ventricle and downward displacement of cerebellum (Chiari malformation).

**CT examination of the skull (Fig. 4-C) :**

Showed the occipital bone defect with occipital menigo-encephalocele. The fourth ventricle was not visualized with supratentorial ventriculomegaly.

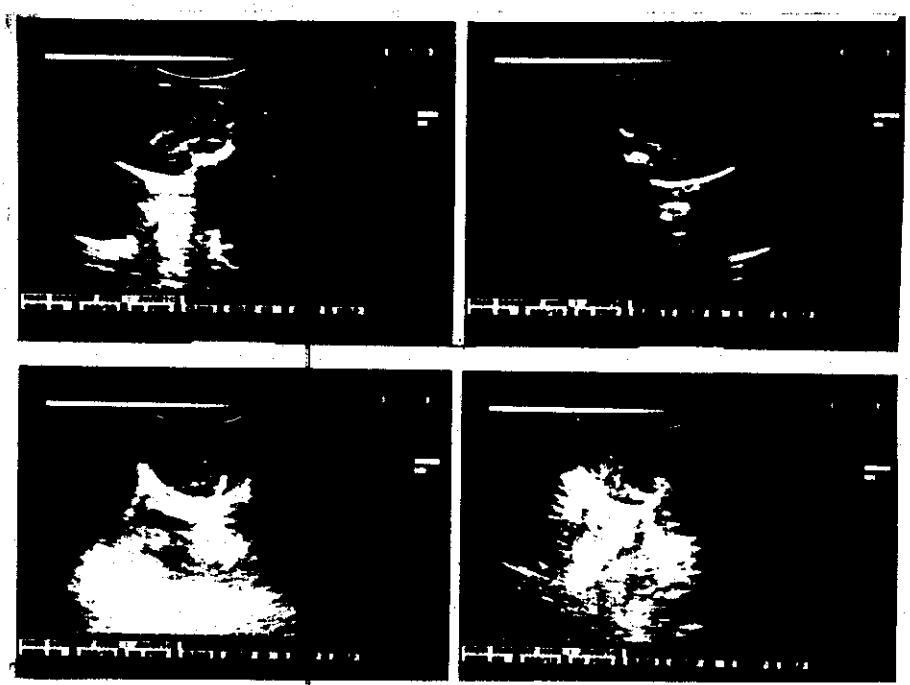
**Diagnosis :**

Occipital meningo-encephalocele with chiari-III malformation

*Fig. (4):*

(A)

(B)



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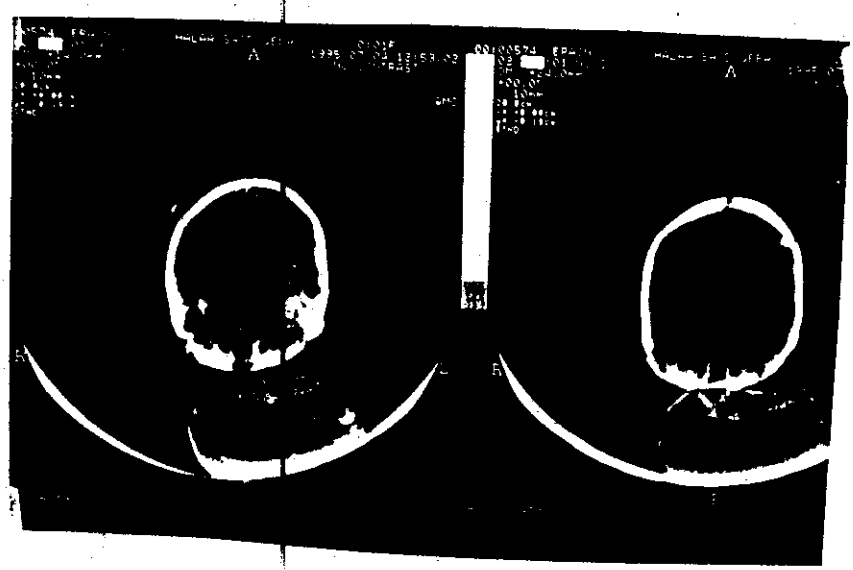


## *Case No. (5):*

A preterm newborn infant,one day age (35 wks gestaginal age and 2000 gm birth wt) presented clinically with extracranial head swelling. On examination, there was high parieto-occipital cystic swelling with cleft palate. Provisional clinical diagnosis was encephalocele.

**Plain x-ray of the skull in lateral view (Fig. 5-A) :**

Showed the high parieto-occipital swelling with underlying bony defect.

**Cranial sonography (Fig. 5-B & C) revealed :**

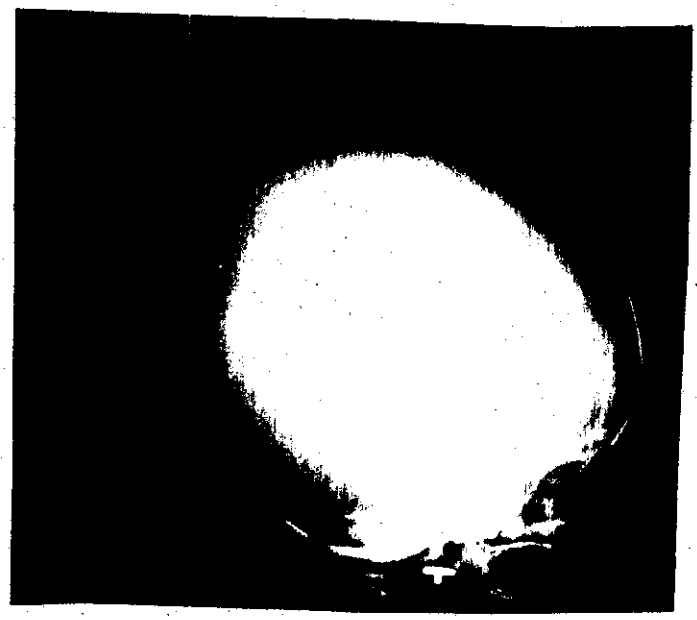
- The swelling contents were clear CSF (meningocele).
- The cranial contents showed common mid-line ventricle (measuring 91mm at mid-coronal width) with attenuated cerebral mantle (12 mm). No lateral ventricles or third ventricle division. The falx cerebri, interhemispheric fissure and septum pellucidium were absent. The thalami were fused.

**Diagnosis :**

Alobar holoproscencephaly with parieto-occipital meningo-cele.

*Fig. (5):*

(A)



(B)

(C)

*Case No. (6):*

Full term infant, 12 months age clinically presented with large head and delayed milestone development. Provisional clinical diagnosis was hydrocephalus.

**Cranial sonography in coronal and sagittal planes through anterior fontanelle (Fig. 6-A,B & C) revealed :**

- Absent septum pellucidium and corpus callosum.
- Marked separation of rudimentary frontal horns fused with superiorly extended and dilated third ventricle. Normal appearance of thalami and interhemispheric fissure. Sonographic diagnosis was agenesis of the corpus callosum associated with lobar type of holoproscencephaly.

**CT examination of the brain (Fig. 6-D) :**

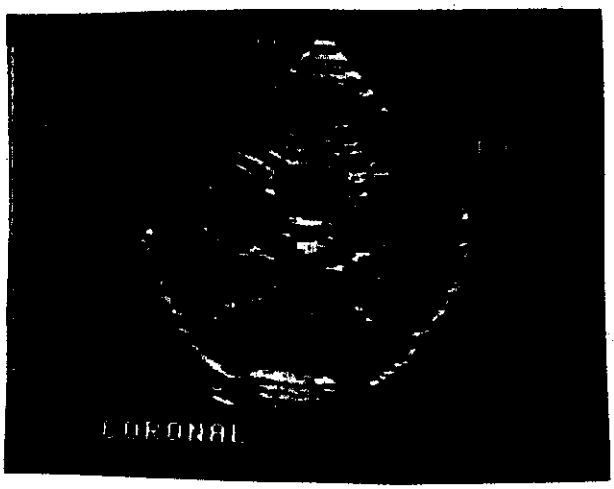
Confirmed sonographic diagnosis.

**Diagnosis :**

Agenesis of the corpus callosum and lobar holoprosencephaly

*Fig. (6):*

(A)



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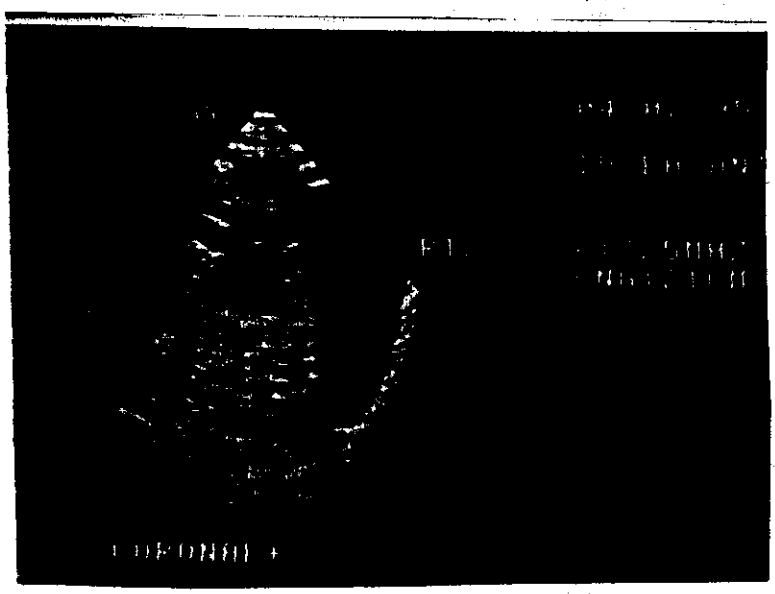

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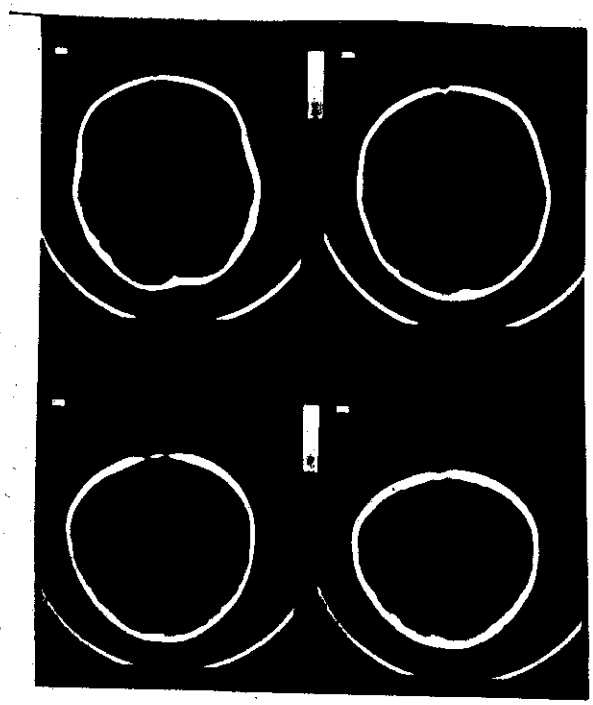
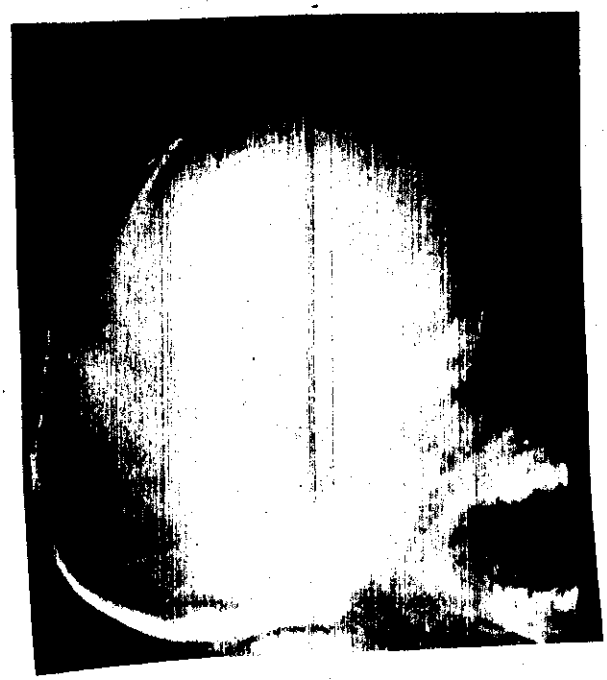


*Fig. (7):*

(A)



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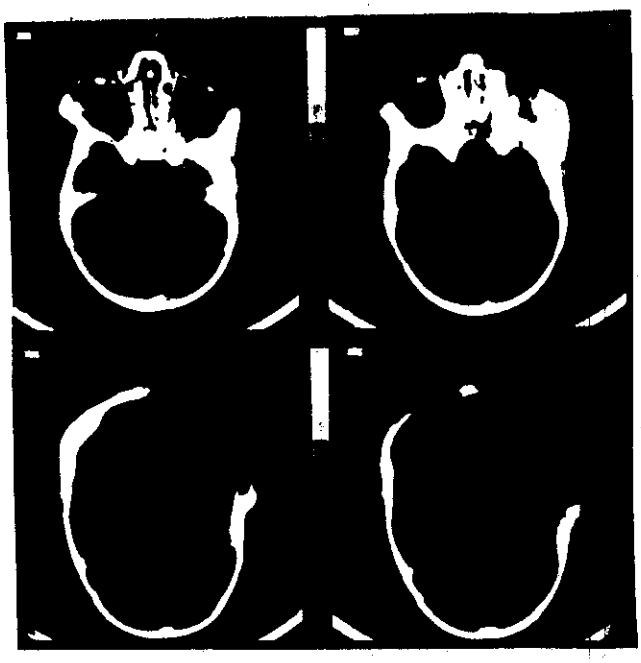

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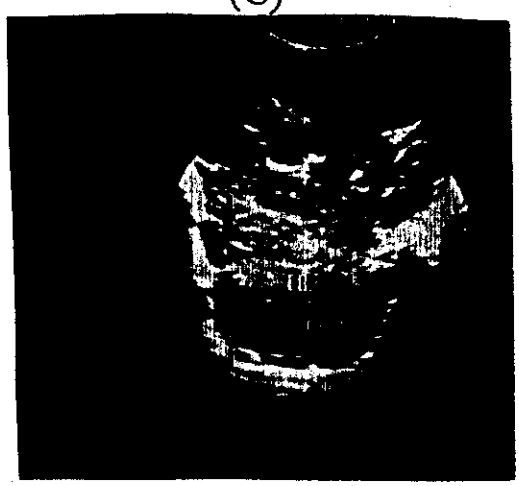

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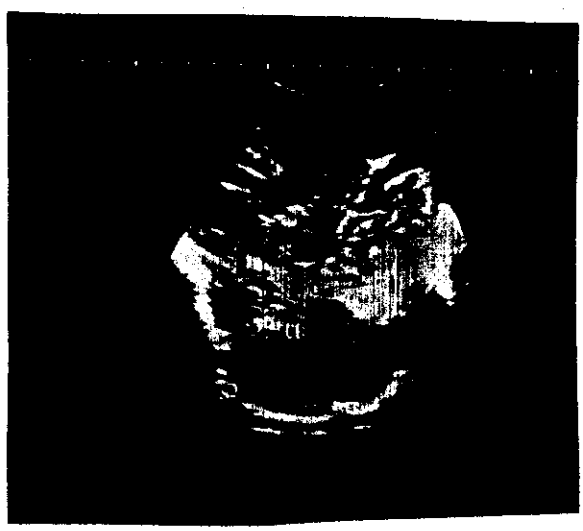


## *Case No. (8):*

Full term newborn infant presented clinically with history of head trauma followed by extracranial head swelling. On examination, there was high parieto-occipital cystic swelling with no palpable bony defects. Provisional clinical diagnosis was cephalhematoma.

**Plain x-ray of the skull in lateral view (Fig. 8-A) revealed :**

Extracranial soft tissue swelling with no bony defects.

**Cranial sonography (Fig. 8-B & C) :**

Showed echo-free collection between elevated periosteum and intact skull bones. Intracranial contents were normal.

**Diagnosis :**

Cephalhematoma.

*Fig. (8):*

(A)

(B)

(C)

## *Case No. (9):*

An infant, one month age clinically presented with extra-cranial head swelling. On examination, this swelling was cystic in mid-line occipital region with palpable underlying bony defect.

**Plain x-ray of skull in lateral view (Fig. 9-A):**

Confirmed the occipital bony defect with overlying soft tissue swelling.

**Cranial sonography (Fig. 9-B & C) :**

Showed turbid cystic contents of the occipital swelling. The bony defect could not be detected sonographically and intracranial contents were normal.

**CT examination of the skull (Fig. 9-D) revealed :**

The occipital bony defect with cystic contents of the swelling and normal intracranial structures.

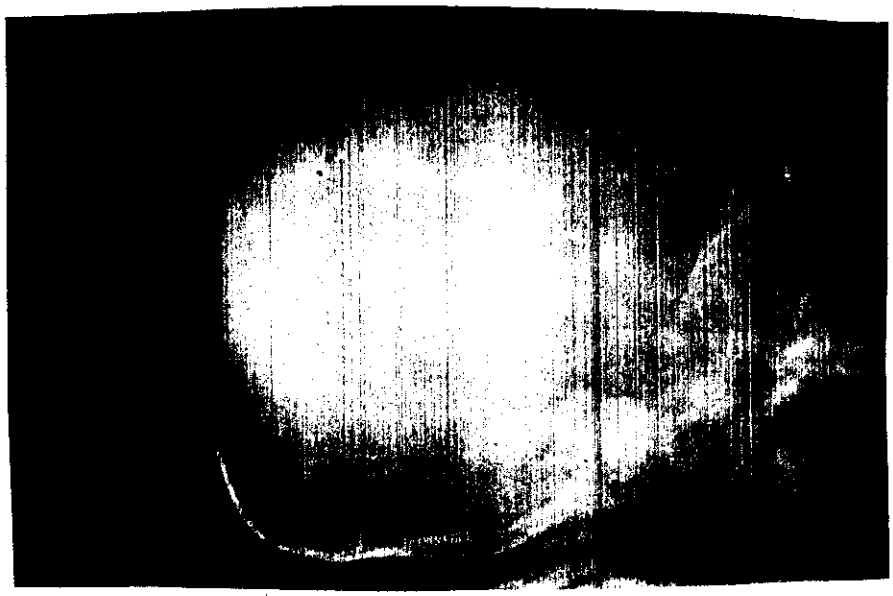
**Excision biopsy** revealed Dermoid cyst.

**Diagnosis :**

Occipital Dermoid cyst.

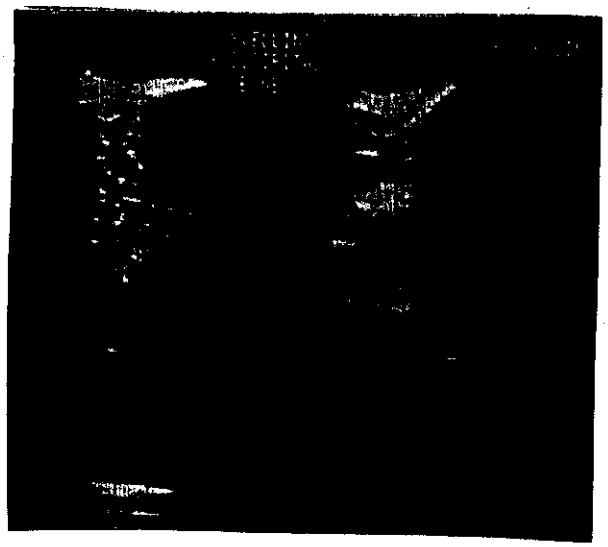
*Fig. (9):*

(A)



(B)

(C)



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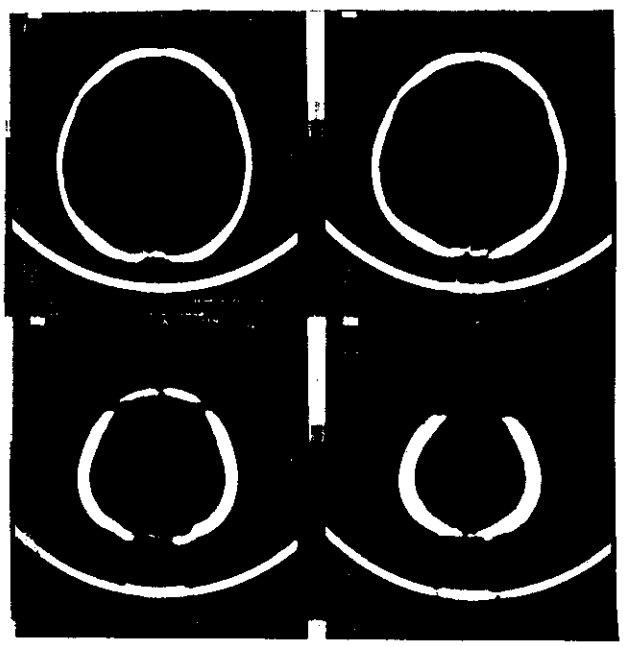


## *Case No. (10):*

Full term infant, 8 months age presented clinically with large head and mental retardation. Provisional clinical diagnosis was hydrocephalus.

**Cranial sonography (Fig. 10-A,B & C) :**

Showed bilateral symmetrical CSF clefts extending from subependyma of temporal horns of lateral ventricles to subarachnoid spaces at cortical bones. There was associated Dandy walker variant seen as retrocerebellar small cyst with hypoplastic vermis and moderate supratentorial ventriculomegaly.

**CT examination of the brain (Fig. 10-D) :**

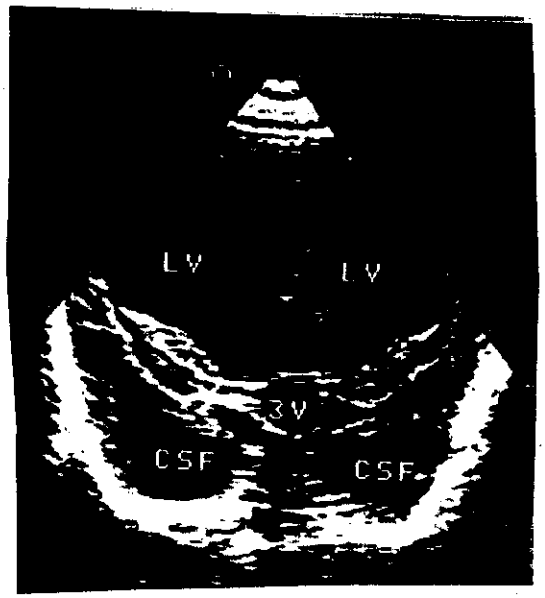
Confirmed sonographic data.

**Diagnosis :**

Schizencephaly with Dandy walker variant.

*Fig. (10):*

(A)

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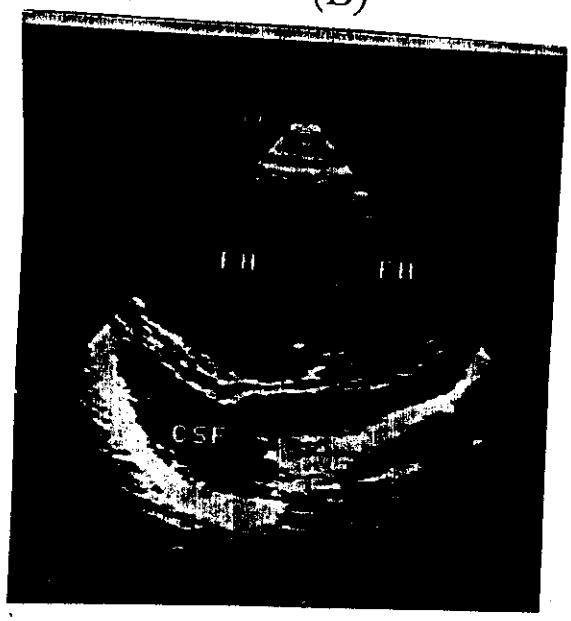


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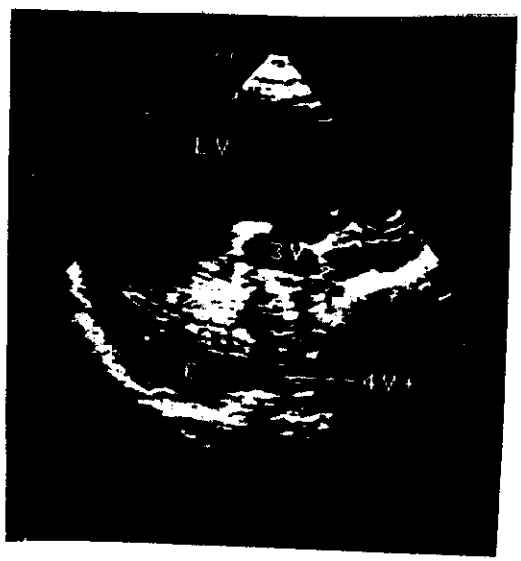


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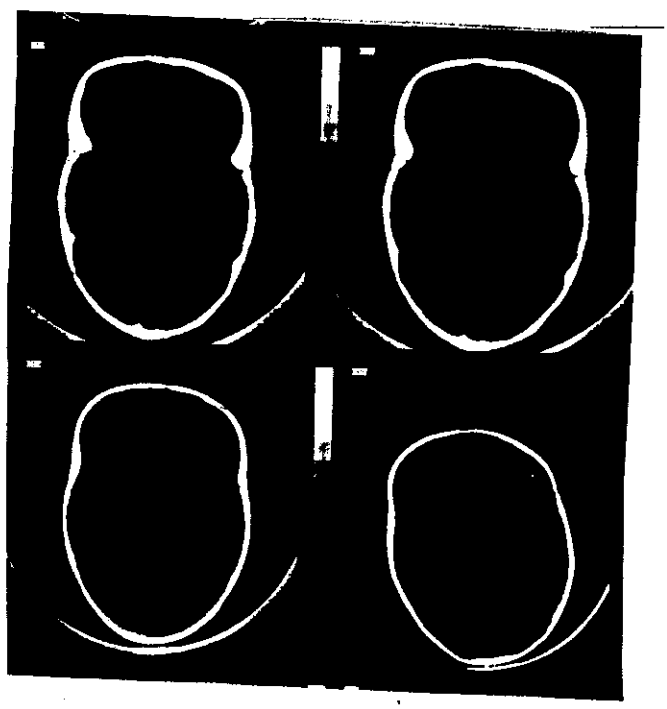


## *Case No. (11):*

An infant, 12 months age clinically presented with symptoms and signs of increase intracranial tension (large head, convulsions, projectile vomiting ...etc). There was past history of meningitis 2 months ago. Provisional clinical diagnosis was post-meningitis hydrocephalus.

**Plain x-ray of skull in PA view (Fig. 11-A) :**

Showed macrocephaly with suture diastasis.

**Cranial sonography (Fig. 11-B & C) :**

Showed symmetrical moderate dilatation of whole ventricles with no mid-line shift.

CCVW = 33 mm.

CM = 35 mm.

**Cranial Doppler study of MCA through anterior fontanelle (Fig. 11-D) reveald :**

Maximum systolic velocity = 80 m/s.

Minimum diastolic velocity = 8.8 m/s.

RI = 89% (elevated).

**CT examination of the brain (Fig. 11-E&F) :**

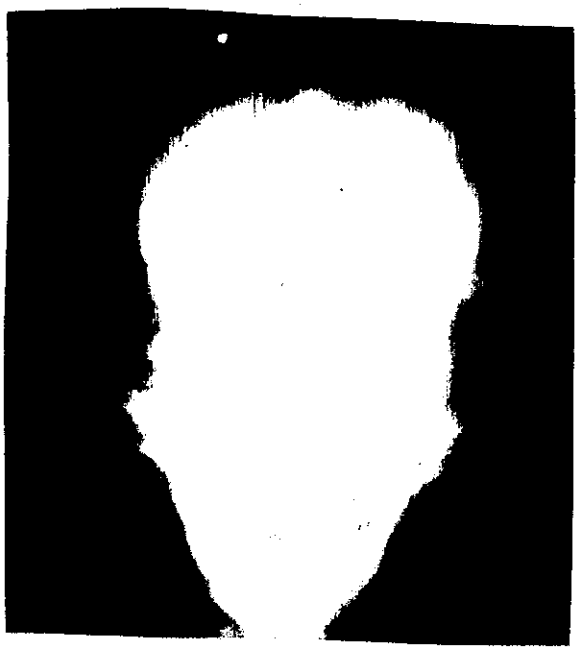
Confirmed sonographic data.

**Diagnosis :**

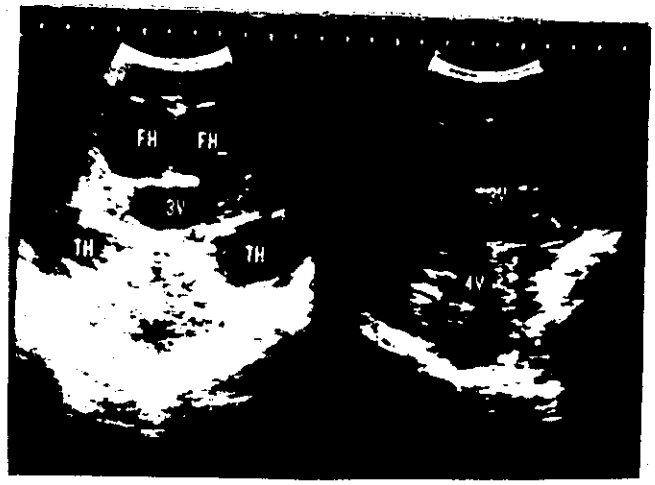
Post-meningitic EVOH.

*Fig. (11):*

(A)

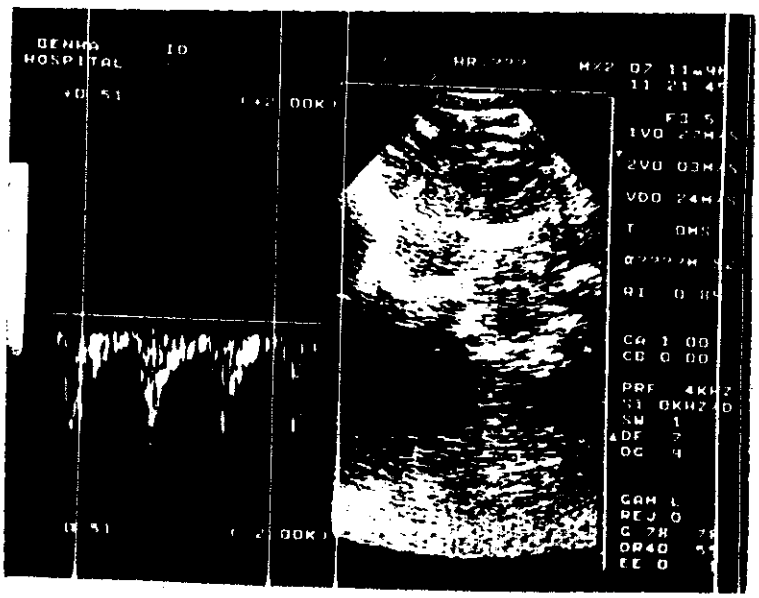


(B)




(C)


(D)



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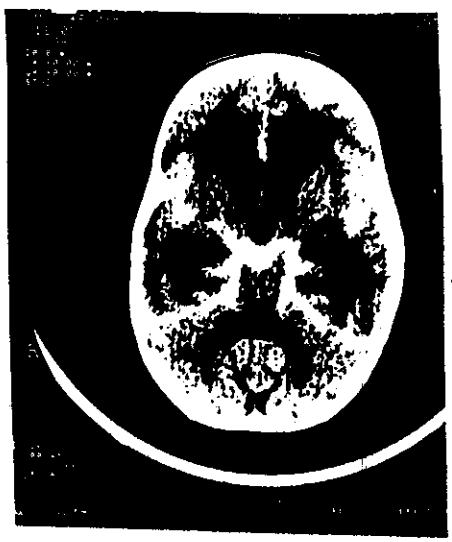
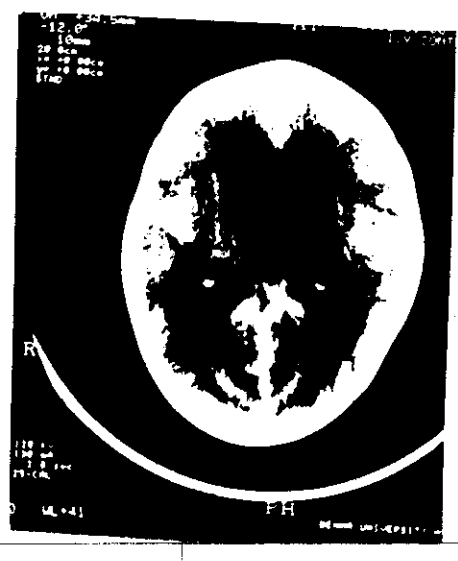


(F)



## *Case No. (12):*

A preterm newborn infant (34 wks gestaginal age and 2100 gm birth wt) considered as high risk infant with no abnormal clinical findings.

**Cranial sonography (Fig. 12-A, B & C) :**

Showed mild dilatation of whole ventricles with no mid-line shift.

No intracranial hemorrhage or PVL.

CCVW = 22 mm.

CM = 46 mm.

**Cranial Doppler study of ACA (Fig. (12-D) revealed :**

Maximum systolic velocity = 68 m/s.

Minimum diastolic velocity = 21 m/s.

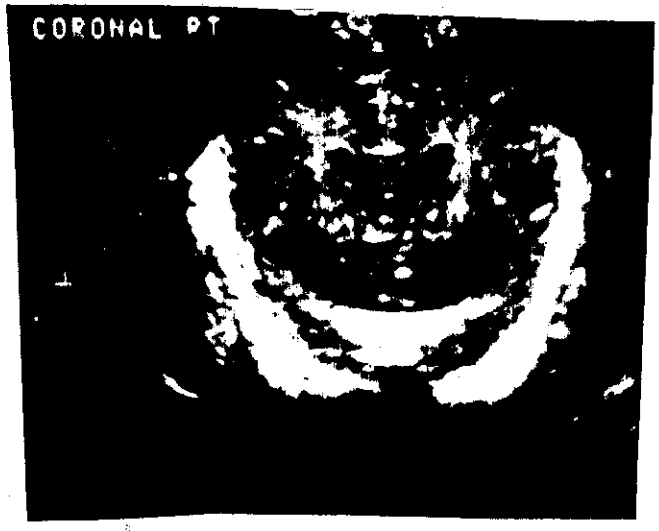
RI = 69% (normal).

**Diagnosis :**

Mild EVOH with normal RI value.

*Fig. (12):*

(A)

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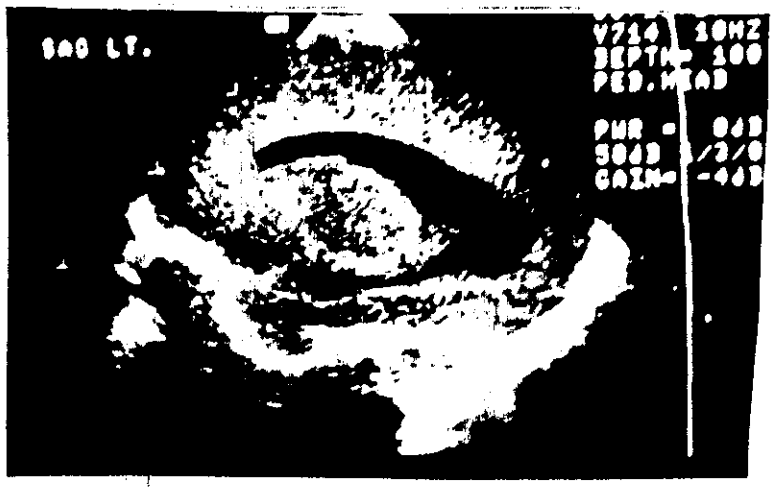
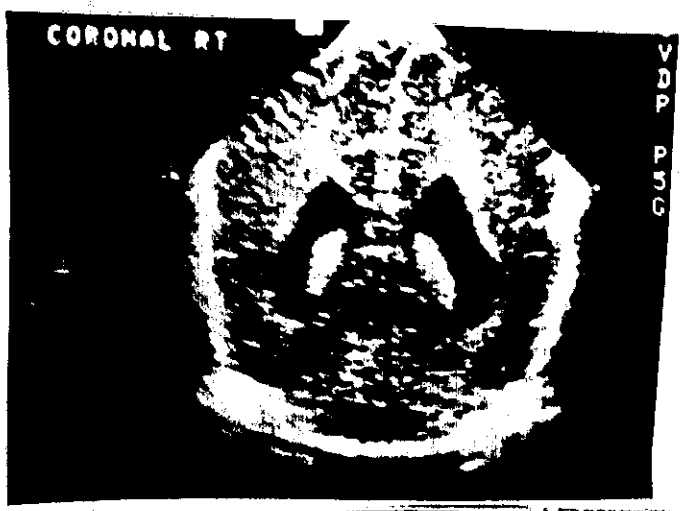
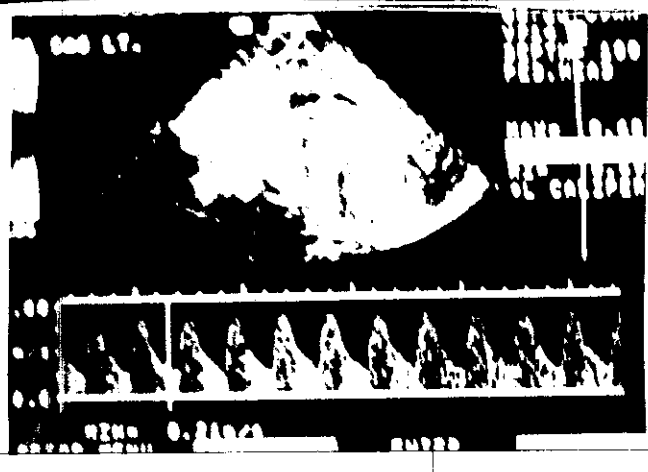



(C)




(D)



*Case No. (13):*

An infant, 2 months age presented clinically with symptoms and signs of increase intracranial tension in the form of macrocephaly, persistant vomiting, bulging tense fontanelles and repeated attacks of convulsions. Provisional clinical diagnosis was hydrocephalus.

**Plain x-ray of the skull in lateral view (Fig. 13-A) revealed :**

Evidence of increased intracranial tension in the form of suture diastasis, macrocephaly and bulging fontanelles.

**Cranial sonography in coronal and sagittal planes through anterior fontanelle (Fig. 13-B & C) :**

Moderate symmetrical supratentorial ventriculomegaly with normal fourth ventricle size and position.

CCVW = 38 mm.

CM = 27 mm.

**Cranial Doppler study of MCA (Fig. 13-D):**

Maximum systolic velocity = 93 m/s.

Minimum diastolic velocity = 8.3 m/s.

RI = 91% (elevated).

**CT brain examination (Fig. 13-E) :**

Confirmed sonographic data.

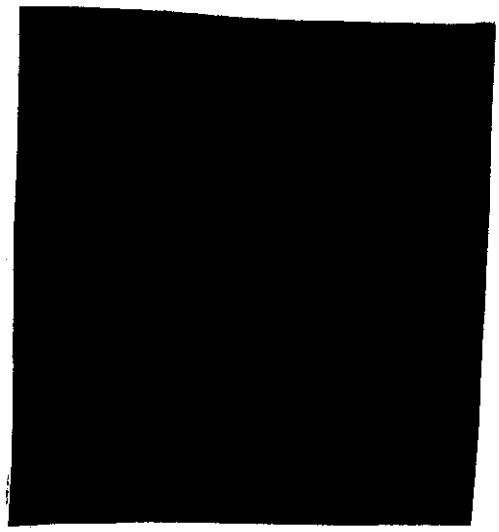
**Diagnosis :**

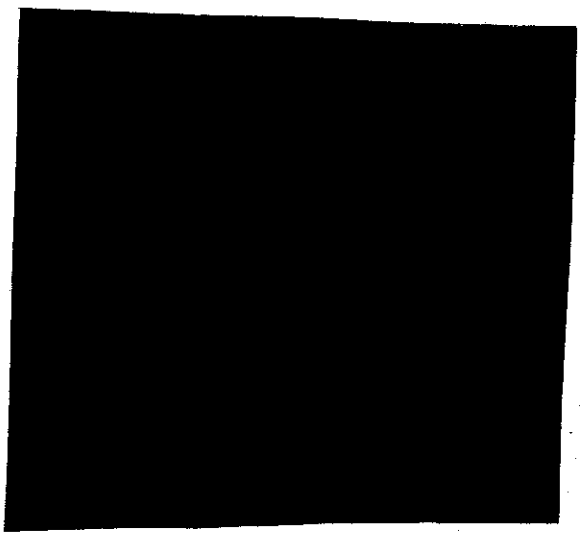
IVOH (Aqueduct stenosis).

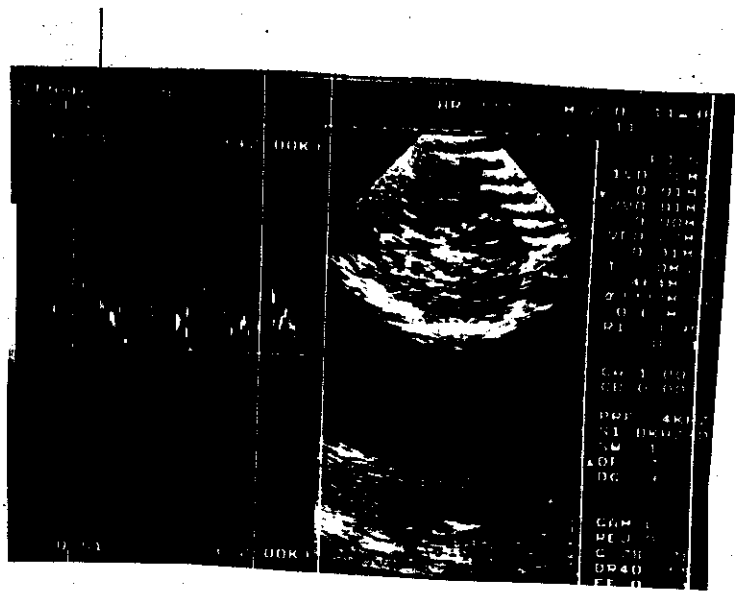
*Fig. (13):*

(A)

(B)







(E)

*Case No. (14):*

An infant, 9 months age previously diagnosed as aqueduct stenosis and ventriculo-peritoneal shunt was performed 2 months ago. This case was referred to assess shunt tube function.

**Plain x-ray of the skull, chest and abdomen in AP views (Fig. 14-A) revealed :**

No disconnection of the ventriculo-peritoneal shunt throughout its course.

**Cranial sonography (Fig. 14-B, C & D) revealed :**

Marked supratentorial ventriculomegaly with normal size and position of fourth ventricle. The proximal end of the shunt tube was seen in the Rt lateral ventricle adherent to choroid plexus.

**CT examination of the brain (Fig. 14-E, F & G) :**

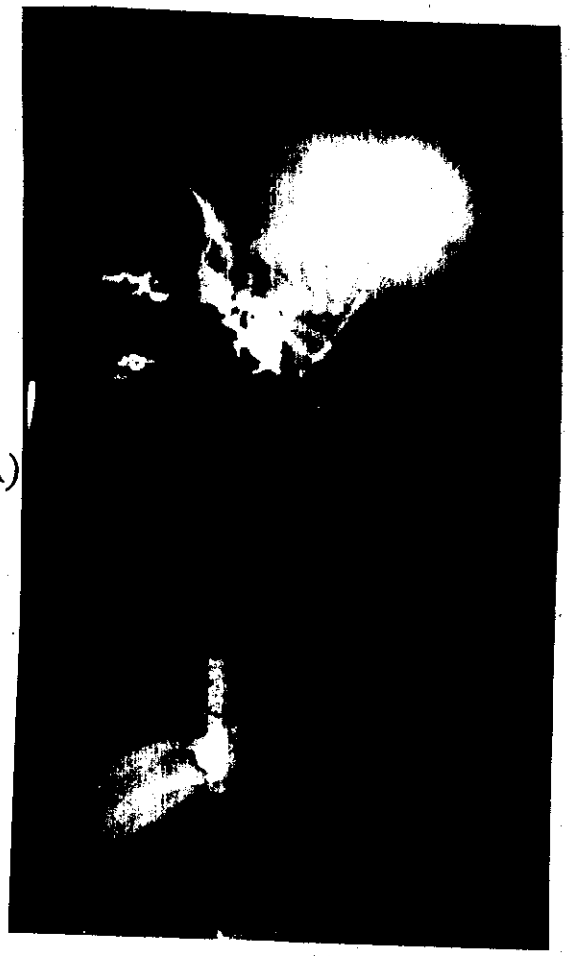
Confirmed sonographic data.

**Diagnosis :**

* Supratentoreal obstructive hydrocephalus (aqueductal stenosis).
* Malfunctioning shunt, likely due to obstruction of the proximal end by the adherent chrorid plexus.

*Fig. (14):*

(A)



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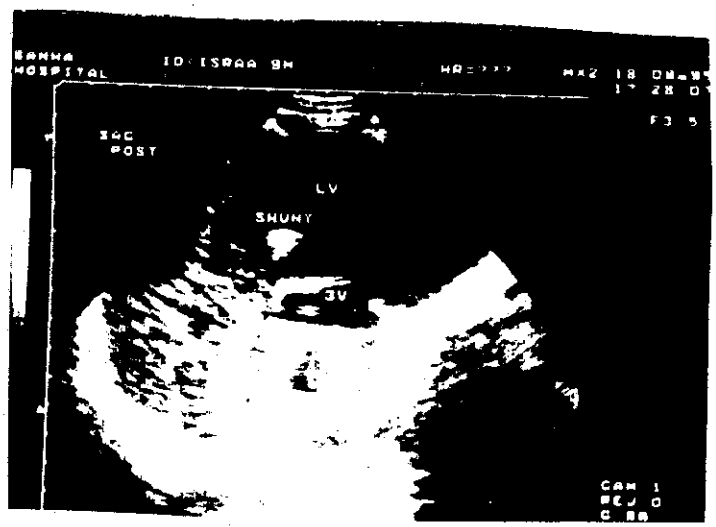


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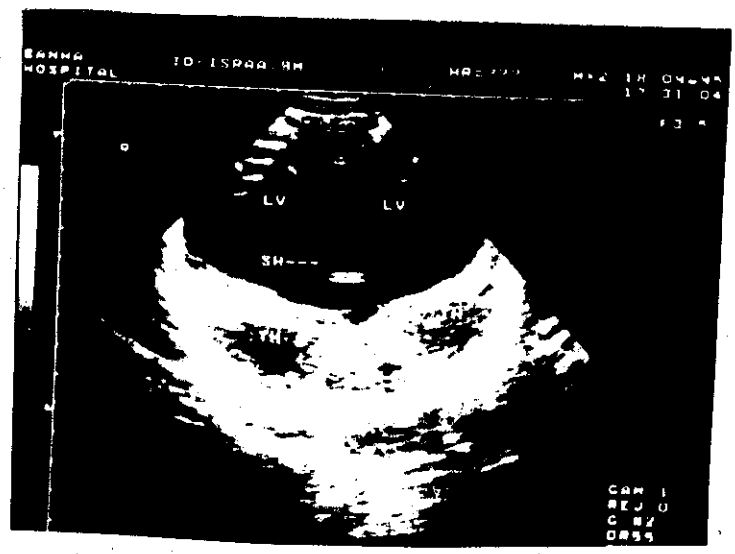


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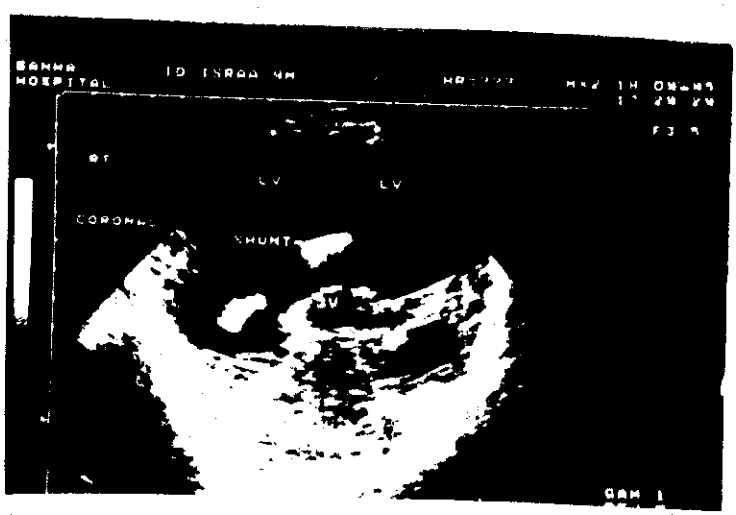
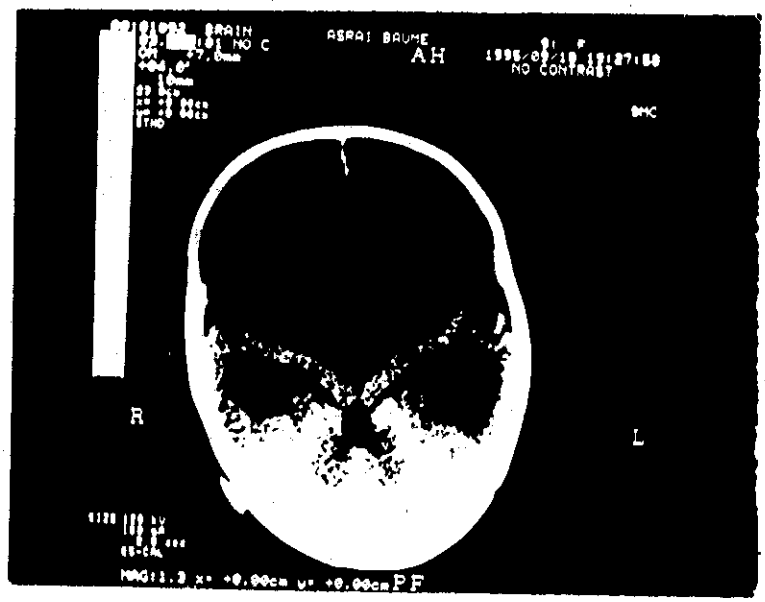
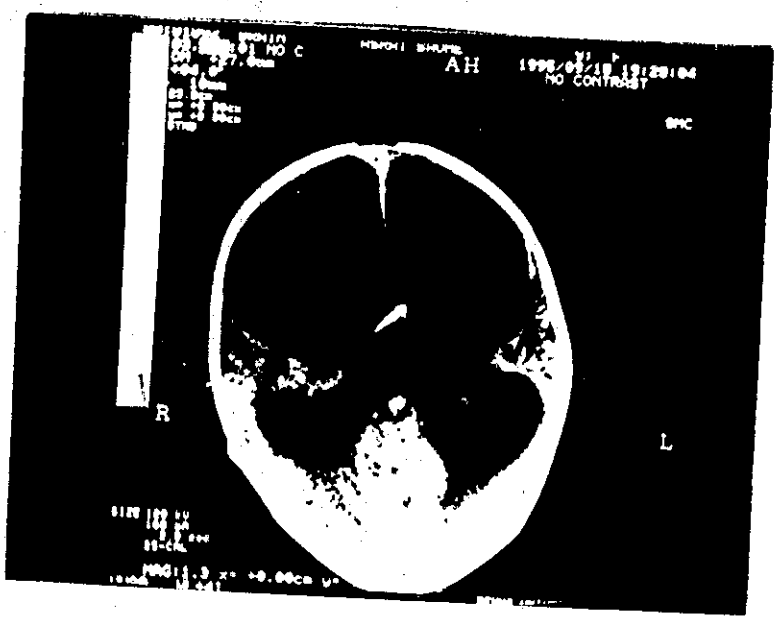


Fig.(14)

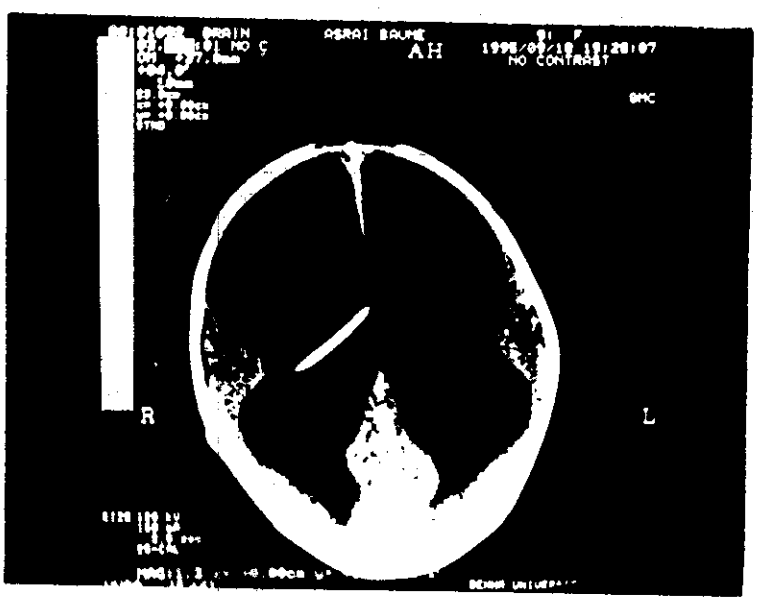
(E)


ASRAI BAUME
AH
NO CONTRAST
R
L

(F)


AH
NO CONTRAST
R
L

(G)


ASRAI BAUME
AH
NO CONTRAST
R
L

## *Case No. (15):*

A full term, 9 months age infant was done ventriculo-peritoneal shunt operation 3 months ago presented for follow up after shunt operation.

**Cranial sonography (Fig. 15-A & B) revealed :**

Bilateral extra-axial fluid collection of turbid nature and fluid/ fluid level and collapsed attenuated ventricles except left temporal horn and third ventricle.

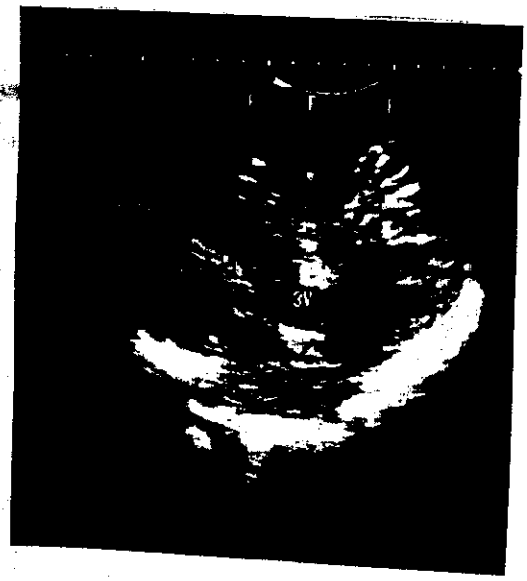
**CT brain examination (Fig. 15-C) :**

Confirmed sonographic data and diagnosis of subdural empyema and SVS was made.

**N.B.** : This patient referred to do tapping from anterior fontanelle followed by left subtemporal craniectomy.

*Fig. (15):*

(A)



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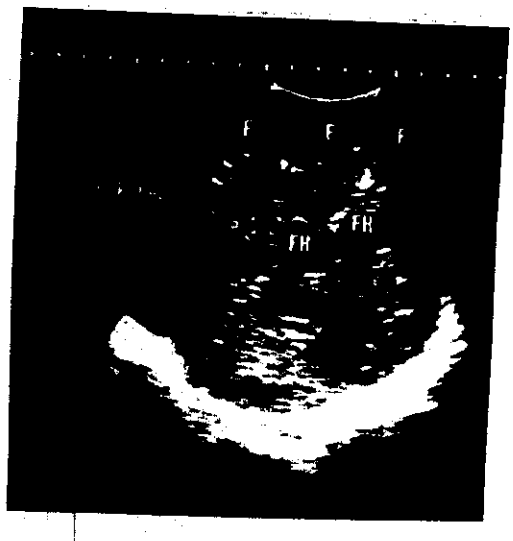

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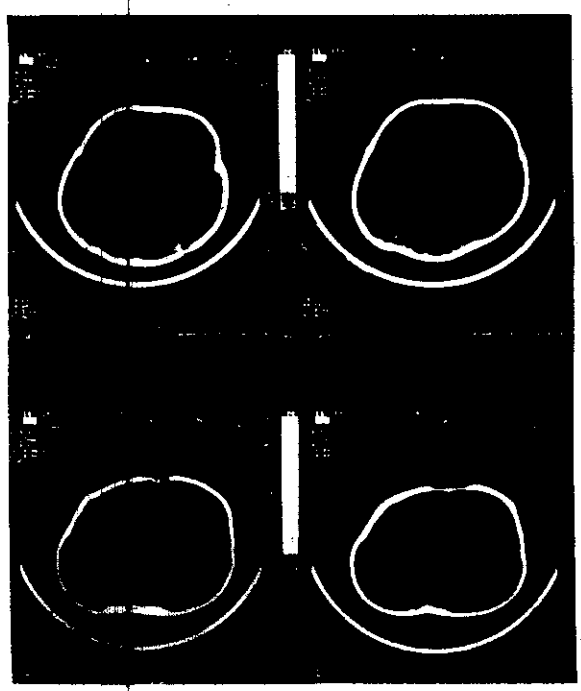


## *Case No. (16):*

A full term infant, 2 months age presented clinically with symptoms and signs of increase intracranial tension.

**Cranial sonography (Fig. 16-A & B) :**

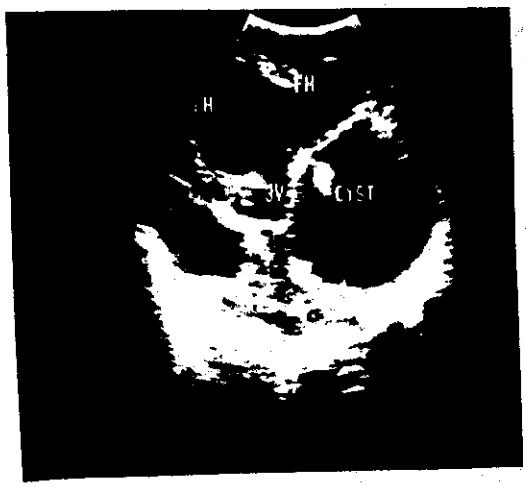
Showed extra-axial CSF cystic lesion at Rt tempro-parietal region with moderate supratentorial ventriculomegaly and mid-line shift to the left by mass effect of this cystic lesion.

**Pre & post-contrast CT brain examination (Fig. 16-C & D) :**

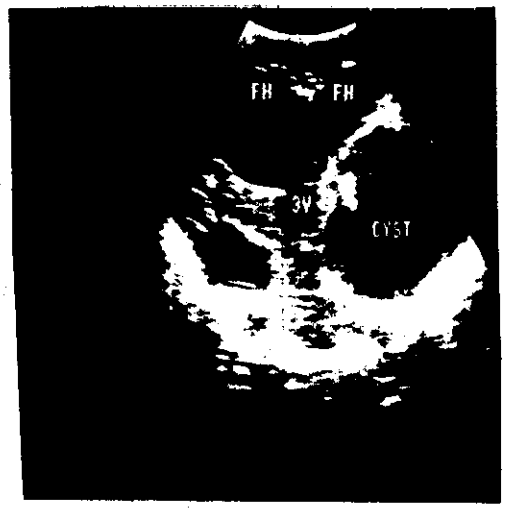
Confirmed diagnosis of Rt. tempro-parietal arachnoid cyst with IVOH, likely due to aqueductal compression.

*Fig. (16):*

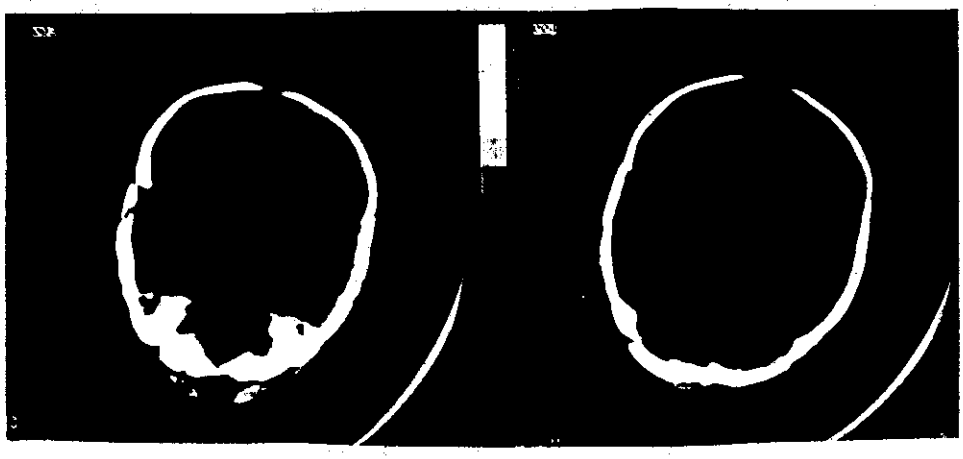
(A)



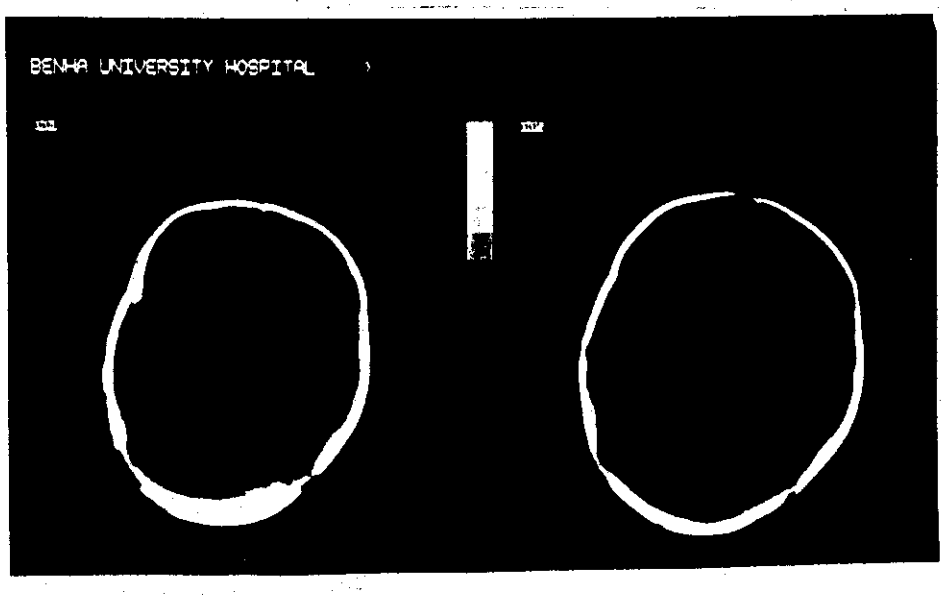

(B)




(C)



(D)



## *Case No. (17):*

7 months infant presented clinically with fever, mental retardation and irritability. Provisional clinical diagnosis was meningo-encephalitis.

**Cranial sonography (Fig. 17-A, B & C) showed :**

Multiple intra-axial non-communicated porencephalic cystic lesions at Rt frontal lobe associated with supratentorial ventriculomegaly.

**Pre & post-contrast CT brain examination (Fig. 17-D) :**

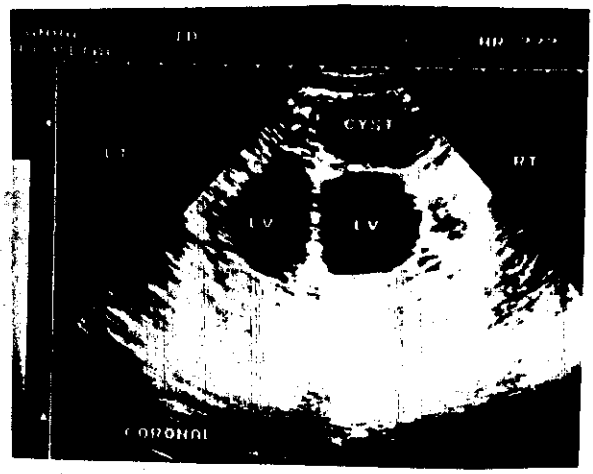
Confirmed sonographic findings and added cortical atrophic changes and superior sagittal sinus thrombosis (+ve Delta sign).

**Diagnosis :**

Multiple non-communicated Rt frontal porencephalic cysts with cerebral atrophy and superior sagittal sinus thrombosis.

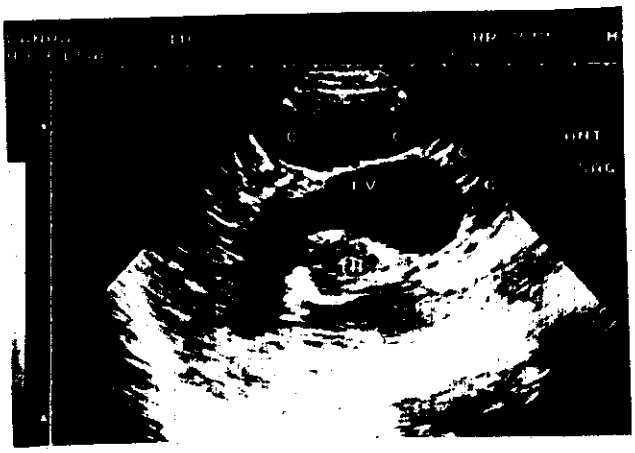
*Fig. (17):*

(A)




(B)

(C)

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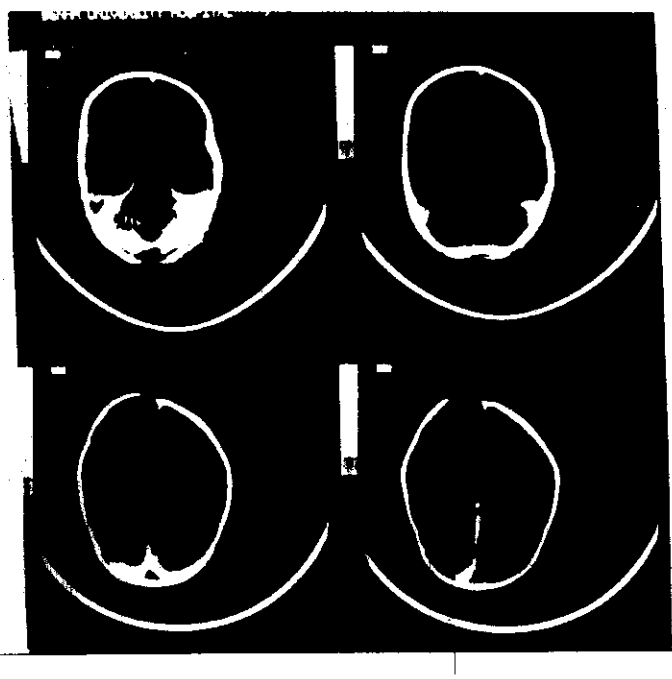


*Case No. (18):*

12 months infant presented clinically with fever and repeated attacks of convulsions.

**Cranial sonography in coronal, sagittal and axial planes through anterior fontanelle and temporal bone (Fig. 18- A,B & C) :**

Showed thick echogenic walled cystic lesion of turbid fluid contents seen in the Rt tempro-parietal region with compression of Rt lateral frontal horn and minimal mid-line shift to the left.

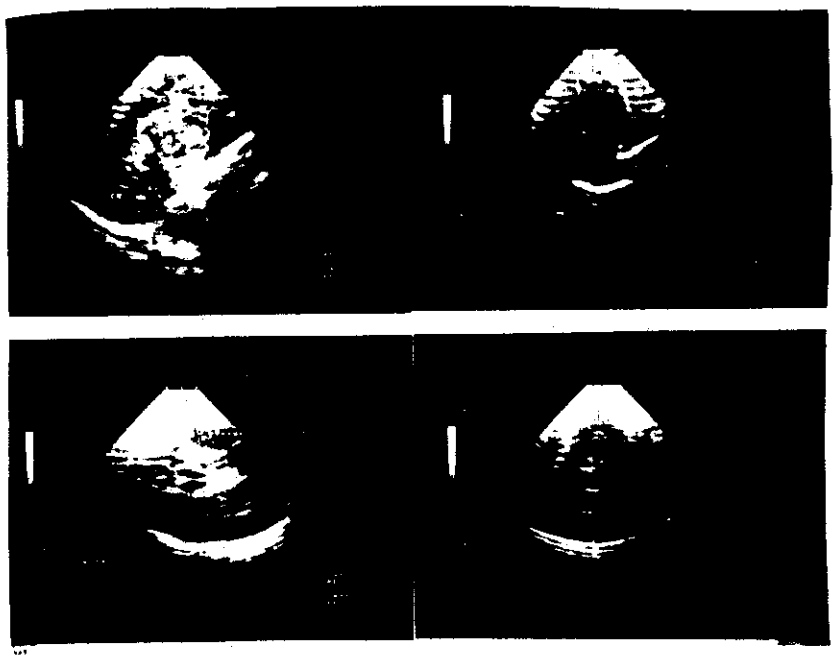
**Post-contrast CT brain (Fig. 18-D):**

Showed marginally enhancing regular walled lesion with perifocal oedema.

**Diagnosis :**

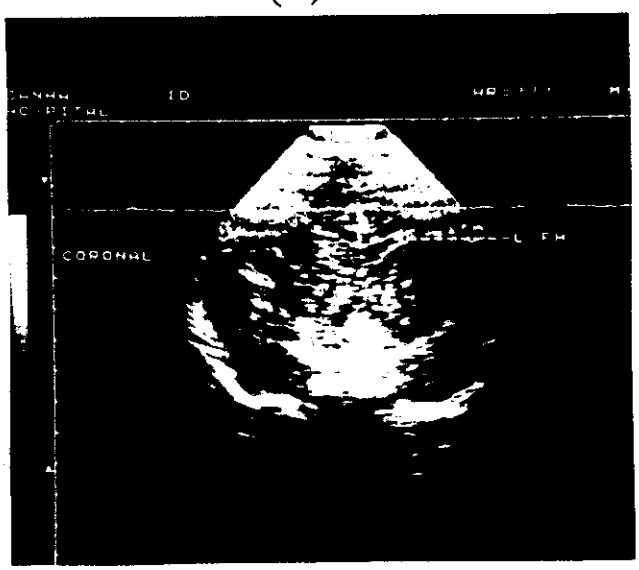
Brain abscess.

Fig. *(18)*:

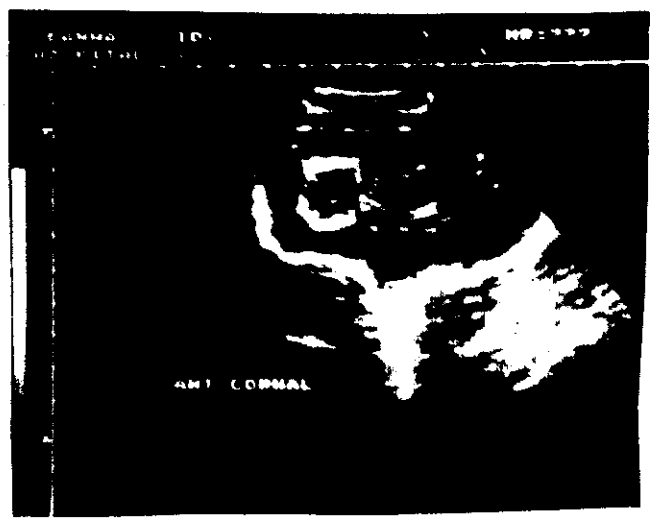


(A)

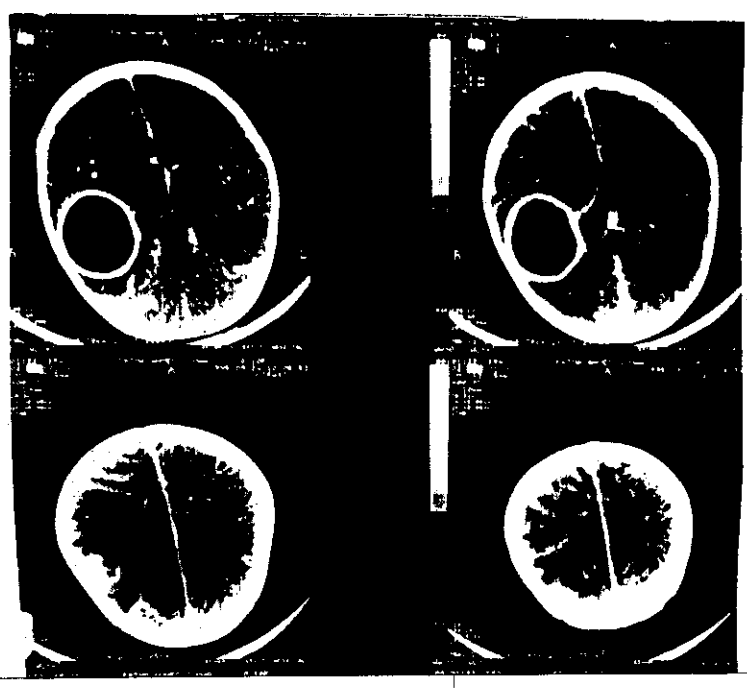
(B)




(C)




(D)



## *Case No. (19):*

One month full term infant clinically presented with fever, repeated attacks of convulsions, signs of increase intracranial tension and lack of suckling.

**Cranial sonography (Fig. 19-A & B) :**

Showed diffuse increase of brain echogenicity with prominent echogenic cortical sulci and thick echogenic interhemispheric fissure and sylvian fissure.

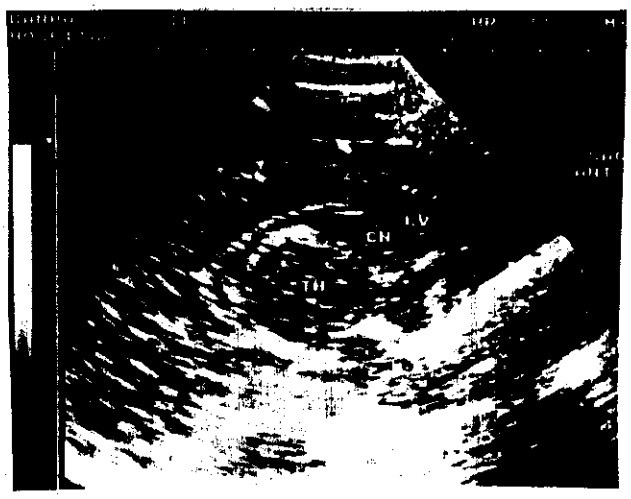
**Post-contrast CT brain (Fig. 19-C):**

Showed meningeal enhancement after contrast and added minimal subdural fluid collection.

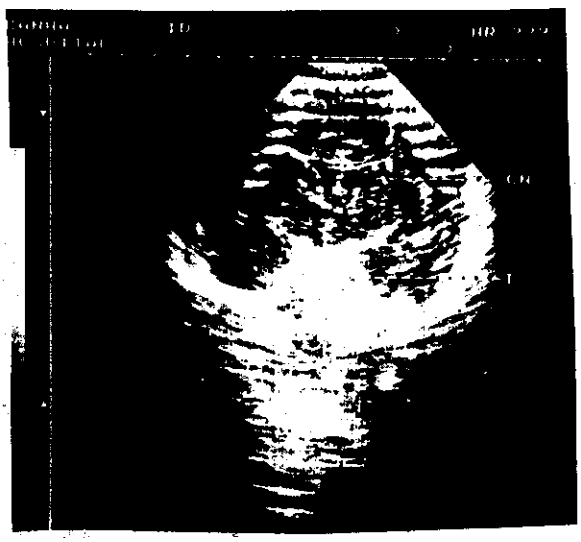
**N.B.** : Lumbar puncture was done to examine CSF and diagnosis of meningitis was confirmed.

*Fig. (19):*

(A)




(B)

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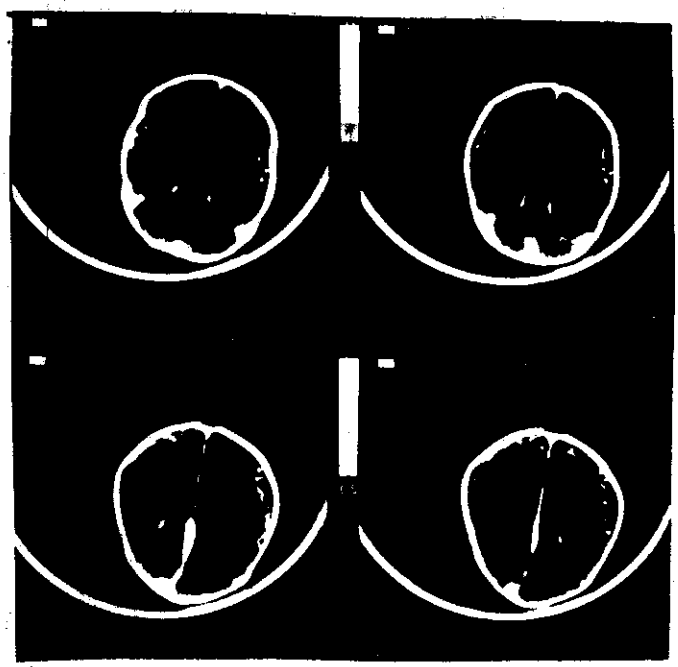


## *Case No. (20):*

Five months old infant presented clinically with delayed milestone development, fever and convulsions.

**Cranial sonography (Fig. 20-A & B) revealed :**

Moderate supratentorial ventriculomegaly, widening of IHF and prominent cortical sulci. Bilateral basal ganglia and periventricular calcification were also seen.

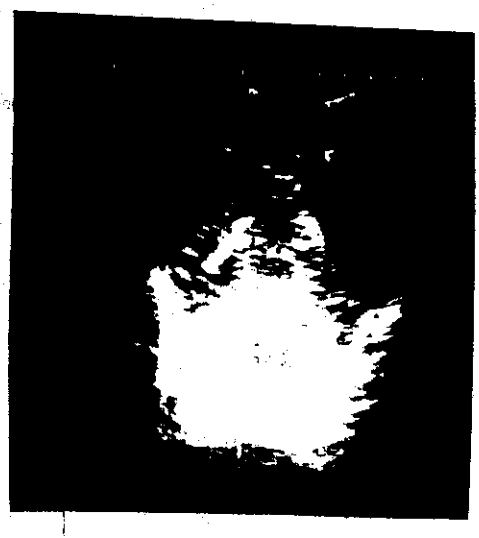
**CT examination of the brain (Fig. 20-C) :**

Confirmed sonographic data and diagnosis of TORCH infection was made.

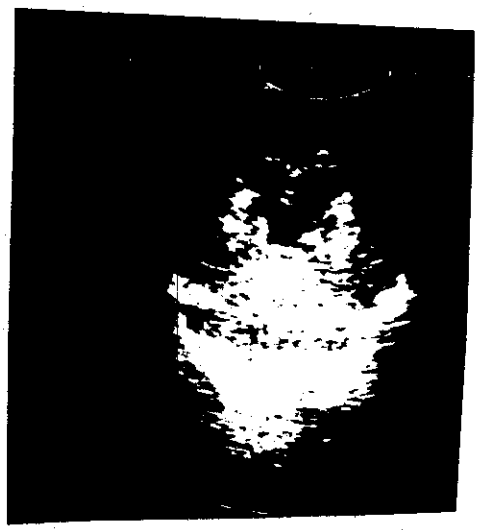
**N.B.** : Serological examination for CMV was positive in this case.

*Fig. (20):*

(A)



(B)



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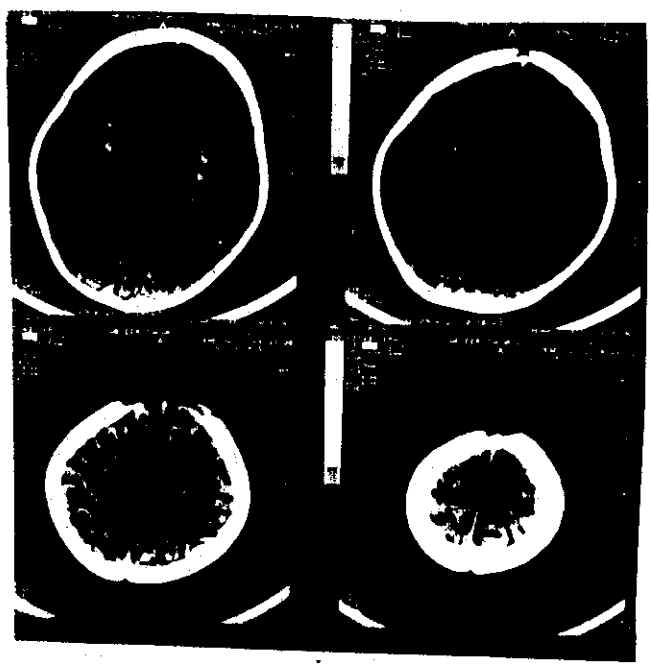


*Case No. (21):*

Premature newborn infant (32 weeks gestaginal age and 1900 gm birth wt) was clinically free and considered as high risk infant.

**Cranial sonography (Fig. 21-A, B & C) showed :**

Small echogenic area in the left thalamo-caudate notch highly impressive of Germinal matrix hermorrhage with no intraventricular extension. No ventriculomegaly or parenchymal hemorrhagic lesions. Diagnosis of grade-I left subependymal hemorrhage was made.

**Cranial Doppler study of the ACA (Fig. 21-D) :**

Maximum systolic velocity = 60 m/s.

Minimum diastolic velocity = 13 m/s.

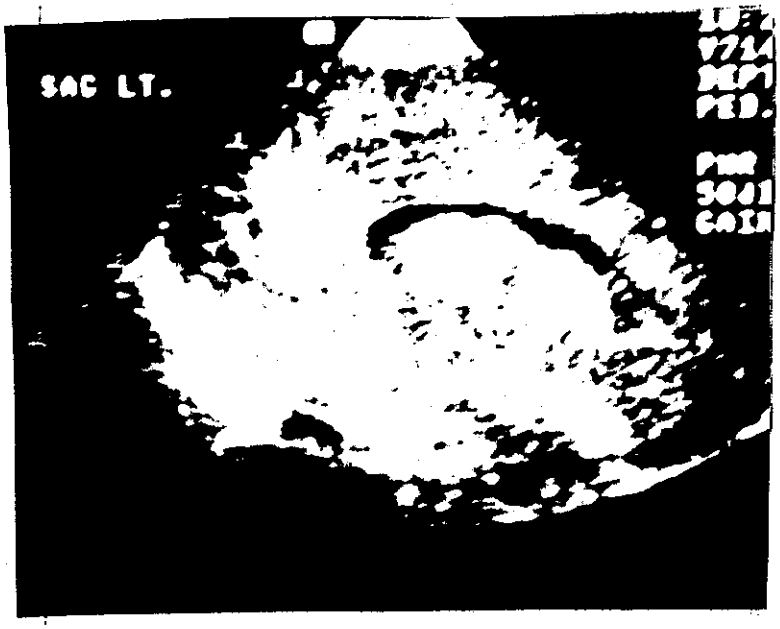
RI = 78% (normal).

**Diagnosis :**

Grade-I SEH.

*Fig. (21):*

(A)

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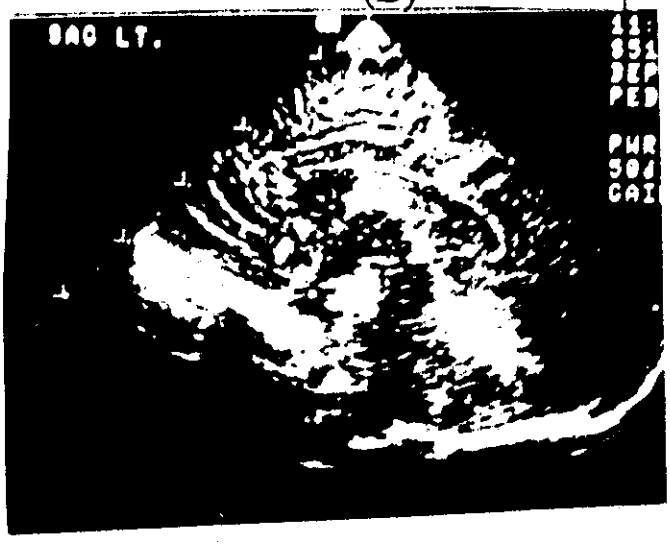


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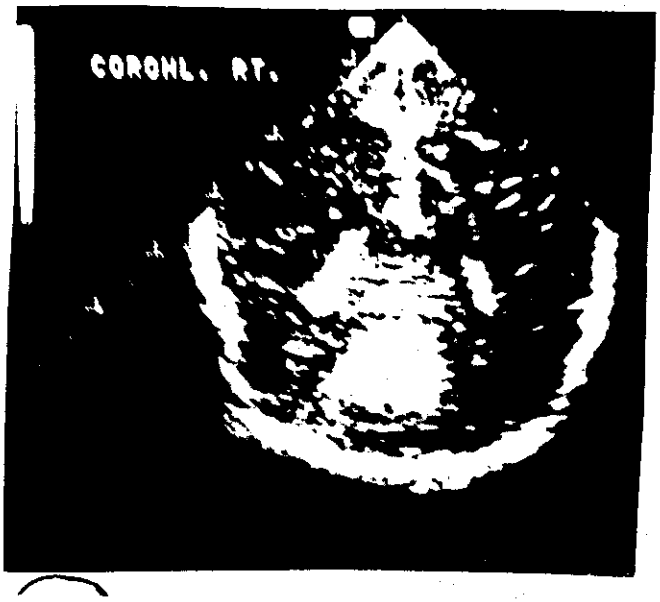
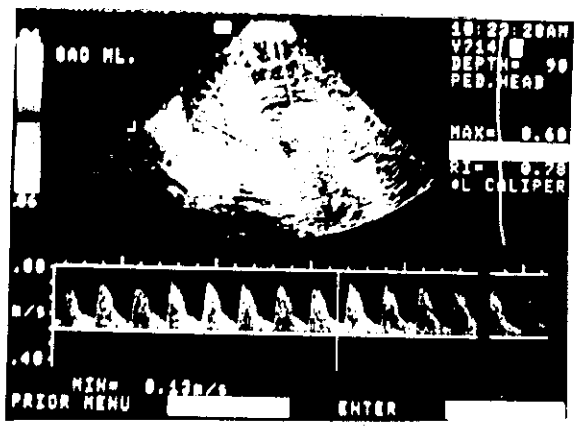



(D)



*Case No. (22):*

A pre-term newborn infant (33 wks gestaginal age - 1800 gm birth wt) was presented at 10 days age by large head, convulsions and considered as high risk infant.

**Cranial sonography (Fig. 22-A, B & C):**

Large germinal matrix echogenic hemorrhagic lesion at Rt thalamo-caudate groove with Rt frontal parenchymal extension, ventriculomegaly and intraventricular bleeding in the form of thick choroid plexus (14 mm) and intraventricular cast. Diagnosis of grade-IV SE-IV hemorrhage was made.

**Cranial Doppler study of MCA (Fig. 22-D) revealed :**

Maximum systolic velocity = 93 m/s.

Minimum diastolic velocity = 8.37 m/s.

RI = 91% (elevated).

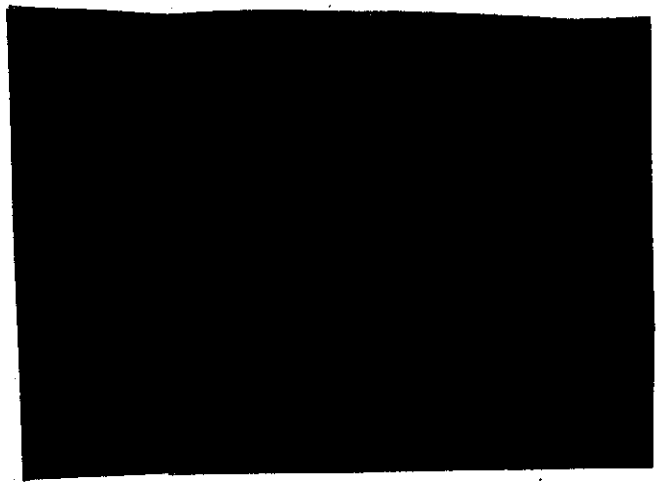
**Diagnosis** :

Grade-IV SE - IV hemorrhage.

*Fig. (22):*

(A)

(B)



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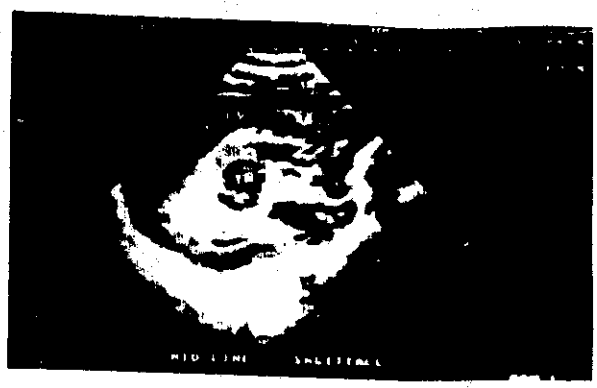

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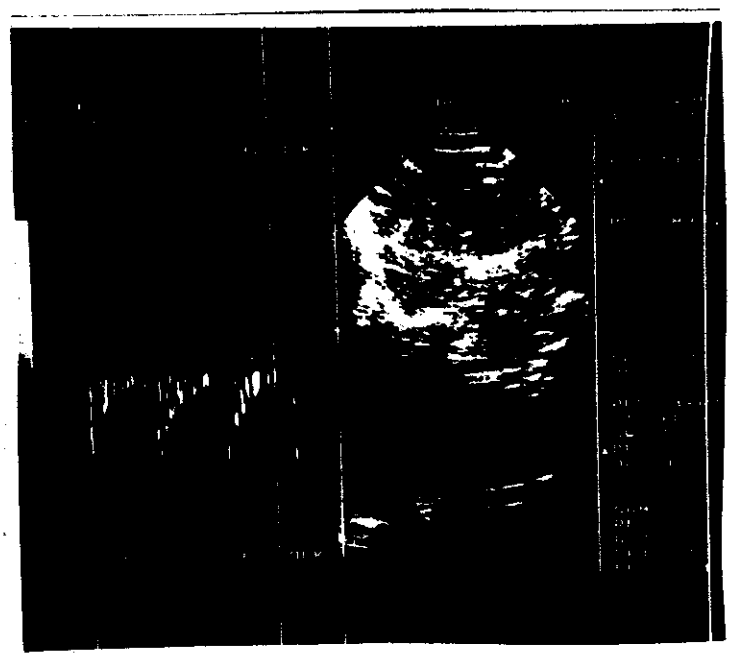


*Case No. (23):*

Full term infant, 3 months age examined after history of head trauma.

**Cranial sonography (Fig. 23-A & B) :**

Showed strongly echogenic area in the left parietal region with effaced left lateral ventricle by mass affect. The left sylvian fissure was thick and echogenic in comparison to the Rt one.

**CT brain examination (Fig. 23-C & D):**

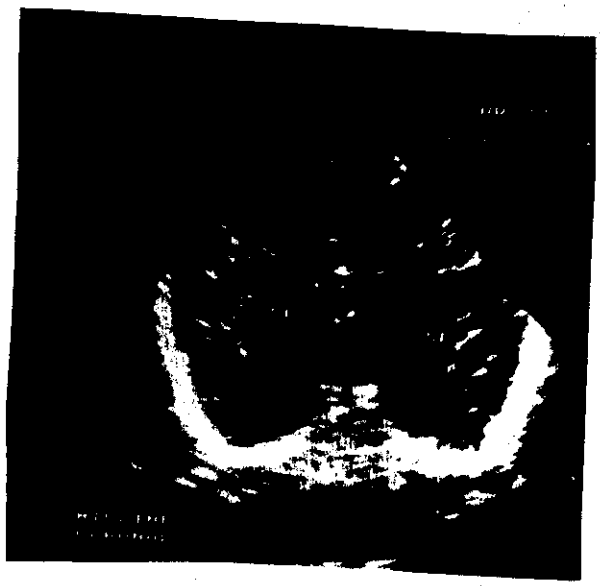
Confirmed the fresh blood density of these lesions.

**Diagnosis :**

Left parietal intraparencephymal hematoma and left subarachnoid smearing.

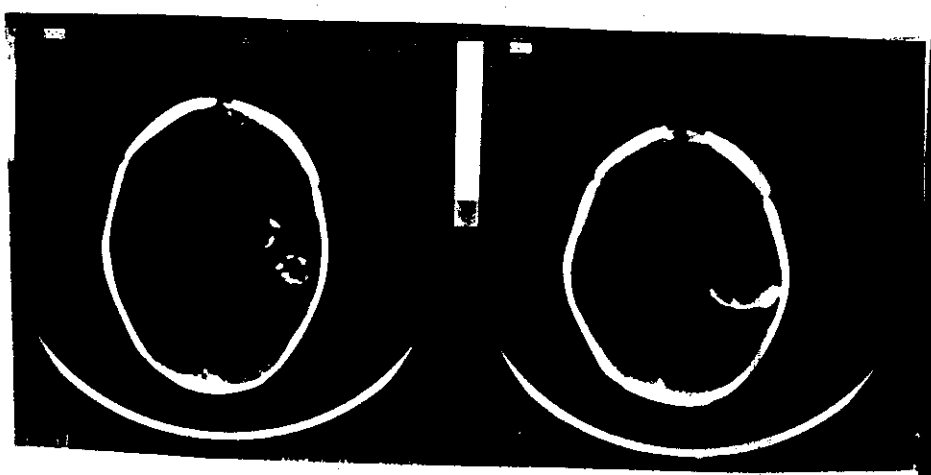
*Fig. (23):*

(A)



(B)

(C)



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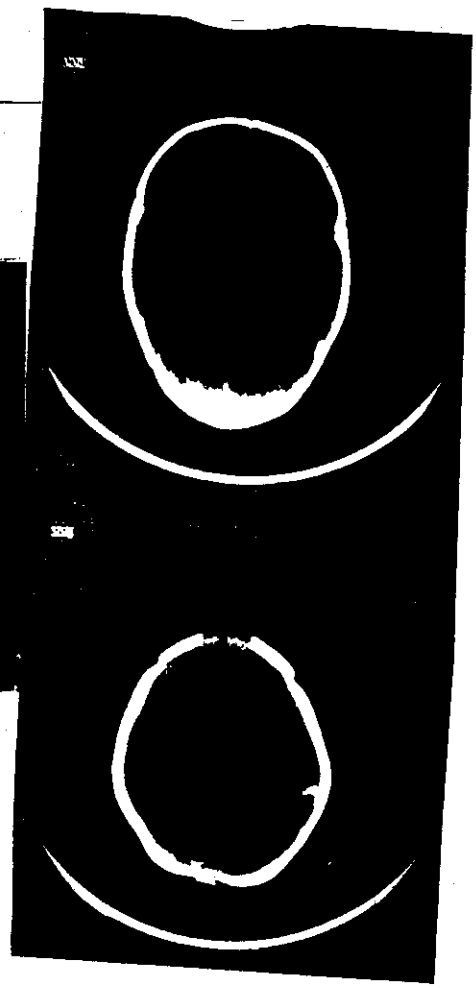


## *Case No. (24):*

Four months infant clinically presented with delayed milestone development, MR and microcephaly. There was past history of birth asphyxia.

**Cranial sonography (Fig. 24-A):**

Showed mild supratentorial ventriculomegaly, widening of IHF and basal subarachnoid spaces.

**Cranial Doppler study of MCA (Fig. 24-B):**

Maximum systolic velocity = 58 m/s.

Minimum diastolic velocity = 15 m/s.

RI = 74% (normal).

**CT brain examination (Fig. 24-C):**

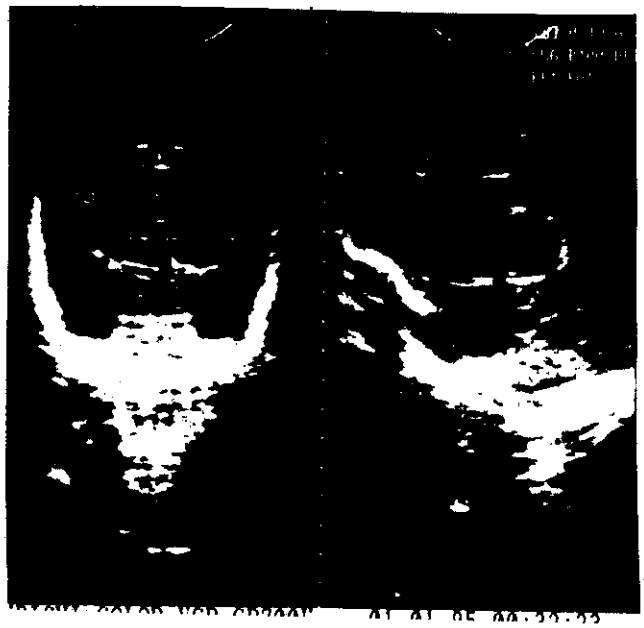
Confirmed sonographic data.

**Diagnosis :**

Cerebral atrophic changes.

*Fig. (24):*

(A)



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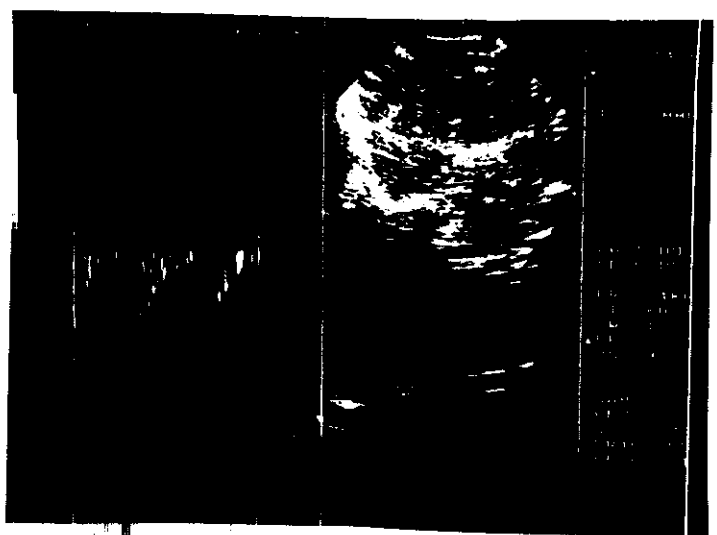
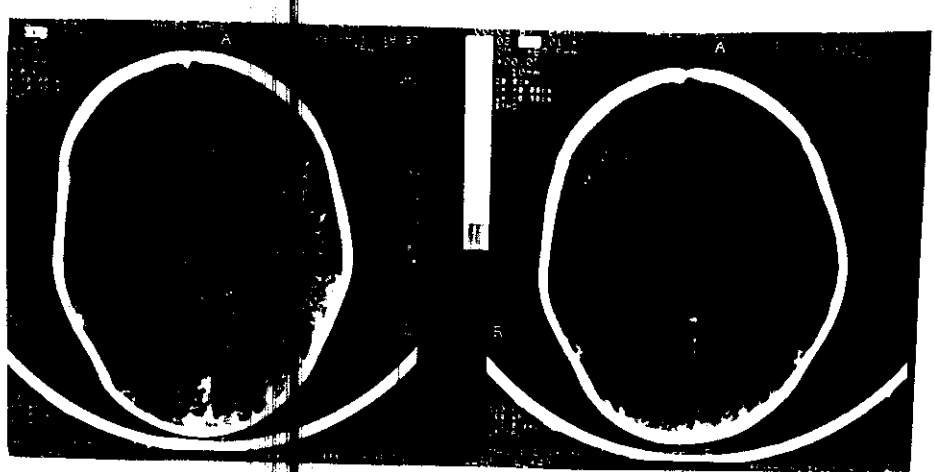


(C)



## *Case No. (25):*

This infant was presented with signs of increase intracranial tension (Macrocephaly and bulging fontanelles) with Rt hemiplegia and Rt facial nerve palsy.

**Cranial sonography (Fig. 25-A, B & C) revealed :**

Left tempro-parietal echogenic intra-axial SOL with central area of cystic changes and mid-line shift to the Rt.

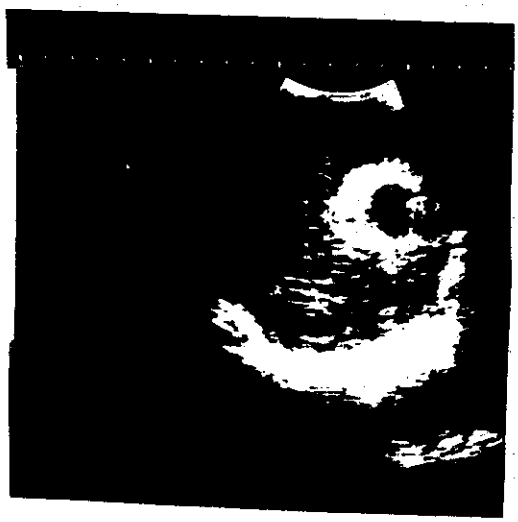
**CT examination of the brain (Fig. 25-D):**

Confirmed sonographic data and showed irregular enhancing thick walled SOL with enhancing nidus within the cystic central component.

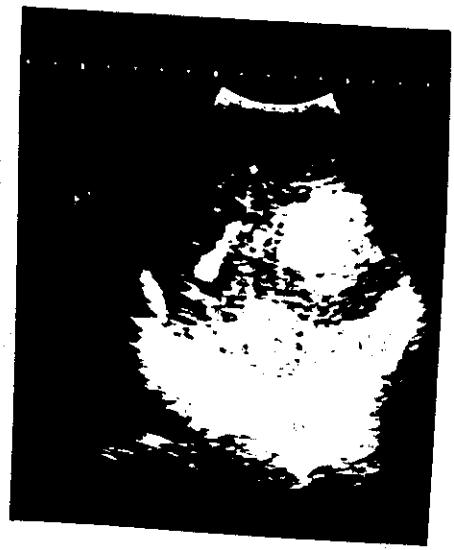
**N.B.** : Post-operative biopsy showed a primitive neuro-ectodermal tumour of infancy.

*Fig. (25):*

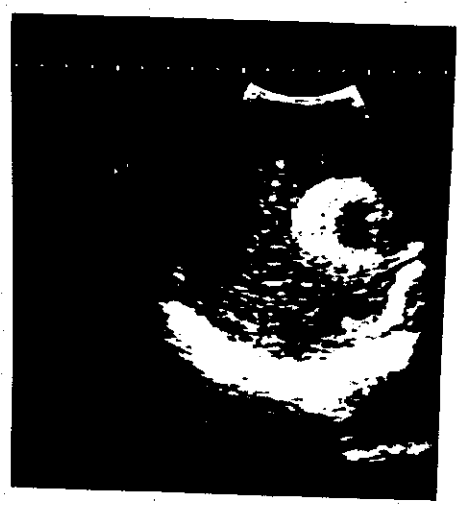
(A)



(B)



(C)



(D)

# DISCUSSION

# DISCUSSION

The newborn infant is susceptible to a wide range of neurological disorders during antenatal, perinatal and postnatal life. The neonatal neurologists in the recent years are interesting in early and accurate diagnosis of intracranial lesions in infancy to save the infant from major neurological and developmental problems. Early detection of congenital brain malformations may help the pediatric neurosurgeon to solve the problem and maintain good mental development of the infant. Many acquired lesions may affect the infant's brain. Intracranial vascular lesions and infections may lead to severe neurological damage. Early diagnosis and proper management are the only way to prevent bad neurological outcome of the infant.

***Barnes, 1992,*** stated that, neonatal brain imaging has become a very exciting field with the introduction of high resolution tomographic imaging in the past 10 years. Cranial sonography, computed tomography and magnetic resonance imaging can readily detect gross anatomic abnormalities in the brain and we referred to as "anatomic imaging". Positron emission tomography and single photon emission computed tomography are capable of detecting functional disturbances in the brain and are referred to as "functional imaging".

Cranial sonography has reached a level of maturity that allows the technique to be the first screening examination necessary to evaluate intracranial lesions in infancy. Ultrasound becomes a competitive tool to the other anatomic imaging modalities in their pediatric neuroradiological applications. Ultrasound has the advantage of its portability which allows the examination to be performed at the bedside in the critically ill infants and premature newborns. Ultrasound is also less expensive and requires no sedation with no radiation hazards ***(Hagen-Ansert, 1995).***

In this work we aimed at showing the versatility of ultrasound in the investigation of intracranial pathology in infancy. The brains of 65 infants were included in this study. All cases were examined by real time cranial sonography. There was no need for sedation before the examination because the transducer can be held on the fontanelle so that it moves with the head and thus movement of the infant does not interfere with the formation of the image. Feeding of the infant half an hour before the examination was advised so that the baby will not cry from hunger.

***Babcock & Han (1981)*** started to use the anterior fontanelle as an acoustic window to the brain. The anterior fontanelle is the largest natural bone free window in the skull. ***Levene et al. (1985)*** used high frequency sector transducers to obtain higher quality images. They reported that, frequencies in the range of 5 : 7.5 MHz are the most useful for imaging the infant brain. They also

recommended that, older infants with closing fontanelle may require 3.5 MHz probes for adequate penteration. ***Hagen-Ansert (1995)*** Described the standard coronal, sagittal, para-sagittal and axial planes for imaging the infant's brain through anterior fontanelle and tempro-parietal bone of the skull.

In this study we followed the technique and standard planes described by ***Levene et al. (1985) and Hagen-Ansert (1995)*** using 3.5 : 5 MHz real time sector probes through the anterior fontanelle to obtain coronal, sagittal and para-sagittal images of the infant's brain. Linear or convex probes of 5 MHz were used to obtain axial images by placing the probe laterally on the scalp parallel to the cantho-meatal line.

***Fischer et al. (1985)*** used lateral ventricular ratio (LVR), combined coronal ventricular width (CCVW) and cerebral mantle thickness (CM) to assess degree of hydrocephalic infants. In this work, following of these measurements were done in (38) cases to detect degree of hydrocephalus.

**The different pathological lesions found in our study will be classified and discussed according to our results in the following groups :**

***Group (I): Congenital brain malformations :***

Increasing recognition of congenital brain malformations is becoming possible with the routine use of ultrasound as a screening modality in the investigation of such disorders.

**Arnold chiari malformation** is actually a spectrum of anomalies having a common basic malformation of the brain stem and cerebellum associated with dysraphism of the spinal cord and spine. There is herniation of the cerebellar tonsils and cerebellum into the foramen magnum causing compression of the fourth ventricle and hydrocephalus. If a meningocele is present it is nearly pathognomonic for the Arnold chiari malformation ***(Babcock & Han, 1981).***

Ten cases of Arnold chiari malformation were diagnosed in this work. Sonographic and CT findings were characteristic. These included ventricular enlargement typically involving the third and lateral ventricles with downward displacement of the cerebellum and difficult visualization of the fourth ventricle. There was pointing of the frontal horns with markedly dilated occipital horns and enlarged massa intermedia filling most of the dilated third ventricle. These findings correspond with findings reported by ***De-La-Cruz et al. (1989)*** after examination of 25 infants by cranial sonography, CT and MRI.

Nine cases out of our 10 cases of Arnold chiari malformation were presented with high lumbar swelling. Sonographic examination of 4 cases of lumbar swelling by applying linear 5 MHz probe over the lumbar swelling showed the cystic mass with echogenic tissue inside (cord) i.e. meningo-myelocele. The site of communication with the lumbar subarachnoid space was evident.

***Grant et al. (1983) & Levene et al. (1985)*** had found that cases of Arnold chiari malformation were associated with myelomeningocele (75%) and meningocele (25%) in their studies.

One case of Arnold chiari malformation was presented after lumbar meningocele repair and ventriculo-peritoneal shunting 3 months ago. Cranial sonography of this case showed proximal end of the shunt tube within Rt lateral ventricle with mild supratentorial ventriculomegaly and others sonographic signs of Arnold chiari malformation. Pelvi-abdominal sonography of this case was done to exclude localized collection around distal end of the shunt tube. Bilateral hydronephrosis with distended urinary bladder and huge amount of residual urine were found and the diagnosis of neurogenic bladder was evident.

No avilable previous studies could be found to evaluate associated neuro-urological abnormalities in cases of Arnold chiari malformations and we recommend further assessment for this point.

**An encephalocele** develops when the neural tube does not close resulting in a skull defect usually in the occipital region. It could be either meningocele, encephalomeningocele or simple encephalocele ***(Haaga & Alfidi, 1985).*** Four cases of encephalocele were diagnosed in this study, which comprised 3 cases of meningoencephalocele and one case of meningocele.

***Harwood-Nash & Fitz (1976)*** reported that the most frequent site of encephalocele were in the occipital region which comprised 70%, parietal and posterior frontal encephaloceles were the next most common 20%, anterior frontal and basal encephaloceles were the least common 10%. In the detected 4 cases of encephalocele, 3 cases were in occipital region, one case was in fronto-parietal region. No basal encephaloceles were encountered in this study.

Encephaloceles are usually easily diagnosed clinically in the newborn by direct observation. However it is necessary to define the skull defect, to determine the presence or absence of neural tissue in the herniated sac and to define the intracranial anatomy ***(Byrd et al., 1978).*** We have found that both US and CT have the same ability to detect the contents of the herniated sac and to define the intracranial anatomy, yet CT and plain x-ray of the skull were superior to US in detection of skull defects. These findings correspond with findings reported by ***Byrd et al. (1978).***

***Chervenack et al. (1993),*** found that, in the most common type of occipital encephalocele, there's common association of chiari III malformation (80%). In the two cases of occipital encephalocele, US detected one case with associated chiari malformation type III, CT confirmed this diagnosis. In the second case, US failed to detect this association and CT easily diagnosed chiari-III malformation. In this case, the ventricular system was not dilated and fourth ventricle was not visualized by CT examination.

The limited number of diagnosed occipital encephalocele in this study and their sonographic findings may suggest that US may fail in the diagnosis of pathological changes of Chiari malformation in non-dilated ventricles.

***Levene et al. (1985)*** reported that clinical confusion between cephalhematoma and encephalocele may occur. We were able by ultrasound to differentiate between the two conditions. In cephalhematoma the blood will appear as an echo-free area between two sharp linear echoes produced by the elevated periosteum and the intact skull vault, in contrast to encephalocele where a skull defect may be detected and no echogenic periosteum overlying it. In this study 2 cases of cephalhematoma were encountered by US and plain x-ray of the skull. Follow up of one case revealed complete resolution of the hematoma over a period of 1.5 months. Occipital dermoid cyst is another extracranial swelling that should not be confused with encephalocele. In this study, only one case of occipital dermoid cyst was suspected after cranial US, CT and plain xray examinations. Exicision biopsy confirmed this diagnosis.

In the **Dandy walker malformation,** the key finding is the presence of a posterior fossa cyst which is actually an extremely enlarged fourth ventricle due to atresia of the foramina of Magendie and Luschka with cerebellar vermian dysgenesis. In addition there is hydrocephalus involving the third and lateral ventricles. The basilar cisterns are obliterated by the cyst and the posterior fossa is markedly enlarged. The tentorium, straight sinus and transverse

sinuses are elevated ***(Carmel, 1977).*** Two cases of Dandy-Walker cyst were encountered in this study. Both US and CT showed equally the posterior fossa cyst wth absence of cerebellar vermis and supratentorial ventriculomegaly. These findings correspond with those of ***Tritrakarn et al. (1989)*** who added in his study that, US had similar sensitivity to CT and MRI in diagnosis of Dandy Walker cysts.

In the **Dandy Walker variant,** there is a retrocerebellar posterior fossa cyst with partially formed fourth ventricle. The posterior fossa is not as large as in the usual Dandy Walker syndrome. Supratentorial hydrocephalus is commonly absent ***(Harwood-Nash and Fitz, 1976).***

These findings were well-demonstrated in 4 cases in this study by either US or CT equally. These findings correspond with those of ***Hagen-Ansert (1995)*** after examination of 250 cases of Dandy Walker variant and other posterior fossa cystic lesions by US, CT and MRI examination.

**Holoprosencephaly** is a developmental abnormality of fore-brain diverticulation leading to a single midline ventricle. The spectrum of holoprosencephaly includes the most sever form, alobar holoprosencephaly, a less sever form, semilobar holoprosencephaly and the midlest form, lobar holoprosencephaly. In the alobar holoprosencephaly, the is a large single cavity with only a minimal

amount of cerebral tissue seen peripherally and fused thalami. In semilobar holoprosencephaly, sure cerebral tissue is present. In lobar holoprosencephaly, there is more cleavage of the prosencephalon but it remains incomplete. There is defeciency of cerebral tissue resulting in slightly dilated lateral ventricles, flattening of the roof and squaring of the frontal horns and absence of the septum pellucidium ***(Manelfle & Severly, 1982).***

Two cases of holoprosencephaly were diagnosed by cranial sonography in this study. The first case showed common ventricle, absent falx, absent septum pellucidium and fused thalami. This picture is characteristic of alobar type. In the second case cranial sonography and CT brain showed absent septum pellucidium and corpus callosum with rudimentary anterior falx and interhemispheric fissure. There were marked separation of frontal horns fused with superiorly extended and dilated third ventricle. This picture is characteristic of lobar type of holoprosencephaly associated with agenesis of corpus callosum. These findings correspond with findings reported by ***Baerts (1990)*** after his examination of 50 cases of holoprosencephaly by different imaging modalities.

**Agenesis of the corpus callosum** is a common anomaly. The defect may be asymptomatic. There are no clinical symptoms specific to absene of the corpus callosum and the signs observed are those of the associated malformations. Three cases of agenesis of corpus callosum were detected by cranial sonography and CT. Both

modalities showed equally the diagnostic criteria of agenesis of corpus callosum in the form of marked separation of the marked separation of the frontal horns, concave medial borders of the lateral ventricles, elongation of the foramina of Monro, generalized dilatation of the third ventricle with a varying degree of dorsal extension and radial arrangement of sulci around roof of the third ventricle. These findings correspond with ***Skeffington, 1982*** who found that sonography has similar sensitivity of CT in diagnosis of agenesis of corpus callosum.

**Schizencephaly** is a rare congenital anomaly characterized by bilateral symmetrical hemispheric clefts extends from lateral ventricles to subarachnoid spaces and sylvian fissures ***(Rumack & Johnson, 1984).*** In this study only one case of schizencephaly was detected. This case presented with mental retardation and macrocephaly. Cranial sonography and CT examination showed the bilateral symmetrical schizencephalic clefts equally.

**Sturge weber syndrome** (Encephalotrigeminal angiomatosis) is a syndrome consists of port-wine naveus, mental retardation and epilepsy with leptomeningeal angiomatosis usually at the same side of port-wine naveus. Calcifications starts beneath the leptomeningeal angiomatosis is usually seen after 2 years age ***(Wagner, 1981).***

In this study only one case of sturge weber syndrome was detected. This case presented with mental retardation, Rt. port-wine

facial naveus and convulsions. Cranial sonography failed to detect this syndrome and sonographic data was normal. Post-contrast CT brain showed Rt. occipital gyral enhancement following its cortical envolution with no evidence of calcifications. This finding correspond with ***Levene et al. (1985)*** findings that cranial sonography has no role in detection of sturge weber syndrome. ***Chugani (1992)*** found that, CT and MRI can be used to define the extent of the cerebral angioma in sturge weber syndrome. He also found that positron emission tomography (PET) typically revealed unilateral hypometabolism ipsilateral to the facial nevus and PET is more sensitive than CT and MRI in early detection of the cerebral involvement in sturge weber syndrome.

### *Group (II): Hydrocephalus :*

The clinical diagnosis of hydrocephalus in the neonates or young infants is conventionally based on the presence of an abnormally rapid increase in occipito-frontal circumference (OFC) supported by cranial suture diastasis and in some cases a tense anterior fontanelle ***(Levene et al., 1985).*** However during this study ultrasonography may show dilatation of the ventricles without any clinical indication of hydrocephalus, this was particularly observed in preterm infants (9 cases out of 38 hydro-cephalic infants). This finding correspond with ***Osman, 1989*** findings after examination of 147 cases of hydrocephalus by cranial sonography.

Ventricular size and configuration are well shown on ultrasound scans. The ventricular system may be measured on both coronal and sagittal scans. In coronal scans ***Fischer et al., 1985*** used the combined coronal ventricular width (CCVW) of lateral ventricles and cerebral mantle thickness (CM) to assess degree of hydrocephalus. They found that CCVW measures less than 8 mm and CM thickness more than 4.8 cm in the normal infants. They classify degree of hydrocephalus into slight (CCVW = 8 : 12 mm); mild (CCVW = 20 : 30 mm); moderate (CCVW = 30 : 40 mm) and sever (CCVW = more than 40 mm). ***El-Shafei & Hafez, 1991*** found that, intelligence quotient (IQ) distribution became normal when cerebral mantle (CM) thickness is more than 2.8 cm and patients who had cerebral mantle thickness less than 2 cm reached an IQ of no better than 80. ***Rumack & Johnson (1984)*** used axial views to measure lateral ventricular ratio (LVR) which is normally from 24% to 34%.

In this study 38 cases of hydrocephalus were detected. We found 5 cases (13.1%) of slight hydrocephalus; 6 cases (15.8%) of mild hydrocephalus; 17 cases (44.8%) of moderate hydrocephalus and 10 cases (26.3%) of sever hydrocephalus. This classification followed the classification of ***Fischer et al., 1985*** to assess the degree of hydrocephalus.

In cases of slight hydrocephalus (13.1% in this study), the outlines of the lateral ventricles becomes rounded and frontal horns

were ballooned. The occipital horns were more dilated than frontal horns. These findings correspond with ***El-Mogy et al. (1986) and Osman (1989)*** findings in their cases of early hydrocephalus.

Obstructive hydrocephalus may be classified into intraventricular (IVOH or non-communicating type) and extra-ventricular (EVOH or communicating type). In IVOH (non-communicating hydrocephalus) obstruction may be at the level of foramen of Monro, aqueduct level or exit foramin of the fourth ventricle. In the EVOH (communicating hydrocephalus) obstruction may occur at any site peripheral to the outlets of the fourth ventricle in the subarachnoid spaces and basal cisterns ***(Harsh et al., 1986).***

In this study ultrasound examination could accurately determine the level of obstruction in 38 cases of hydrocephalus. We detected 14 cases of EVOH (36.9%), 3 cases of IVOH at foramen of Monro level (7.9%), 19 cases of IVOH at level of aqueduct (50%) and 2 cases of IVOH at level of exit foramina of fourth ventricle (5.2%).

In this study the most common level of obstruction was at the level of aqueduct of sylvius 50% (19 out of 38 cases). This correspond with ***Osman (1989)*** findings of 54% aqueduct obstruction and ***El-Mogy (1986)*** findings of 60% aqueduct obstruction.

Communicating hydrocephalus (EVOH) can be detected by sonography as there will be dilatation of all the ventricles, cisterna magna and subarachnoid spaces ***(Leven et al., 1985).*** These findings were encountered in our 14 cases of EVOH. The etiology of EVOH in our 14 cases were, post-infective in 6 cases (42.86%); post-hemorrhagic in 4 cases (28.57%) and no-apparent detectable cause in 4 cases (28.57%). These findings correspond with ***El-Mogy (1986)*** findings, that the most common causes of EVOH are infection (40%) and hemorrhage (30%).

Non-communcating hydrocephalus (IVOH) at level of foramen of Monro may be unilateral or bilateral. ***Levene et al. (1985)*** mentioned that bilateral obstruction is quite rare in infants and typically occurs in older children secondary to large supraseller cyst or tumour adjacent to foramen of Monro. This finding does not coincide with our results where we met 3 cases of IVOH at level of foramen of Monro, 2 cases were due to bilateral obstruction (66.66%) and one case was due to unilateral obstruction (33.33%). The etiology of foramen of Monro obstruction in this study were porencephalic cyst (1 case=33.33%), ventriculitis (1 case=33.33%) and no apparant cause detected in one case (33.33%).

The sonographic findings in foramen of Monro obstruction included unilateral or bilateral dilatation of lateral ventricles according whether the obstruction is on one or both sides. Other

ventricles were of normal size. This coincides with the findings of ***Levene et al., 1985 and Osman, 1989.***

IVOH at level of aqueduct of sylvins is diagnosed by sonography when the lateral ventricles and third ventricle are dilated with normal appearance of the fourth ventricle ***(Babcock & Han, 1981).*** These findings coincide with our study of 19 cases of aqueduct obstruction. The etiology of aqueduct obstruction in our study were congenital aqueduct stenosis (7 cases = 36.84%), chiari II & III malformation (11 cases = 57.9%) and Arachnoid cyst (1 case 5.26%). These results were detected by both US and CT equally. These findings coincides with those of ***Tien et al. (1990)*** who found that congenital aqueduct stenosis encountered of 40% of their study.

On the other hand obstruction at the exit foramin of fourth ventricle was encountered in 2 cases of Dandy walker cyst (5.2% out of 38 cases of hydrocephalus). The sonographic findings and CT findings of the two cases were coinciding with the findings of ***Tritrakarn et al. (1989)*** as previously discussed.

Cranial US is used to assess cases of hydrocephalus after shunt operation. Shunt complications include recurrent obstruction, subdural collection and hematoma, infection, slit-ventricle syndrome (SVS) and isolated fourth ventricle. ***Quencer (1992)*** adviced to perform cranial US and CT for assessment of proximal

shunt malfunction. He also recommended pelvi-abdominal sonography and plain films to assess distal shunt malfunction.

In this study 4 cases followed after ventriculo-peritoneal shunt operation by cranial sonography, pelvi-abdominal sonography, CT brain and plain x-ray films. We found 2 cases out of 4 with proximal shunt obstruction by adherent choroid plexus. One case showed successful shunt operation with no apparant obstruction, migration or disconnection of the shunt tube. One case showed subdural empyema and evidence of slit ventricles syndrome, this case referred to do tapping from anterior fontanelle and left subtomporal craniectomy.

### *Group (III): Cystic brain lesions :*

Intracranial cystic lesions are fluid filled spaces within the cranium that displace adjacent parenchyma to produce a mass effect. The fluid may be normal CSF, inflammatory transduate or may contain a high concentration of protein ***(Mack et al., 1980).*** Intracranial cystic lesions were encountered in 21 cases of this study. Most of these cystic lesions were discussed in congenital lesions i.e. (2 cases of Dandy walker cysts; 4 cases of Dandy walker variant; 2 cases of holoprosencephaly; 2 cases of agenesis of corpus callosum and one case of schizencephaly).

**Porencephalic cyst** is a complex, poorly defined term now applied to any cerebral excavation or cavity which may or may not communicate with the ventricles. This can be divided into schizen-

cephaly and encephaloclastic porencephaly. Porencephaly may be single (simple porencephaly) or multiple (poly-porencephaly) usually due to prenatal or post-natal insult leading to circumscribed defect. Hemorrhage, infarction, infection and trauma are the usual causes ***(Chilton & Cremin, 1983).***

In this study 4 cases of porencephalic cysts were detected. Multiple porencephalic cysts were found in one case and single cyst in 3 cases. Communication with the ventricular system was demonstrated in 2 cases. We found that cranial sonography and CT can equally detected the cystic nature of the lesion and site of communication with the ventricles (if present). These findings coincides with ***Chilton & Cremin (1983)*** findings in diagnosis of porencephaly.

**Arachnoid cysts** are cavities between arachnoid membrane and pia matter. They may be congenital which are usually found at sylvian or interhemispheric fissures or secondary which occur most commonly around basiler cisterns adjacent to the third ventricle and in the posterior fossa due to post-traumatic or post-meningitic adhesions ***(Rumack & Johnson, 1984).*** In our series we detected 4 cases of arachnoid cyst. Cranial sonography detected 3 cases, that appeared as extra-axial CSF cystic lesions and confirmed by CT findings. Sonography failed to detect one case of small temporal arachnoid cyst but CT easily detected it. Sonography false negative result of this case may be due to extreme peripheral location of the lesion which could not be detected in both coronal or sagittal scans

through anterior fontanelle. This finding correspond with ***Levene et al. (1985)*** finding of false negative results of cranial sonography in detection of extra-axial peripherally located lesions.

**Cavum septum pellucidium** is a mid-line cystic structure above the third ventricle and anterior to foramen of Monro interposed between frontal horns. Normally no communication with the ventricular system with obliteration of the cavum septum pellucidium in 85% of infants by age of 2 months ***(Babcock & Han, 1981).*** In this study 2 cases of cavum septum pellucidium were detected by both cranial sonography and CT equally.

***Group (IV): Intracranial infection :***

Central nervous system infection are very serious in the first year of life. Many of the infections begin in utero, and the pregnant mother may not be symptomatic even though the infant has extensive disease. Unfortunately, most of the organisms causing CNS infection in the neonates are either difficult or impossible to treat. In addition, the neonate appears to have more difficulty in limiting the extension of meningitis, so that it frequently ends by encephalitis ***(Bell & McCormick, 1981).***

The differential diagnosis of antenatally acquired infections includes rubella, cytomegalovirus, syphilis, toxophlamosis, herpes encephalitis and human immunodeficiency virus (HIV) ***(Bale & Murph, 1992).***

Ultrasound findings in **cytomegalovirus infection** are described by ***Fisher et al. (1985).*** Peri-ventricular calcifications typically are scattered along the ventricular wall. They may be small enough that acoustic shadowing does not occur. Diffuse brain damage with ventriculomegaly and scattered areas of encephalomalacia are also detected. ***Levene et al. (1985)*** added that, multiple subependymal pseudocysts may be the only finding in cytomegalovirus infection.

Only one case of cytomegalovirus infection was reported in this study. Cranial sonography of this case showed supratentorial ventriculomegaly with prominent cortical sulci and widening of interhemispheric fissure. Basal ganglia and periventricular calcifications were also seen. CT examination of this case confirmed the sonographic findings and the possibility of TORCH infection was considered. Serological examination for CMV in this case was positive.

The commonest neonatally acquired infection are bacterial and caused by group B-streptococci or E. coli. After the newborn period, H. influenza becomes the most common cause of CNS infection in infants and children ***(Bell & McCromick, 1981).***

In this study, 3 cases of **brain abscesses** were detected. Cranial sonography showed cystic lesion of turbid fluid contents and thick echogenic wall with perifocal increased echogenicity of

oedema. There were mass effect in the form of compression of the ipsilateral ventricles and mid-line shift to the contralateral side. Post-contrast CT examination of these cases showed typical ring enhancement characteristic of brain abscess. These findings correspond with findings of ***Levene et al. (1985)*** who found that, CT is more specific in diagnosis of focal cerebritis and brain abscess than cranial sonography.

**Ventriculitis** was detected in 7 cases in this study. In 6 cases cranial sonography showed ventriculomegaly with ventriculitis in the form of turbid CSF contents of the dilated ventricles with internal septations and fluid/fluid levels. CT findings confirmed the diagnosis of ventriculitis by enhancing ependymal walls of the dilated ventricles in 4 cases.

One case of ventriculitis could not be detected by US and was easily proved by post-contrast CT study. In this case the ventricular system was not dilated.

These findings correspond with ***Barnes (1992)*** findings in cases of ventriculitis. He noticed that US had false negative results in cases of ventriculitis with non-dilated ventricles but in cases of ventriculomegaly US was more specific and sensitive than CT in diagnosis of associated ventriculitis with no sedation, contrast injection or radiation hazards.

Only one case of **meningitis** was detected in this study. Cranial sonography findings were those of diffuse brain oedema (increased brain echogenicity obscuring anatomical landmarks with attenuated ventricles). The sylvian fissures were thick and echogenic with prominent echogenic cortical sulci. CT examination showed meningeal enhancement after contrast with minimal subdural effusion. Lumbar puncture was done to examine CSF and diagnosis of meningitis was confirmed.

These findings correspond with ***Levene et al. (1985)*** who found that cranial sonography had limited role in detection of uncomplicated menigitis and CT is more specific than cranial sonography in those cases.

Only one case of **subdural empyema** was detected in this study. Cranial sonography showed extra-axial concavo-convex turbid fluid collection with fluid/fluid level and collapsed ventricular system. This case had history of previous ventriculo-peritoneal shunt operation. CT examination confirmed diagnosis of subdural empyema and slit ventricle syndrome (SVS). Tapping from anterior fontanelle and left subtemporal craniectomy was done. The detected sonographic findings of subdural empyema in this case correspond with ***Reeder & Sanders (1983)*** findings that cranial sonography can detected the nature and pattern of subdural collection but differentiation from subdural empyema or

hemorrhage is difficult on sonographic bases and CT examination is recommended for differentiation.

***Group (V) : Intracranial hemorrhage :***

***Weindling et al. (1985)*** stated that, **subependymal-intraventricular hemorrhages** (SEHs-IVHs) are the most common hemorrhagic lesions in pre-term newborn infants. These lesions affect 30% to 50% of infants less than 34 wks gestaginal age. The condition started as isolated subependymal hemorrhage in germinal matrix (thalamo-caudate groove) then extends to ventricular system (IVH) and finally parenchymal extension (IPH).

***Papile et al. (1978) and Levene et al. (1985)*** classified SEH-IVH into four grades: SEH or IVH without ventricular enlargement as grade (I); SEH or IVH with mild ventricular enlargement as grade (II); SEH or IVH with moderate or large ventricular enlargement as grade (III) and SEH or IVH with intraparenchymal hemorrhage as grade (IV).

***Bejar et al. (1986)*** found that, cranial sonography is more sensitive for detection of SEH-IVH than CT. Hemoglobin concentration greater than 5 : 6 mg/dl are required to detect blood in the ventricular cavity with CT, whereas sonography can visualize blood when the concentration of red blood cells in the CSF is only 1:2 mg/dl. ***Levene et al. (1985)*** stated that, SEH-IVH is the most commonest form of intracranial pathology to be recognized by ultrasound.

In this study 5 cases of SEH-IVH were diagnosed. All these 5 infants were premature of gestaginal age ranging from 31 to 33 weeks and birth weight ranging from 1500 to 1900 grams. This correspond with ***Weindling et al. (1985)*** finding of high incidence of this lesion among premature infants less than 34 wks gestaginal age and low birth weight infants less than 2000 gm.

Cranial sonography of these 5 infants revealed :

- Two cases of isolated SEH (grade-I subependymal hemorrhage) seen as bright echodensity over the head of caudate nucleus and thalamocaudate groove detected in both sagittal and coronal scans. These findings consistant with ***Hagen-Ansert (1995)*** findings of subependymal hemorrhage in 200 cases of premature infants. He explained high frequency of these hemorrhagic lesions in tiny infants by the increased capillary fragility in the germinal matrix.
- One case of bilateral SEH at both thalamo-caudate grooves with intraventricular extension (IVH) and moderate ventriculomegaly but no intraparenchymal extension. Rt-frontoparietal porencephalic cyst was also detected in this case. The diagnosis of grade III SEH-IVH was made according to ***Papile et al. (1978)*** grading system. ***Hill et al. (1982)*** found that, bilateral SEH is not uncommon findings in these lesions. ***Hagen-Ansert (1995)*** explained associated ventriculomegaly as post-hemorrhagic communicating hydrocephalus and porencephalic cystic lesion as end-stage of parenchymal hematoma.

- Two cases of grade-IV SEH-IVH were detected by finding thalamo-caudate groove hematoma with intraventricular and intraparenchymal extension (IPH). ***Levene et al. (1985)*** stated that, grade III & IV SEH-IVHs had poor prognosis. They recommend serial follow up cranial sonography examinations for proper grading and management of these infants.

***Levene et al. (1985)*** stated that, **subdural hematoma** will collect between the dura and brain if there is a venous laceration due to head trauma. They also found that CT is better than cranial sonography in detection of subdural and epidural hematomas. ***Mack et al. (1981)*** found that, subdural hematoma may be diagnosed by cranial sonography in axial and coronal scans if hematoma is large (at least 1 cm thick) associated with mid-line shift.

During this study 3 cases of subdural hematoma were detected. Cranial sonography failed to detect two case of small subdural hematomas easily detected by CT examination. One case of full-term infant presented with history of head injury and unequal pupils with repeated attacks of convulsions was diagnosed by cranial sonography. In this case, there was echo-free extra-axial collection of concavo-convex shape between brain and skull bones with mass effect on the ipsilateral ventricles and mid-line shift to the contralateral side. The diagnosis of acute subdural hematoma was made and this infant was operated upon by evacuation of hematoma. Two weeks after operation, cranial sonography showed

no subdural collection and no mid-line shift and ventricular system returned to normal size and position.

The commonest site of origin of **intraparenchymal hemorrhage** (IPH) is extension from SEH-IVH. Spontaneous IPH may occur secondary to trauma or bleeding disorder with angiomatous malformation. Diagnosis by cranial sonography should not be difficult, as the hemorrhage is seen as strongly echogenic area with mass effect, but other possibilities of hemorrhagic infarction or extensive peri-ventricular leukomalacia cannot be excluded on bases of cranial sonography ***(Hagen-Ansert, 1995).***

***Levene et al. (1985)*** found that, few days after acute bleeding the clot becomes cystic and is reabsorbed completely in 3 : 4 weeks, leaving porencephalic cyst. During this study, cranial sonography detected 2 cases of (IPH) as strongly echogenic area within the cerebral hemisphere and associated mass effect on the ipsilateral ventricles and mid-line shift to contralateral side. CT confirmed fresh blood density of this detectable lesions.

**Subarachnoid hemorrhage** has been a difficult diagnostic problem by sonography and very few reports exsist on the ultrasound detection of (SAH), generally this diagnosis is thought to be extremely unreliable ***(Levene et al., 1985). Hill et al. (1982)*** suggested that SAH could be detected if widening of the sylvian fissure and prominent subarachnoid spaces were seen on

ultrasound. ***Mack et al. (1981)*** did not detect SAH by ultrasound in any of the nine cases in which hemorrhage was subsequently proved at autopsy. In view of these reports it is surprising that ***Grant et al. (1982),*** using linear probe, claimed to detect SAH in 98% of cases proved by CT scan.

***Hagen-Ansert (1995)*** stated that, the problem with the sonographic diagnosis of SAH is the close proximity of the subarachnoid space to bone echoes. It is extremely unlikely that small volume of blood will be collected, but it is possible that thrombus within the sylvian fissure may be recognized. Because SAH can be missed on US, CT should be the primary method of investigation of SAH.

During this study, one case of SAH was suspected by cranial sonography as the sylvian fissures were thick and echogenic. CT examinations confirmed the diagnosis.

***Group VI : Cerebral atrophic changes :***

Diffuse cerebral atrophy in infants can be the result of different etiologies, the most common of which is cerebral anoxia which cause neuronal loss associated with gliosis and oedema. The end result is diffuse cortical and central atrophy ***(Levene et al., 1985).***

The sonographic examination of diagnosed three cases of brain atrophy in this study revealed mild ventriculomegaly with homogenously decreased cerebral hemispheres echogenicity, widening of interhemispheric fissure, prominent cortical sulci and widening of basal subarachnoid spaces. CT examination of these cases confirmed the diagnosis and added superior sagittal sinus thrombosis (Delta sign) is one case not detected by US.

The sonographic appearance of these cases coincided with those of ***Osman (1989) and Barnes (1992).*** They also added that the dilated ventricles may simulate the picture of communicating hydrocephalus. Yet the hypoechoic density of the brain parenchyma will be more in favour of atrophy. ***Huang & Chio (1991)*** added more that cranial Doppler study and RI value can be helpful in differentiation.

***Group VII : Intracranial neoplasm :***

Intracranial tumours are very uncommon in children less than 2 years of age and very rare in newborn period. Brain tumours in infancy differes from tumours in childhood in histopathologic type, location, symptoms and signs. They are more common in the supratentorial compartment in infants than in older children and are more commonly neuroectodermal in origin ***(Rorke et al., 1985).***

Correlation between sonographic and CT findings of brain tumours have been done by ***Han et al. (1984).*** They found that sonographic findings of brain tumours are not specific.

During this study only one case of brain tumour was detected. This infant presented with signs of increased intracranial tension, right hemiplegia and right facial nerve palsy. Cranial sonography revealed an echogenic soft tissue SOL at the left temproparietal region. Cystic degeneration and mid-line shift to the right were also detected. CT examination confirmed sonographic data and showed irregular enhancing thick wall of the SOL with enhancing nidus. Post-operative biopsy showed primitive neuro-ectodermal tumour of infancy.

***Cranial Doppler application :***

Duplex sonography is a recent adaptation of ultrasound technology to examine cerebral haemodynamics. ***Wong et al. (1989),*** described that, this technique can be applied during the standard sonographic examination and can provide quantitive and qualitative informations on normal and abnormal flow pattern of the anterior, middle and posterior cerebral arteries through the anterior and posterior fontanelles. ***Siebert et al. (1989)*** used resistive index (RI) as an indicator of cerebro-vascular resistance. They reported that average RI for healthy newborn was 75% $\pm$ 10.

In this study, (15) infants were examined by cranial Doppler sonography through the anterior fontanelle during the standard sonographic examination in coronal and sagittal planes. Detection of anterior and middle arterial mean velocity, end-systolic velocity,

end-diastolic velocity and RI values were estimated in the examined 15 cases.

***Pearce (1992)*** found that there is clear relationship between RI values and increased intracranial pressure due to hydrocephalus. In his study, RI was elevated with hydrocephalus. ***Lupetin et al. (1995)*** found that in cases of sever hydrocephalus, RI values were more elevated than cases of moderate or mild hydrocephalus.

In this study (6) hydrocephalic infants were examined by cranial Doppler study. One case of slight hydrocephalus showed normal RI values (69 : 74%) but other 5 cases of more hydrocephalic degrees showed elevated RI (85% : 95%). These finding correspond with ***Lupetin et al. (1995)*** finding that; the more severity of hydrocephalic degree, the more elevation of RI value.

***Huang & Chio (1991)*** stated that, RI is useful in differentiating between hydrocephalus and ventriculomegaly due to brain atrophy as RI is elevated only in hydrocephalus. During this study RI values were estimated in 3 cases of ventriculomegaly due to brain atrophy. RI values of these 3 cases were normal (63 : 75%). According to this important finding, RI estimation can add valuable point of differentiation between ventriculomegaly due to brain atrophy and ventriculomegaly due to hydrocephalus, especially in cases of communicating hydrocephalus (EVOH) where anatomic