Use of computerized tomography scanning in supratentorial arachnoid cysts

A report on 20 children and four adults

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Congenital supratentorial arachnoid cysts are large lesions that tend to cause severe distortion and compression of the brain, particularly in infants and children. Diagnosis of such cysts has often been delayed and uncertain in the past, but development of computerized tomography (CT) has greatly improved the ease and accuracy of their identification, helping to provide for earlier surgical treatment and better care of patients. The authors report 24 cases of congenital supratentorial arachnoid cysts, 18 of which were studied with CT scanning; this method proved very valuable in pre- and postoperative assessment in all cases, and far superior to other diagnostic methods.

Key Words • computerized tomography • supratentorial cyst • arachnoid cyst

Intracranial arachnoid cysts are uncommon congenital lesions of considerable interest and importance, the origins and exact nature of which remain uncertain. Cysts may be located adjacent to the cerebellum or brain stem as well as above the tentorium, and are sometimes very large, perhaps occupying an entire hemicranium. A variety of clinical problems may be produced by such lesions, but in this paper we are considering only supratentorial cysts. Their membranous walls resemble slightly thickened arachnoid. They are loosely attached to the dura mater and cerebral cortex, and are often adherent along the base of the skull or falx. The interior is occasionally compartmentalized. The fluid contained inside is usually colorless and closely resembles cerebrospinal fluid (CSF); it may be yellow, with excess protein due in some cases to previous hemorrhage. Rarely, a second cyst is present. Cysts above the tentorium are sometimes classified by location into three types: parasagittal or interhemispheric, convexity, and Sylvian, although the symptoms produced by these are not generally distinguishable. With all these cysts, compression and distortion of the adjacent cerebrum are frequently severe but the cortex is rarely penetrated, and there is no gross communication with ventricles or subarachnoid spaces. The longitudinal sinus and falx are displaced away from the midline, and the cranium over the large sac is usually rounded, thin, and more spacious than the opposite side.

In this paper we summarize the findings and radiological features of this disorder, as well as the essentials of treatment, with special reference to a series of 24 patients, of whom 20 were in the pediatric age group, and four were adults. These patients were seen over a period of 25 years; 17 of them were first treated before the advent of computerized tomography (CT) scanning.

Symptoms and Findings

Symptoms produced by supratentorial arachnoid cysts are due basically to elevated intracranial pressure (ICP). In affected infants, persistent vomiting, irritability, and lethargy are common; convulsions are occasionally observed. Adults and older children often complain of headache, and occasionally bleeding into a cyst may precipitate sudden symptoms of ICP. The head may be larger than average at birth or grow unduly in the early weeks or months and, in
chronically affected patients, head sizes range from normal to well above average. Examination suggests conventional hydrocephalus but bulging of one parietal or temporal region is frequently present. Visual loss, strabismus, optic atrophy, papilledema, and hemiparesis have all been reported. Simple transillumination of the infant head causes lighting up of a wide area over the cyst and electroencephalographic tracings show regional suppression. Some patients with these lesions have remarkably few difficulties over many years, probably because the cyst enlarges very slowly and does not invade the brain.

In our 20 pediatric patients, the most common complaint was head enlargement. This was found at birth or early infancy in 14 patients and we observed asymmetry of the vault in half. Development was slow in nine of the 20, visual impairment was suspected in four, and three had papilledema. One adult patient had slight left proptosis for several years, then developed left eye pain at the age of 60 years, when investigation disclosed a large, left Sylvian cyst. A second woman was normal until she suffered sudden headache and hemiparesis at 34 years of age; angiography and a CT scan showed a Sylvian cyst and no evidence of bleeding. Two other previously asymptomatic adults, aged 55 and 67 years, noted subacute temporal and periorbital pain and were found to have Sylvian cysts.
CT scan in supratentorial arachnoid cysts

Radiological Features

It is now essential that patients with the symptoms and findings described above be investigated by means of CT scanning. This method usually defines supratentorial arachnoid cysts as relatively large, clearly demarcated, non-enhancing globular lesions situated between the dura mater and the deformed hemisphere. Sylvian cysts sometimes appear square with nearly straight sides and bases because they tend to shorten the temporal lobe and flatten the insula (Fig. 1). The cerebral cortex surrounding a cyst often shows the density of gray matter, but appears compressed, and the brain exhibits moderate to severe distortion; ventricles are usually shifted away from the lesion and do not communicate with it, and some degree of hydrocephalus is common. Smooth protrusion of the overlying skull is often apparent (Figs. 2 and 3 left). The cyst fluid is normally the density of water, but may be more opaque due to increased protein or blood.

Cystic neoplasms can be distinguished by the presence of an enhancing mass in one or more CT sections. Chronic subdural hematomas are much less globular in contour than a cyst, and the fluid they contain is usually denser (but may be isodense). The surrounding membranes are thicker and tend to show enhancement (Fig. 3 right). Porencephaly and other dysplasias appear more irregular in configuration and almost always show communication with the subarachnoid space or ventricles (Fig. 4). The brain surface that forms the wall of such lesions is often uneven and lacks a gyral pattern. Perhaps the most important comment regarding diagnosis is that one must avoid the mistake of identifying a large and strange-appearing intracranial defect as a hopeless degenerative or hypoplastic process that cannot be treated; the “defect” may be a benign curable cyst.

In our series, a total of 18 patients were examined by CT scans. Eleven patients were so investigated several months or years after the original craniotomies; in seven, scans were performed before any operation. Review of the latter group reveals that all showed very characteristic signs of arachnoid cyst but original interpretation was uncertain in three, and cystic tumor or cerebral hypoplasia were tentatively diagnosed. The other 11 studies were done at various intervals up to 19 years postoperatively and are reviewed in the Results of Treatment section.

Roentgenograms of the skull in patients with supratentorial arachnoid cyst almost always show asymmetry of the vault and thinning of bone over the lesion. The sagittal suture and sinus groove may be displaced away, the ipsilateral petrous bone somewhat depressed, and, especially with Sylvian cysts, the middle fossa is enlarged and the sphenoid wing elevated. These changes may also be produced by large subdural hematomas, tumors of long standing, unilateral ventricular dilatation, and porencephalic defects. Cerebral angiography shows a large avascular lesion, and dislocation of arteries, internal cerebral veins, and sagittal sinus to the opposite side. With convexity cysts, superficial veins remain on the outer layer of arachnoid beneath the dura mater while arteries are pushed downward on the hemisphere, helping to differentiate cysts from hypoplasia and neoplasms (Fig. 5). La Cour, et al., stressed that cerebral angiography has the potential to reveal a coexisting subdural hematoma that may not be visualized in CT.

Fig. 5. Angiograms, anteroposterior view (left) and lateral view (right), showing a large avascular space, and depression of the arteries and left hemisphere. The veins remain close to the dura. The cyst is between layers of arachnoid.
FIG. 6. Studies in a 3-month-old boy. **Left:** Preoperative two-needle air study showing no communication between a large right defect and severely displaced ventricles. At craniotomy extreme indentation of hemisphere by a convexity cyst was found. Membranectomy and subsequent shunting were performed. **Right:** Ten years later, the cyst remnants are small (arrow), and the brain is distorted.

scan if the hematoma is isodense. Ventriculography was once a reasonably diagnostic method but required separate punctures for the ventricular system and the cyst; this procedure is no longer recommended.

In the present series, plain skull films showed expansion and often thinning of the parietal area or middle fossa in all but one of the 24 patients. Ventriculography performed in 13 cases, demonstrated a large non-communicating defect in five, but diagnosis was clarified only in the three whose ventricles were also needled (Fig. 6 left). Pneumoencephalograms, done in four patients, indicated mass effect only. Angiography was very helpful for diagnosis in four of the eight who had this study.

FIG. 7. Postoperative computerized tomography scans in a patient who underwent left parietal craniotomy and removal of membranes of a large left parasagittal cyst at 15 months old. **Left:** Scan 4 years postoperatively, when the patient had developed persistent headache. Residual cyst is seen in the occipitoparietal area; fluid contents were of diluted blood density. There is localized expansion of the left lateral ventricle. The cyst was irrigated (bloody fluid), and cystoperitoneal shunting was performed. **Center:** Scan performed 7 months later. The cyst is smaller, and the fluid clearer; some clot is still present. **Right:** Scan 2 1/2 years after the spontaneous hemorrhage. The cyst is nearly eradicated; the ventricles are unchanged. There is evidence of cortical atrophy. The clinical course was good.

**Treatment**

Most writers have concluded that supratentorial arachnoid cysts should be treated by bone flap and at least partial removal of membranes; primary cystoperitoneal shunt has also been advised as has delayed shunt from the cyst to the peritoneal cavity or vascular system, if pressure symptoms recur. Aicardi and Bauman concluded that craniotomy was advisable if ICP developed, but recommended observation in "asymptomatic cases," and Smith and Smith cautioned that surgery is not free of risk. Treatment by aspiration through craniectomy openings is not apt to give lasting benefit.

All 24 of the patients in our series were treated by surgical methods; there was no surgical mortality or significant complications. Osteoplastic craniotomy and subtotal removal of the cyst wall was achieved in 23 patients, and one early case was treated only by aspiration through small craniectomies. In six cases, ventriculostomy was done by fenestration between the medial wall of one lateral ventricle and the cyst cavity; three of these later required cystoperitoneal or cardiac shunt for recurring pressure. Shunting was also needed in four patients who had a hemorrhage into the cyst as late as 4 years following craniotomy (Fig. 7). Two children were treated for subdural hematomas which developed several months following their primary operation.

We feel now that any child who has been shown by CT scan to almost certainly have an arachnoid cyst should be treated by craniotomy and subtotal removal of the membranous cyst wall. This reduces the compressive effects of the mass and usually controls ICP. Our experience suggests that internal ventriculostomy is not worthwhile, and we do not recommend shunting.
as a primary procedure in young children before more definitive measures. In the case of an adult, particularly one who is elderly, cystoperitoneal shunting may at times be wiser as a first step with subsequent craniotomy if symptoms continue. In all cases treated by craniotomy, a postoperative CT scan should be obtained in about 3 months, and periodically for 1 to 2 years; if the cyst cavity does not become significantly smaller, cystoperitoneal shunting should be considered to assist expansion of the brain. If, instead, the scan demonstrates increased dilatation of the ventricles, presumably due to blockage of the arachnoid pathways or aqueduct, a ventriculoperitoneal shunt is advised.

Results of Treatment

The reported results of surgical treatment of supratentorial arachnoid cysts have been generally favorable, although most series are relatively small and the follow-up period is limited. However, in spite of variations in surgical technique and unknown factors in the natural history of untreated cysts, it can be clearly shown that surgery has been very beneficial in many patients. Extended observation of a larger number of cases will be needed to provide more complete information regarding long-term results.

In the present series, postoperative observation ranged from 8 months to 19 years. Of 15 patients who had excellent or good results, two are mildly retarded but two are exceptionally bright; four other children with fair results are moderately defective and one is hemiparetic. Three with marked mental loss and hemiparesis are considered poor results; one of these was treated with burr-hole aspirations. All four adult patients recovered well after craniotomy and mem- branectomy for Sylvian cysts, and are neurologically normal.

Correlation between postoperative CT findings and the long-term condition of certain patients is of interest. Eight children, 6 weeks to 15 months old at the time of surgery, were found to have very large cysts occupying most of one hemicranium; all were treated by craniotomy, and six subsequently required shunting. They were re-examined and scanned 6 to 19 years later. Seven showed the following late changes on CT: The cyst remnants were small, usually not more than 10% of the original volume; ventricles were not notably dilated but showed odd irregularities, and in one patient there was outpouching in the area of the previous cyst (Figs. 6–8, Table 1). Other changes included regional or general overgrowth of the brain and some widening of the sulci. Recent examinations showed no neurological defects in these patients, and all were of good general appearance although their heads were large, measuring at or above the 98th percentile. One had good intelligence and was considered normal, but the other seven showed varying degrees of learning difficulties and mild personality defects. Considering the very severe distortion of the brain produced by the original cysts, it is remarkable to observe how well these patients function.

Comment

In reviewing our cases and the work of others, it becomes apparent that CT scanning has significantly improved the care of patients with intracranial arachnoid cysts. Clinical appraisal and surgical techniques remain important, as always; but CT scanning has increased the frequency and accuracy of early diagnosis, aided considerably in the management of operations, and enhanced postsurgical care. It is logical to predict that, in the future, arachnoid cysts will be identified more commonly and their origins and nature better understood. Prompt diagnosis and treatment will help to reduce brain damage and provide better long-term results for afflicted patients.

References


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