ABSENT SEPTUM PELLUCIDUM : IS IT IMPORTANT

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ABSTRACT

The absent septum pellucidum on imaging was thought to be normal variation when present alone. On the review of reported cases, however, it has been reclaimed that this finding alone is very rare. We reviewed the 204 reported cases of absent septum pellucidum (ASP) with other associated anomalies from 1978 through 1998. There are only six cases reported to have ASP alone. Two of them were schizophrenic. Most of the cases were associated with septo-optic-hypothalamic dysplasia. There were 26 cases associated with other anomalies of mid-line defect and 4 cases with migrational or differentiation anomalies of neurones. Some authors claimed that the findings may only indicate the timing of a congenital insult. Many reports showed cases of only ASP on imagings in patients with clinically proven to have optic nerve hypoplasia and/or hypothalamic-pituitary dysfunction. This implied that the abnormality of optic nerve and hypothalamic-pituitary axis are out of sensitivity of the imagings to be demonstrated. We believe that when an ASP is found on the imaging, the searching for other associated anomalies should be done carefully eventhough nothing else are demonstrated, emphasizing clinician to evaluate clinical abnormalities of optic nerve and hormonal dysfunction should be done.

Radiologists, who work in the field of neuroimagings either computed tomography (CT) or magnetic resonance imagings (MRI) of brains, at least once have seen the septum pellucidum loss. They might have a question whether it is important. If there are other associated anomalies, the question may be easy. But if it is found alone, the other questions will follow. In the past, the absent septum pellucidum (ASP) alone on CT was thought to be normal variation or not to have any significant in clinical course. After studying by MRI, it has been found that ASP alone is very rare. This article is emphasized in the significant of the septum pellucidum in human nervous system and radiologic points to help the clinicians dealing with these patients.

ANATOMY

The septum pellucidum (SP) is a thin structure. The word "pellucidum" means transparent. In fact, it consists of two thin translucent membranes stretching between corpus callosum about 1.5 – 3 mm. Andy and Stephen used the term septum telencephali meaning the thin membrane at the proximal end of the telencephalon. They separated the membrane into two parts : the thin part located superiorly consists of glial cells and fiber bundles called septum pellucidum. This part is found only in higher mammals. The inferior part called septum verum consists of nuclei found also in the lower animals. The septum verum cannot be separated from the

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SP and joins with the subcallosal or paraterminal gyrus. In the septum verum, there are many fiber systems passing. It works like the delayed stations between the hypothalamus and hippocampus. So the septum verum (or SP. in general meaning) controls the signals between the diencephalon and the limbic system.

EMBRYOLOGY

SP is developed from the primitive lamina terminalis, the so call "commissural plate", at about 10 - 12 weeks gestational age. It develops along with the corpus callosum, the anterior and hippocampal commissure until adult-like at 17 weeks gestation.

The lamina terminalis is the central membranous tissue at the cephalic end of the neuropore. It develops from closure of the neural tube and determines the location of the prosencephalon. At both sides, the budding telencephalon is expanded to be future cerebral hemisphere. The midline thickening structure develops to be the corpus callosum, hippocampal and the anterior commissure. The much more development and the growing of the corpus make the connection with the anterior and hippocampal commissure spread out to be a thin membrane.

Rakic and Yakovlev postulated that each membrane of the SP is developed from cavitation of the medial inferior commissural plate during the growing of the corpus. The cavity inside is the cavum septum pellucidum. After birth, the cavum septum will be closed from posterior to anterior direction.

EVOLUTION

The evolution of SP is inevitably along with corpus callosum which has been detected first in the placental mammals. The more development of frontal lobe means the more clever of the animals. The more enlarged frontal lobe makes the more arch of corpus callosum and the thinner of the SP. In contrast, the olfactory system is the down evolution structure in higher mammals.

FUNCTION

Because the SP is the delayed station between hypothalamus and hippocampus, it is a part of the limbic system controling consciousness, neuroendocrine, autonomic function, sleeping cycle, environmental response and memmory. The fiber tract runs from olfactory bulb to the preoptic area passing the SP but not stopping..

From the anatomic and functional points, one could recognize the important of the SP. We have reviewed 42 medical articles from 1978 through 1998 reporting patients with ASP.[1-42] The total patients was 204 and the associated anomalies were summarized in the table 1. Most of the reported cases were septo-optic dysplasia (125 cases). In this group, nearly half had no other associated anomalies (79 cases). The rest of this group (46 cases) and the non-septo-optic dysplasia cases (79 cases) had other associations such as holoprosencephaly, agenesis of corpus callosum, schizencephaly, migrational and organization disorder, associated destructive causes and cerebellar anomalies. There were only 6 patients reported with ASP alone (2.9%). In these 6 patients, two had psychological disorder. No other information about the other four was reported. This implies that the ASP is significant enough for radiologist to search for other associated anomalies.

IMAGING FINDINGS OF ASP.

The characteristic findings on both CT and MRI are no SP and squared frontal horn of the lateral ventricle (Fig.1). This squared frontal horn is not found in secondary septal necrosis from chronic severe hydrocephalus (Fig.2). The fornix is normally hung above the verum interpositum by the SP. In ASP, the fornix is sinking into the verum interpositum.

Table 1 Reported cases of ASP from 1979-1998

I.	Septo-optic dysplasia	=	125 (61.2 %)
	- Alone	=	79
	- Medial midline defect	=	18
	- Migration / organization disorder, Schizencephaly	=	9
	- Destructive causes (Hypoplasia white matter, thin gray matter, Porencephaly)	=	16
	- Cerebellum disorder	=	1
	- Olfactory bulb agenesis	=	1
II.	Holoprosencephaly	=	13
III.	Agenesis of Corpus callosum	=	12
IV.	Destructive causes (Porencephaly, hydrocephalus, hydranencephaly)	=	9
V.	Migration / organization disorder, Schizencephaly	=	4
VI.	Cerebellum, Chiari II	=	14
VII.	Cephalocele	=	3
VIII.	Absent septum pellucidum alone	=	6 (2.9%)
	- II + III	=	1
	- III + V	=	7
	Total cases	=	**204**

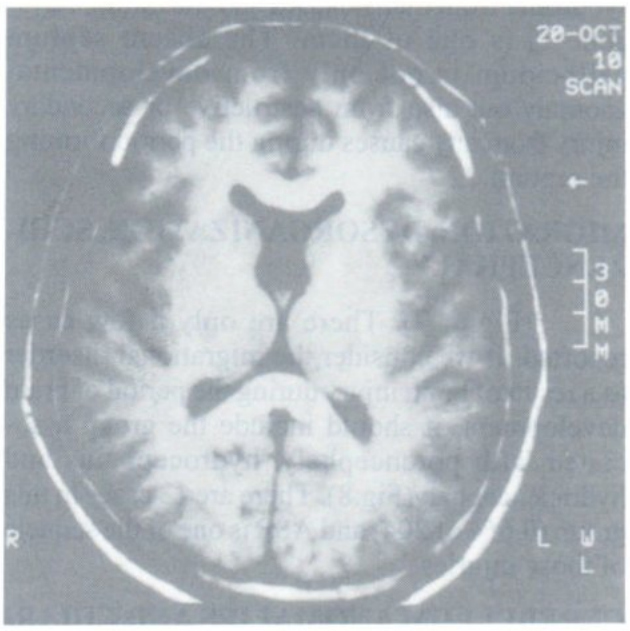


Fig. 1. Axial T1-wi shows absent septum pellucidum and square shape of the frontal horn of lateral ventricle.

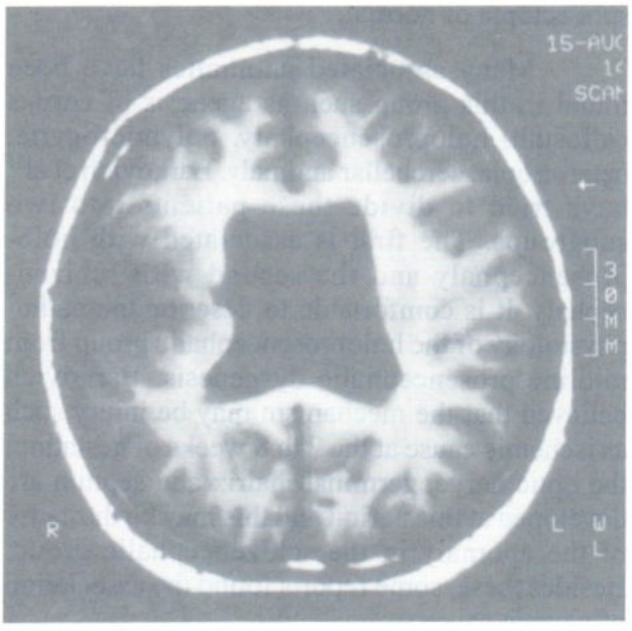


Fig. 2. Axial T1-wi demonstrated partial absent septum possible from pressure necrosis from severe hydrocephalus. Note the shape of the frontal horn of lateral ventricle.

ASSOCIATED ANOMALIES SEPTO-OPTIC DYSPLASIA

The syndrome consists of hypoplasia of optic nerve and ASP (Fig.3). It was first described by Reeves in 1941[45] and 36 cases were reported by de Morsier in 1956.[46] In 1970, Hoyt[34] reported high incidence of hypothalamic-pituitary dysfunction. The following reports have found that there were spectrums of abnormalities in three systems: visual function, hormonal function and seizure. The typical visual abnormality is congenital blindness, nystagmus and optic nerve hypoplasia. Some cases have small optic nerve with normal vision or normal size optic nerve. The common hormonal abnormality is hormonal deficit especially the growth hormone and thyroid stimulating hormone (TSH) with spectrum of variable degree. In the part of ASP, variable degree of abnormality is also found from complete absent, some residual remnant and normal septum. On imagings, ASP may be the only finding ; optic nerve, chiasm and tract may be small or normal and not correlate with the patient's vision ; the hypothalamus and pituitary gland may be hypoplasia, posterior bright spot ectopia or normal.

Many associated anomalies have been found in this group such as agenesis of corpus callosum, holoprosencephaly, polymicrogyria, heterotropia, cerebellar anomaly. Barkovich et al[35] have tried to divide these patients into two subgroups. The first is associated with holoprosencephaly and the second with schizencephaly. It is comfortable to describe the pathophysiology of the holoprosencephalic group from midline prosencephalic dysgenesis. Barkovich believed that the mechanism may be injury such as ischemic cause at the 7 to 8 weeks of gestation, the optic nerve, germinal matrix and septum are developed at this period and this may be the cause of the anomaly in the schizencephalic group. Besides these, some reports found the association of genetic cause.

However, if we find the ASP in patient either with clinical evidence of visual abnormality or not, we should suggest the clinician to search for the possible hormonal abnormality especially GH and TSH deficiency so that the patients could be prevented from the mental retardation.

HOLOPROSENCEPHALY AND AGENESIS OF CORPUS CALLOSUM

As described above, ASP may be caused by midline dysgenesis. It is not surprised to have these two conditions associated in many reported cases. From reviewed papers, there are 26 (12.1 %) cases not included in the septo-optic dysplasia. Imagings of the holoprosencephaly can be divided into 3 subgroups : alobar, semilobar and lobar type by the degree of development of falx cerebri (Fig.4). However, ASP is found in all groups. The corpus callosum may be normal, partial or complete agenesis (Fig.5).

When we look back to the septo-optic dysplasia associated with holoprosencephaly, there are only 18 cases (14.4 % of 125) reported. It could be concluded that the septo-optic dysplasia is the syndrome from many causes and the midline dysgenesis is one of them. The absent septum pellucidum is not only from developmental anomaly but also from destructive or secondary injury from any causes during the period forming the septum.

MIGRATION, DYSORGANIZATION, SCHIZENCEPHALY

(Fig.6, 7). There are only a few cases reported. If we consider the migrational disorder as a result of brain injury during the period of brain development, it should include the group associated with porencephaly, hydrocephalus and hydranencephaly(Fig.8). There are 13 cases in this group (0.6 % of 204) and ASP is one of the sequele of those injuries.

CEREBELLUM ANOMALIES AND CHIARI 2 MALFORMATION

(Fig.9, 10). There is 14% reported. Most of them have associated hydrocephalus. The ASP may be from pressure necrosis.

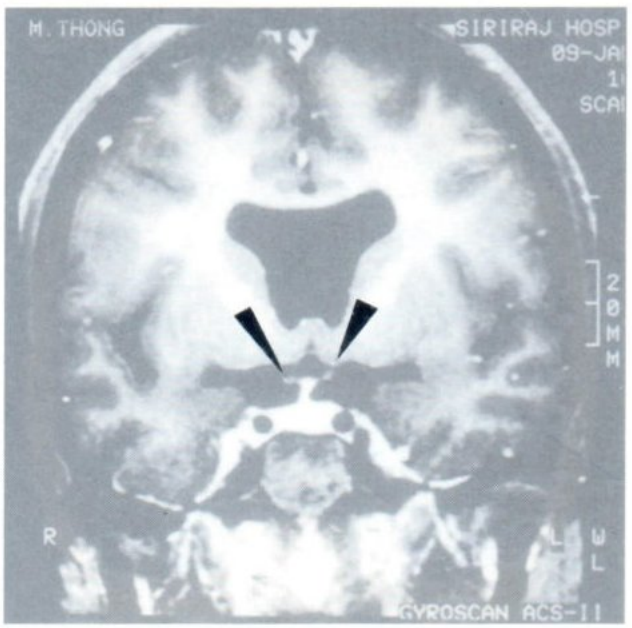


Fig. 3. Coronal T1-wi postenhancement shows the absent septum with hypoplasia of optic nerve and chiasm (arrows).

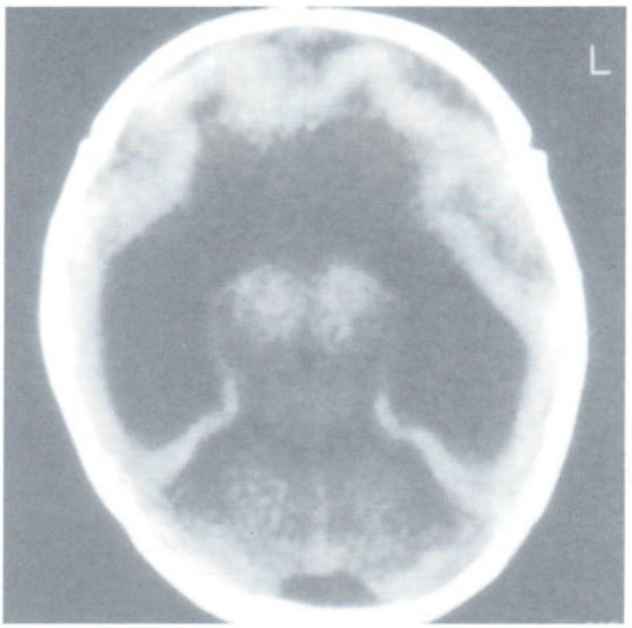
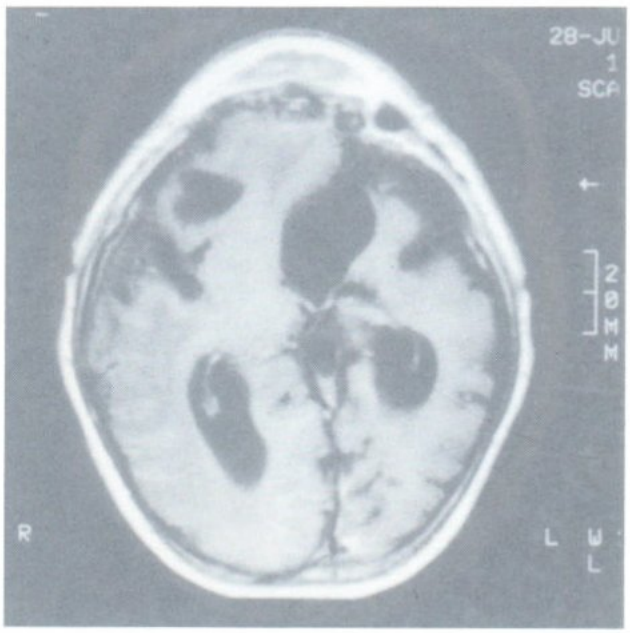
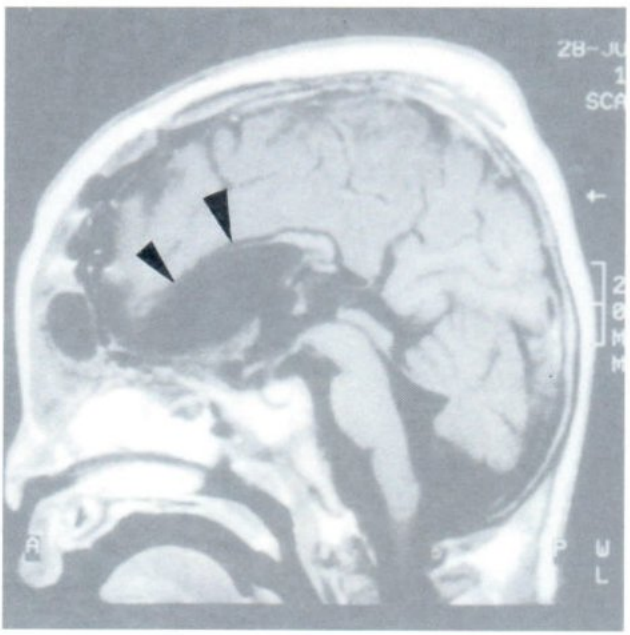


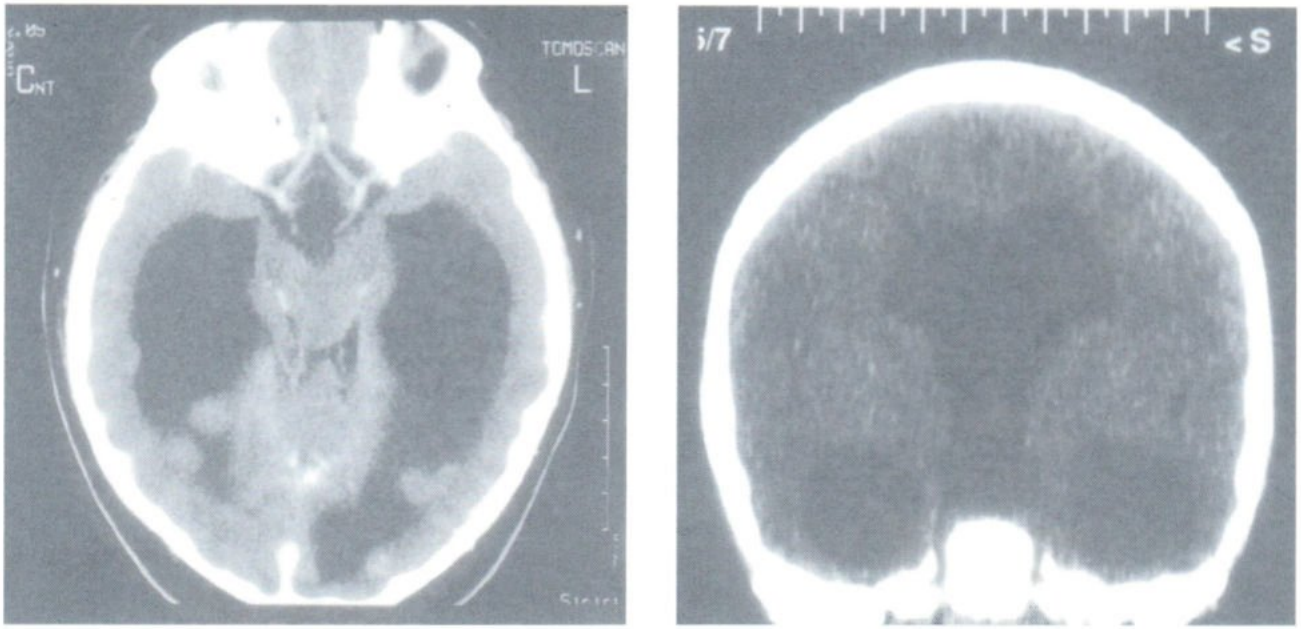
Fig. 4. Axial NECT brain of a baby with cleft lip and palate shows non-separated cerebrum with dilated lateral ventricle and absent septum.





5A **5B**

Fig. 5. T1-wi in axial (A) and sagittal (B) planes of a patient with previous closure of frontal meningocele show absent septum and partial agenesis of corpus callosum from rostrum through body (arrow).



6A 6B

Fig. 6. CT brain in axial (A) and reconstructed coronal (B) planes of a boy with frontoethmoidal meningoencephalocele demonstrate absent septum and heterotropia at subependymoid region (A).

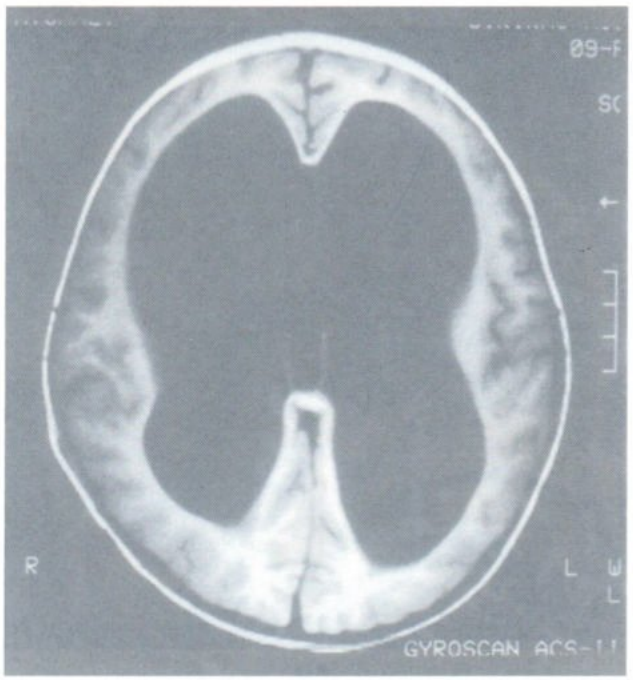


Fig. 7. Axial T1-wi of a patient with absent septum demonstrates right schizencephaly. Note the polymicrogyria of the cortex outlining the cleft.

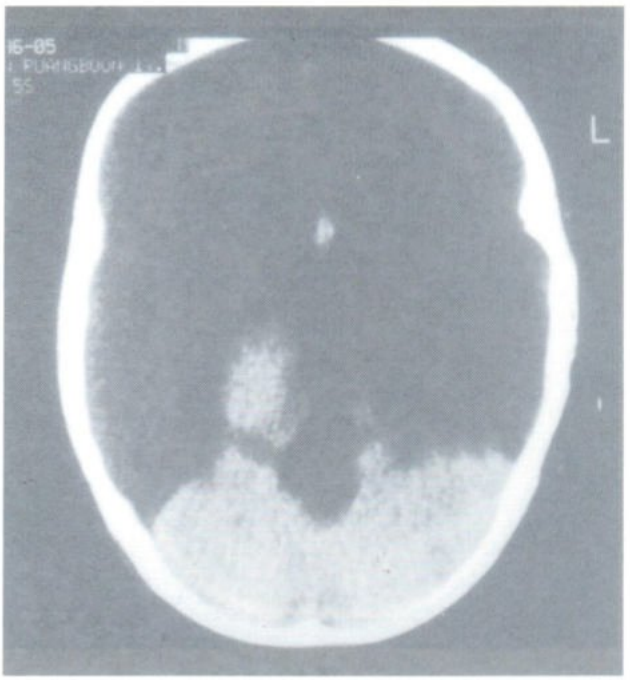
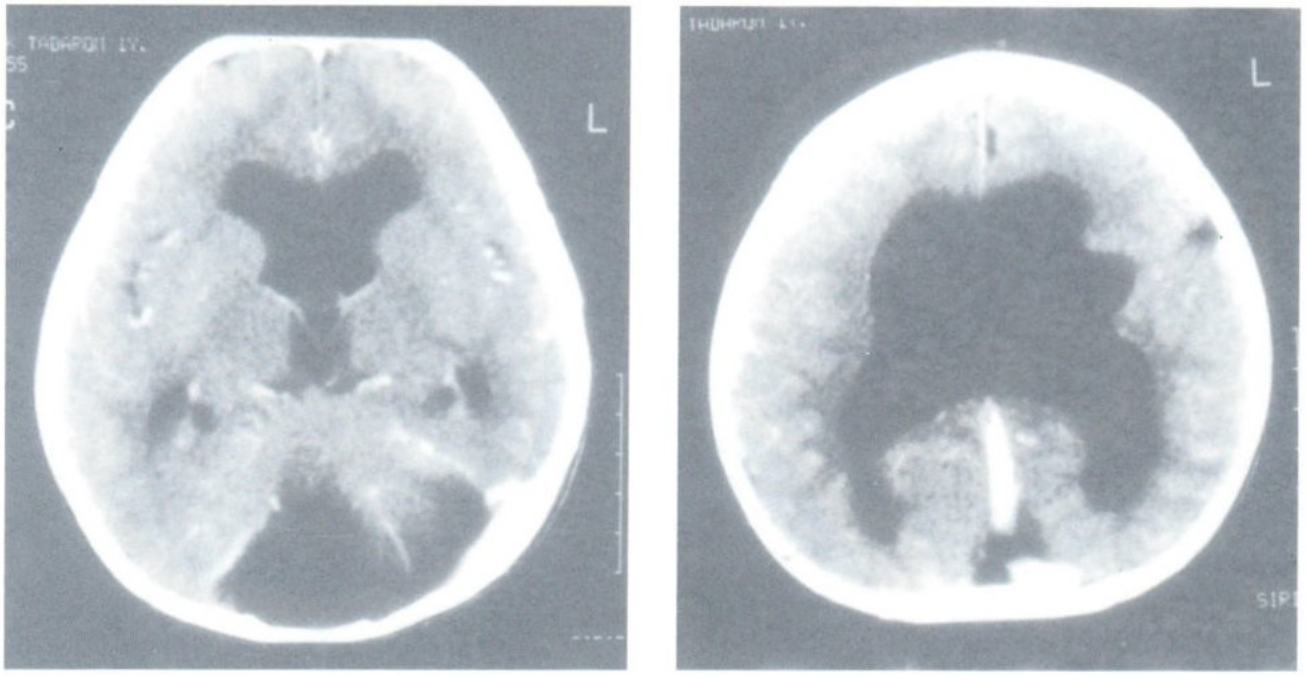


Fig. 8. Axial CT brain of a patient with hydranencephaly shows absent septum.



9A 9B

Fig. 9. Axial CT of a patient with cerebellar hypoplasia (A) shows absent septum and left cerebral cleft (B).

CONCLUSION

We can conclude that ASP is the abnormal finding of the brain either from primary or secondary developmental causes. It is the indicator or marker for radiologist to search for other associated anomalies. CT scan may give lower resolution to see other abnormalities. MRI should be done in the available places. If MRI is not available or no other abnormalities could be found, suggestion to the clinician to search for neurological and psychological disorder should be given, especially in the pediatric septo-optic dysplasia. The early treatment of GH or TSH deficiency will prevent mental retardation and the associated abnormalities may predict the prognosis of the patients.

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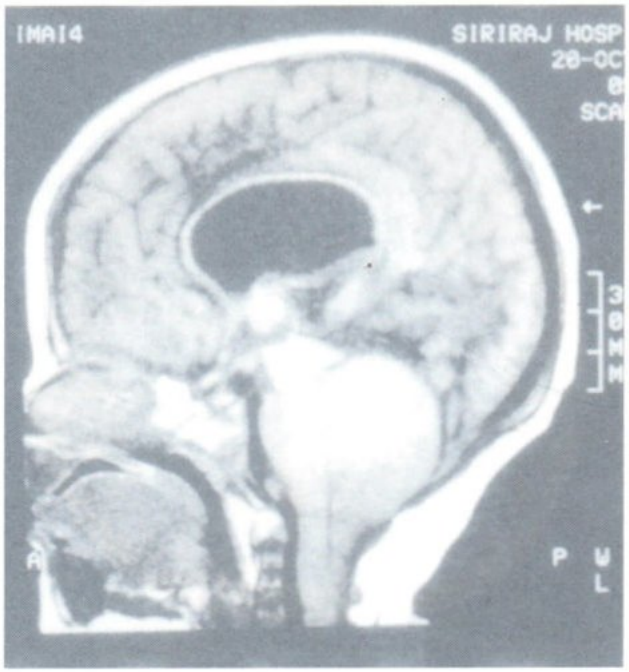
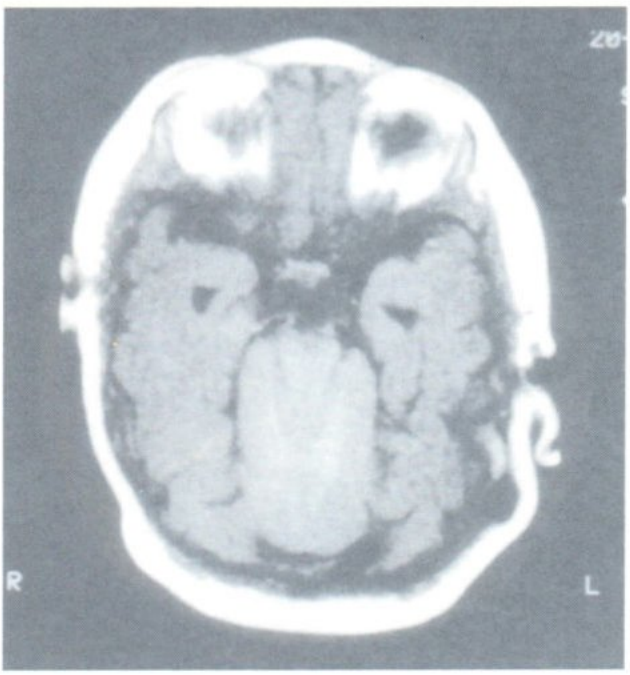


10A



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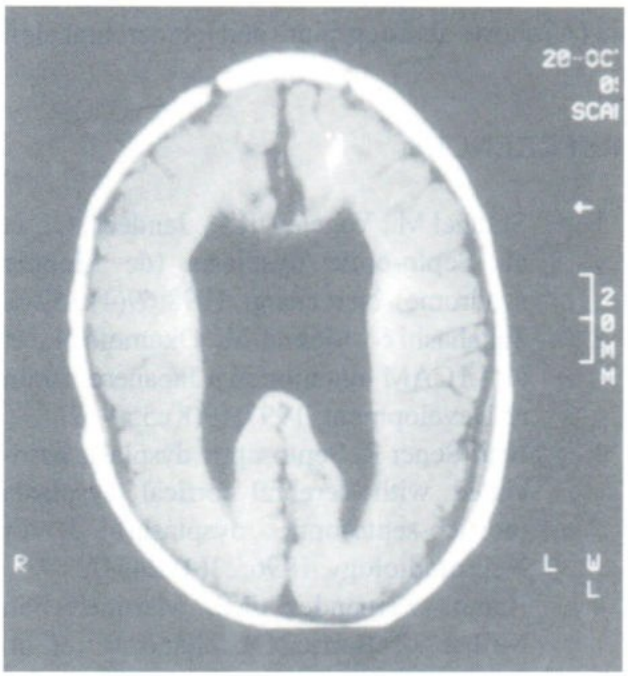

10C

Fig. 10. T1-wi of a patient with Chiari II malformation demonstrate typical beaked tectum and tonsillar herniation (A), triple peak sign of cerebellum (B) and absent septum (C). Note the normal shape of fronfal horn of lateral ventricle.

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