Comparative study between trans-fontanelle us& spiral CT scan in the diagnosis of the congenital hydrocephalus.

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Abstract

Compared between the trans-fontal US & spiral Ct scan exam in the diagnosis of congenital hydrocephalus, A series of 100 infants with age range of (20 days to 12 months) were studied over a period of 2 years in Teaching hospital in Al-diwaniya city.

The commonest type of hydrocephalus in this study were obstructive type (83%).The US exam showing (100%) sensitivity in detection the lateral ventricle dilatation as in spiral CT can , with (97%) in detected the 3rd ventricle dilatation in compared with (100%) for spiral CT scan & (64%) in diagnosis 4th ventricle dilation with (100%) .Trans-fontal US exam showing highly sensitivity in early diagnosis of congenital hydrocephalus, with relatively low sensitivity in differentiation between the obstructive & non-obstructive type (low sensitivity in detection the 4th ventricle).In conclusion trans-fontal US exam can be used as a first choice diagnostic test in the diagnosis of congenital hydrocephalus, and CT scan should be preserved for bony & parenchymal abnormalities.

Anatomy of the ventricular system

The brain & spine are ahollow structures, but the size of the hollow spaces in the interior is variable in different regions of CNS. (2) The largest spaces are **the lateral ventricles** which are enclosed by both cerebral hemisphere.

It consists of:

1- Frontal (anterior) horn.
2- Body.
3- Trigone (atrium).
4- Temporal or descending horn.
5- Occipital (posterior).

These ventricles are C-shaped cavity which extends from its anterior horn in the frontal lobe in a continuous cuvre posteriorly (central part - body -), then inferiorly, & finally anteriorly, to end in the temporal lobe as the temporal horn. From its convex posterior surface a posterior horn extends backwards to a variable extent into occipital horn. (1, 10)

The third ventricle

Is a narrow slit like cavity in the median plane between two thalami. It extends from the foramina of monro anteroirly (near the lamina terminalis) to the superior end of the cerebral aqueduct posteriorly. (1, 10)

The fourth ventricle

Is the diamond-shaped cavity of the hindbrain which extends from the superior border of the pons to the middle of the medulla oblongata. It is lies behind these structures & in front of cerebellum (1).

It narrows superiorly where it become continuous with cerebral aqueduct in the midbrain, & inferiorly communicated with central spinal canal by midline foramen called foramen of Magendie. The lateral recess of ventricle open by tow foramen of Luschka into the cistern of the cerebellopontine angle. (3, 2, 4).

Neonatal skull

The neonatal skull , when compared with adult skull , shows a disproportionately large size of the cranium relative to the face .

The bones of the skull are smooth unilaminar , there being no diploe present . The bones of the vault are not closed knit at sutures, as in adult, but they are separated by unossified membraneous intervals called fontanelles. (5)

The fontanelles are six in number , two , the anterior & posterior are in the median plan & two pairs , the sphenoidal & mastoid appear on each side .

The anterior fontanel which lies between the frontal bone anteriorly & two parietal bones posteriorly is small & no longer clinically palpable by the age of 18 months ,while the posterior

fontanel is closed around 6 months , which bounded by the two parietal bones in front & the occipital bone in behind . (6 ,10)
Four prominent skull sutures which are considerably wider than they appear in the adult . They are coronal suture (between the frontal bone & two parietal bones), the sagittal suture (between the two parietal bones) , the lambdoid suture (between the parietal bones & occipital bone) sequamous suture (between the parietal bones & temporal bones .(7)

Hydrocephalus

The term (hydrocephalus) is derived from the Greek language and means water – head (1,10). Is a condition in which abnormal accumulation of CSF in the brain .(2). Hydrocephalus can caused by impaired CSF flow, reabsorption , or excessive CSF production (3). Based on it is underlying mechanisms , hydrocephalus can classified into **communicated** and **non-communicated**(obstructive).Both communicating & non-communicating type can be either **congenital** or **acquired**(4) .

Communicating hydrocephalus

Is caused by impaired CSF resorption in absence of any CSF-flow obstruction (5).

Non-communicating hydrocephalus (obstructive)

Is caused by CSF – flow obstruction (either external compression or intreventricular lesions) (5) .

Congenital hydrocephalus

Is a buildup CSF within the brain that is present at the birth . The excess fluid can increase pressure in the baby brain , possibly result in brain damage & loss of mental & physical abilities (6,10).Most cases of congenital hydrocephalus are thought to be caused by a complex interaction of congenital & environmental factors (7) .

Causes of congenital hydrocephalus

Aqueductal stenosis (obstruction): it is the commonest cause, because it is narrow & long passageway between the 3rd & 4th ventricles, so the fluid accumulated upstream from the obstruction, producing hydrocephalus.

Neural tube defect (Myelomeningocele)**:** commonly named spina bifida, the spinal cord if exposed at the birth and is often lacking CSF. , this associated with hydrocephalus in 90 %.

Chiari malformatiom type 2**:** part of cerebellum & 4the ventricle extend downward through the foremen magnum, blocking flow out of the fourth ventricle & therefore producing hydrocephalus.

Dandy –walker syndrome**:** the 4th ventricle is enlarging because of partial or complete closed of it is outlet, in addition, a portion of the cerebellum fails to develop.

Arachnoid cyst: may occur anywhere in the brain, in the child, they are often located in the back of the brain & in the region of the 3rd ventricle. The entrapped fluid may block the CSF pathway & producing hydrocephalus. (7)

Patient & methods

During two years 120 infants with clinically large head was submitted to US unite.

The history was taken from every one of them. Data collected included age, sex, type & place of delivery, head circumference, history of febrile illness, prenatal, natal, postnatal history.

The US scanning was done by using real time US unite. A 4-7.5 MHZ Siemens sololine Versa probe & 3.5 MHz Siemens sololine SL-1 sector probe was used.

The examination was done on an ordinary examination table in which the patient supine & the head is held constant between the parents hands , the total examination time was 10- 15 minutes , no anesthesia or sedation was used.

Scanning through the anterior fontanelle by angle the transducer from anterior to posterior to obtain six coronal plans, and from right to left of the mid line to obtains three sagittal plans, while the axial plan taken through the thin squamous part of temporal bone .Only 100 patients was diagnosis by US exam as a cases of hydrocephalus , only this was included in the study & the CT scan exam was done for them .The CT scan done by Somatom Emotion CT from simens soft ware version A40A

The exam done in supine position after giving general anesthesia for each infant by anesthetic,the time of examination is 1 minute , the infants were fasting for at less 6 hours before exam .

About 24 sections were taken in axial plane each section of 5 mm thickness.

The following criteria were evaluated with used US & CT scan to diagnosis the hydrocephalus :

1-commensurate dilatation of the temporal horn of the lateral ventricles.

2- narrowing of ventricular angle (angle between anterior margins of the frontal horns of the lateral ventricles), due to concentric enlargement .

3- round frontal horn in shape .

4- enlargement of ventricular system disproportional to cortical sulci (lateral ventricle ratio is the ratio of the maximum width of the body of lateral ventricles to the half of the greater transverse diameter of the cranial cavity,normally value between 0.2 to0.33).

5- the ventricular index (VI) is the distance from the midline to most lateral aspect of the lateral ventricles at the level of frontal horn (normally range from 7 to 11mm) .

6- cortical mantel thickness at the occipital area which is measuring from lateral wall of the atrium to the closest & most perpendicular calvarial surface.

Results

Total number of 100 infants were examined by US & CT scan , with age of 20days to 12 months , with 59 male (59 %) & 41 female (41 %) , we compared the finding of US exam with CT scan for each infant & regard normal ventricle as finding in US exam with dilated same ventricle in CT scan as false negative result for US exam .

The most cases of hydrocephalus were presented below the age of 6 months.

Table 1: Age & sex distribution in 100 infants with hydrocephalus

Age	Male		Female	
	No.	%	No.	%
0 – 2 mon.	19	19%	11	11%
2 – 4mon.	12	12%	8	8%
4 – 6 mon.	10	10%	9	9%
6 -8 mon.	8	8%	8	8%
8 -10 mon.	5	5%	3	3%
10 -12 mon.	5	5%	2	2%
Total	59	59%	41	41 %

All cases were showing dilated lateral ventricles by US & CT scan, so 100% of cases showing dilated ventricles.

Table (2) The US & CT scan finding for lateral ventricle exam.

Age	US finding		CT finding		Sensitivity of US in compared with CT scan
	No.	%	No.	%	
0–2mon.	30	30%	30	30%	100%
2–4mon.	20	20%	20	20%	100%
4–6mon.	19	19%	19	19%	100%
6-8mon.	16	16%	16	16%	100%
8-10mon.	8	8%	8	8%	100%
10-12mon	7	7%	7	7%	100%
Total	100	100%	100	100%	

99% of cases showing dilated 3rd ventricle by CT scan exam while only 97% can be detected by US exam , & most cases below the 2months age group .

Table 3: The US & CT scan finding for 3rd ventricle exam

Age	US finding		CT finding		Sensitivity of US in compared with CT scan
	No.	%	No.	%	
0 – 2 mon.	28	28%	30	30%	93%
2 – 4mon.	20	20%	20	20%	100%
4 – 6 mon.	19	19%	19	19%	100%
6 -8 mon.	16	16%	16	16%	100%
8 -10 mon.	8	8%	8	8%	100%
10 -12 mon.	6	6%	6	6%	100%
Total	97	97%	99	99%	

The false negative cases was 2 in age group below 2 month
Only 17 % of cases showing dilated 4th ventricle by CT scan exam while 11% cases can be detected by US exam , as other ventricular finding the largest percent was below the 2month age group .

Table (4) The US & CT scan finding for 4th ventricle

Age	US finding		CT finding		Sensitivity of US in compared with CT scan
	No.	%	No.	%	
0 – 2 mon.	6	6%	8	8%	75%
2 – 4mon.	0	0%	0	0%	100%
4 – 6 mon.	2	2%	2	2%	100%
6 -8 mon.	1	1%	4	4%	25%
8 -10 mon.	1	1%	2	2%	50%
10-12mon.	0	0%	1	1%	%50
Total	11	11%	17	17 %	

The false negative cases were 5 cases, seen in all age groups .

Discussion

Because hydrocephalus injures the brain , thought & behavior may be adversely affected , someone with hydrocephalus may have motivation & visual problem , problem with coordination , and may be clumsy . They may hit puberty earlier than the average, about one of four develop epilepsy (90).

Most cases of congenital hydrocephalus are diagnosed during physical exam soon after the birth based on the large head than normal (some of them diagnosed during prenatal ultrasound exam) .The imaging test are usually done to see whether congenital hydrocephalus is the possible cause or other causes of large head, (100). Cranial US was used in the initial evaluation of infants with large head (8).It is a simple, quick , non-invasive & economical diagnostic tool in the management of hydrocephalus and to limited sense as effective as CT (9) .CT scan done to confirm the diagnosis or to provide more detailed picture of the brain & it is structures.(100)

All cases in our study showing dilated both lateral ventricles by US & CT scan exam which regard as sign of hydrocephalus, so we can easy detect dilated both lateral ventricle by US with out any false rate, the sensitivity was 100 % .the US exam also can measure the mental thickness accurately, which can be used as indirect sign for assessment the degree of brain damage fig (1&2).

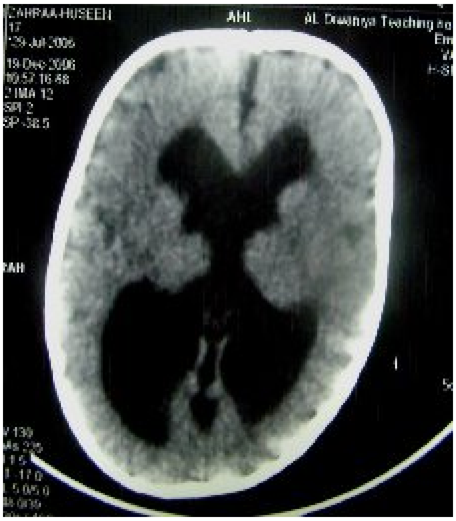

Fig 1: axial CT scan
Dilated both lateral ventricles

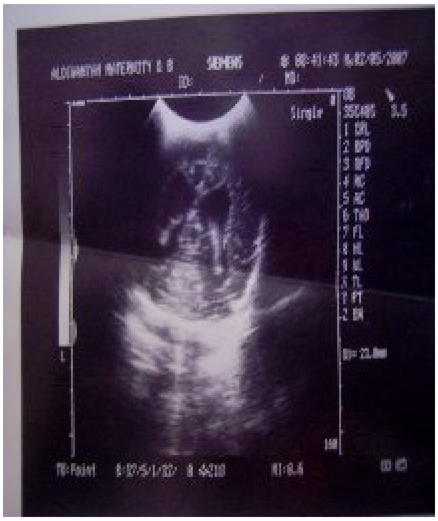

Fig 2: axial SU scan
dilated both lateral ventricles

About the 3rd ventricle there is 2 false negative cases (in age group below the 2 month),in which there is severely dilated both lateral ventricles with multiple different size cystic lesions in all over cerebral hemispheres , with large sub-dural collection , so was not easy see the 3rd ventricle by trans-fontanel US , the sensitivity of US exam was 97% (97 cases from 99) in detection of 3rd ventricle dilation which good degree .fig (3& 4)

The smallest number of cases were showing dilated 4th ventricle , because most causes of congenital hydrocephalus in our study were of obstructive type , only 17 cases were showing dilated 4th ventricle by CT san , & 11 cases of them can be detected by US , the sensitivity of US exam was 64% , the large false negative was in age groups above the 6 month , because the fontanels were smaller (mainly post. fontanel), although the US showing relatively low sensitivity in differentiation between the obstructive & non- obstructive type of hydrocephalus , but this will not effect in the management of infant with hydrocephalus , in both types the VP shunt is the 1st way of treatment to save the brain tissue & protect it from the effects of hydrocephalus , it is sensitive for early diagnosis of hydrocephalus as well as for follow up the shunt & assessing it is function .

From these result , US is an effective easy , non-invasive , available , repeatable primary imaging technique which can easily be performed & sedation of the infant is usually not necessary , and this is in agreement to Pfister (1983), and Machado (1986).

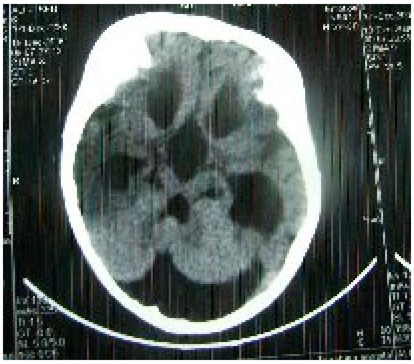

Fig 3: axial CT scan
Dilated both lateral & 3rd ventricles

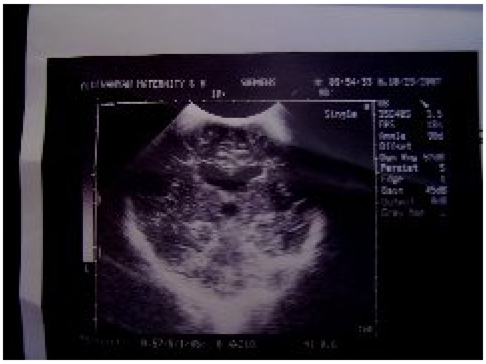

Fig 4: coronal view US scan
Dilated both lateral & 3rd ventricles

Conclusion

Cranial US exam can be used as an initial method for diagnosis of hydrocephalus.It is a convenient,rapid,non-invasive,lack of ionizing diation,repeatable,available,elimination of edation& economical diagnosis imaging .

Trans-fontanel US exam in conjunction with close neurological &developmental examination improves the sensitivity & accuracy of US evaluation of congenital hydrocephalus.

Spiral CT scan that can not be obtained by techniques with lower radiation burden should be reserved for those cases with suspected complex congenital bone anomaly & in patient with severe & progressive neurodevelopmental abnormalities .

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