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Radiological study of primary spontaneous CSF rhinorrhoea

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Abstract
A radiological study of skull base anatomy was performed in patients presenting with primary spontaneous CSF rhinorrhoea. Radiology correctly identified the fistula site in 90 per cent of cases. Contrast CT imaging was found to be the most suitable technique for identifying the presence and site of CSF fistulae. However, pre-contrast bony dehiscences were identified in all patients leaking from the cribriform plate region. More significantly, all of these patients showed deviation of their crista galli, a radiological sign hitherto unreported. These findings support the theory that congenital bony dehiscence is the aetiological basis for this condition. The importance of radiology in the management of this condition is emphasized.

Introduction

Primary spontaneous CSF rhinorrhoea is a rare but interesting clinical condition. As recently as 1970, fewer than 150 cases had been reported in the literature (Brisman *et al.* 1969). Credit is given to St. Clair Thomson for bringing greater clinical recognition to this condition after writing his treatize on the subject in 1899.

Spontaneous CSF rhinorrhoea may be primary or secondary. Primary rhinorrhoea is where no underlying cause can be found (Troland, 1960). Secondary rhinorrhoea may be caused by intracranial pathology; in particular pituitary tumours, gliomas, meningiomas, craniopharyngiomas, encephalocoeles and olfactory neuroblastomas have been reported as causing CSF rhinorrhoea. Extracranial conditions such as osteomas, suppurative sinus disease, angiofibromas and specific granulomatous conditions, such as syphilis and leprosy, may also be responsible (McCoy, 1963). The distinction between primary and secondary CSF rhinorrhoea is, therefore, fundamental from a treatment point of view.

Radiology plays a key role in the management of this condition. First, it is imperative that any underlying cause be found. Second, it is useful to obtain radiological confirmation of the CSF leak. Finally, radiology determines the anatomical site, side and size of the fistula and thereby assists in planning the surgical approach.

Several methods have been used for locating the site of the CSF leak. Amongst these are conventional radiology, pneumoencephalography, dye studies, radioimaging and, more recently, contrast CT imaging.

Di Chiro and Reames (1964), reported the use of radioimaging techniques long before the establishment of contrast CT. Various reports have since supported the use of radioisotope cisternography (Salar *et al.*, 1978; Lantz *et al.*, 1980). However, radioimaging techniques have several drawbacks (Calcaterra, 1980). First, radioimaging cannot reveal the fine anatomical detail required to locate the exact site of the leak, which will, naturally, be very important when planning the surgical approach. Second, isotope is rapidly absorbed into the circulation and thereby distributed into turbinate tissue making interpretation difficult. This may lead to false positive results. Finally, positioning the patient may lead to contamination of pledgets placed elsewhere, again leading to interpretation problems.

In 1977, the use of computed tomography (CT) with a non-ionic water soluble contrast agent (metrizamide) was evaluated (Drayer *et al.*, 1977; Manelfe *et al.*, 1977). In 1978, CT was used to show a fistula in the cribriform plate following intranasal ethmoidectomy (Levy *et al.*, 1978). Since then, other water soluble contrast agents such as Iopamidol have also been used (Hammer and

TABLE I
RADIOLOGICAL FINDINGS

Cribriform plate	
AZ	Minimal deflection of the crista galli. CT cisternogram showed a defect in the right cribriform plate and anterior fovea ethmoidalis.
FM	Crista galli deviated to the left. Defect in the right cribriform plate. Negative CT cisternography.
SS	Crista galli deviated to the right. Opaque left sphenoid sinus. CT cisternography revealed contrast passing through a defect in the cribriform plate into the nasal cavity.
LS	Anterior part of the crista galli deviated on axial CT. CT cisternography confirmed the presence of a defect in the cribriform plate and contrast in the nasal cavity.
JM	Crista galli deviated to the left. CT cisternography confirmed the presence of a defect 1 cm posterior to the crista galli and contrast in the right side of the nasal cavity.
Sphenoid sinus	
BP	CT cisternography showed contrast in the sphenoid sinus.
GN	Fluid level in the right sphenoid sinus. No contrast study.
JS	Fluid in the left sphenoid sinus. Pterygoid recess present on the left side.
TH	Fluid in the left sphenoid sinus. Large lateral sphenoid recess and contrast in the sinus after CT cisternography.
BS	Fluid level in the left sphenoid on CT and probable defect in the region of the pterygoid recess.

TABLE II
OPERATIVE FINDINGS

Cribriform plate	
AZ	Defect in the right cribriform plate and fovea ethmoidalis.
FM	Defect in the right cribriform plate.
SS	Defect in the left cribriform plate.
LS	Defect in the left cribriform plate.
JM	Defect in the right cribriform plate.
Sphenoid sinus	
BP	Defect in sella turcica.
GN	Defect in the right superolateral sphenoid roof.
JS	Leak from a left sided sphenoid recess.
TH	Leak from a large left sided sphenoid recess.
BS	Leak from a left sided sphenoid recess.

Lackner, 1980). Contrast CT imaging has now become established as the most acceptable diagnostic tool.

A retrospective study was performed in ten patients presenting with primary spontaneous CSF rhinorrhoea. A detailed study of skull base anatomy was made so that common aetiological factors might become more apparent, in what constitutes a very large series of this rare condition.

Results

Ten patients presenting with primary spontaneous CSF rhinorrhoea were studied. Their mean age was 46 years with a female/male ratio of 2:1.

Table I shows the radiological findings which can be compared with the operative findings shown in Table II.

There were five patients with cribriform plate defects and five with fistulae into the sphenoid sinus.

Cribriform plate

All five patients showed deflection of their crista galli.

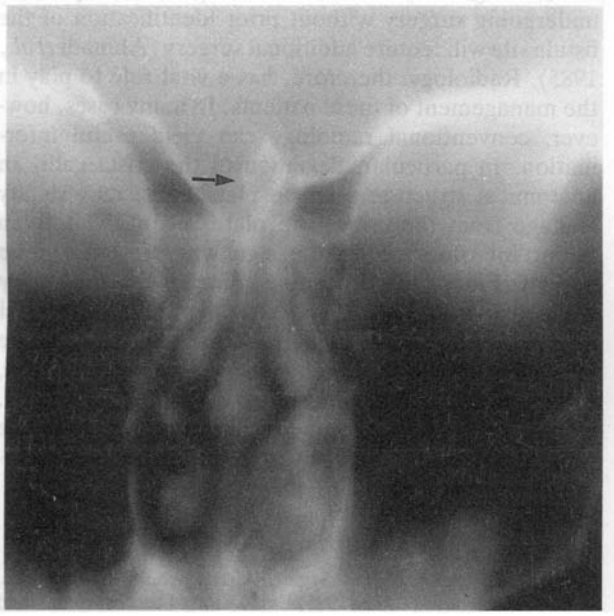

FIG. 1

Shows a coronal CT view of a deviated crista galli, a radiological sign seen in all patients who were surgically found to be leaking from the cribriform plate region.

This was usually best demonstrated by coronal CT or conventional tomography (Fig. 1), but in two patients displacement was best appreciated on axial CT (Fig. 2).

In four patients the site of CSF leak was confirmed by CT cisternography. In the remaining patient the fistula was not shown.

Sphenoid sinus

Two of the five patients in this group were diagnosed before cisternography by the presence of a fluid level in the sphenoid sinus.

The remainder were diagnosed at CT cisternography with contrast entering the sinus cavity.

Pre-contrast bony dehiscences could be identified in all patients found to be leaking from the cribriform plate region. In addition, all had deviation of their crista galli. Figure 3 shows metrizamide contrast leaking from the left cribriform plate region.

Discussion

These findings allow speculation as to the aetiological basis for this condition. It is probable that bony dehiscence and meningocoele formation are predisposing factors. Anderson *et al.* (1961), proposed that normal pulsatile CSF pressures may erode bone leading to the formation of small encephalocoeles. Ommaya (1976), proposed that atrophy of nerves within the region of the cribriform plate or sella turcica might offer another explanation. By creating 'dead space' small meningocoeles might thereby be created. Similarly, Thomson believed that perineural defects of the olfactory nerves were the cause.

An argument against secondary bony atrophy would be that if this were the only explanation, the condition might be expected to be more prevalent in old age, and not as is the case, in middle age. In addition, a higher incidence in women would also be difficult to explain. It is noteworthy, however, that in 30 per cent of cases studied, rhinorrhoea was actually brought upon by nose blowing associated with the common cold. It is easy to understand how the 'Valsalva like' action of nose blowing, by increasing CSF pressure could rupture a men-

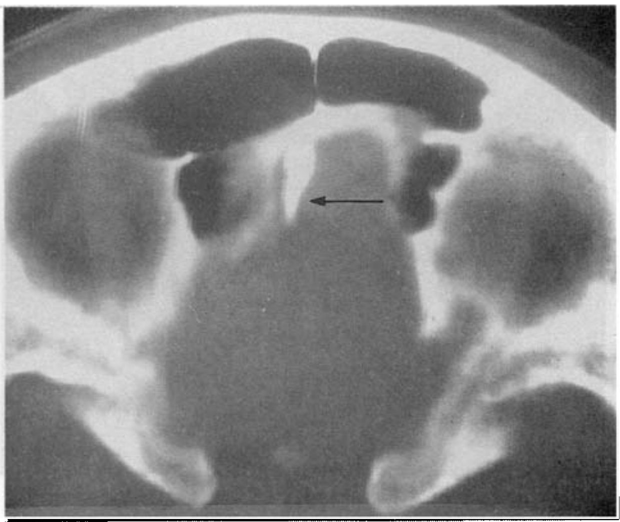

FIG. 2

Shows an axial CT view of a deviated crista galli.

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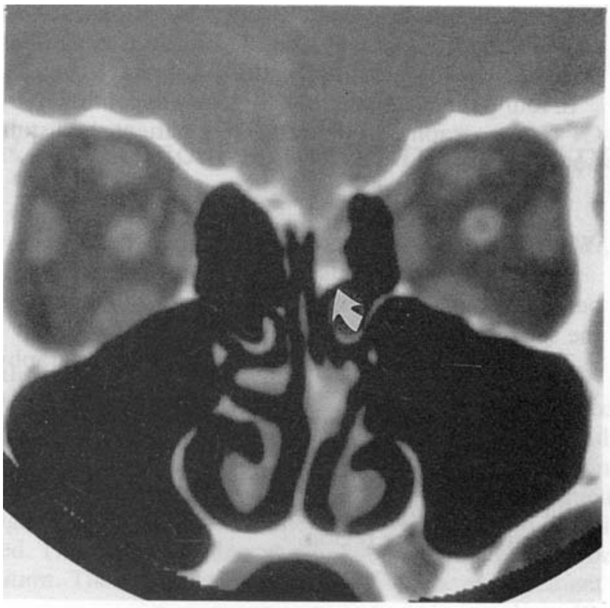

Fig. 3

Shows a coronal CT view following intrathecal administration of contrast (metrizamide) agent. The arrow shows leakage of contrast in the cribriform plate region.

ingocoele at a site of bone dehiscence. At such sites, forces imparted by CSF pressure would not be counteracted by an opposite and equal force from the bony skull base. Rupture would be particularly prone to occur at such sites.

To support the theory that congenital bony dehiscence is an important aetiological factor, the question 'what is the incidence of bony dehiscence in a control population?,' should be addressed.

Ohnishi (1981), found in anatomical studies, that 14 per cent of ethmoid bones had bony dehiscences. Furthermore, these may be multiple. A detail of the utmost surgical importance is that the cribriform plate may extend into the frontal recess, that is, lateral to the middle turbinate bone (Lang, 1989). Similar dehiscences have been described in the sphenoid sinus (Peele, 1957; Morley and Wortzman, 1965). In contrast, frontal sinus dehiscences are reported as an unusual variant, present in approximately 10 per cent of skulls (Lang, 1989).

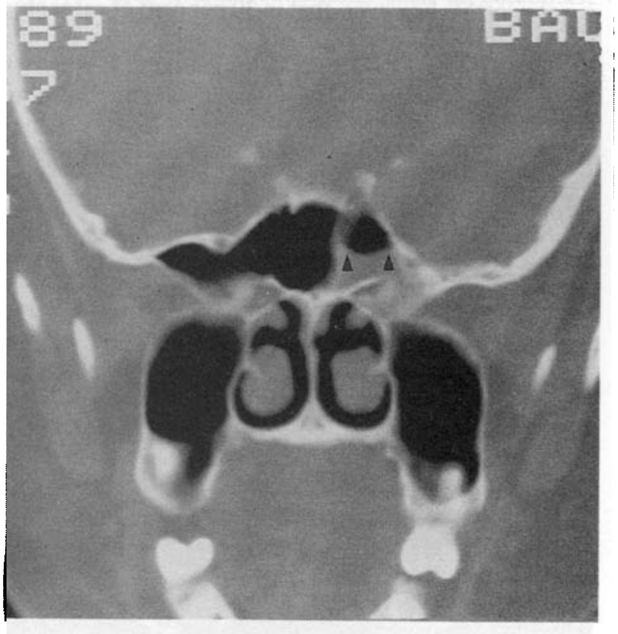

Fig. 4

Shows a coronal CT view of the sphenoid sinus. Excessive pneumatization of the sphenoid sinus can be seen. The arrows show the presence of a fluid level.

Why bony dehiscences occur remains unknown. Excessive pneumatization of the sinuses may be one explanation. Sphenoid recesses are common, in particular inferolateral recesses may be seen in 25 to 36 per cent of sinuses (Lang, 1989). Morley and Wortzman reported lateral extensions in 28 per cent of skulls, in 16 per cent these were bilateral. Recesses may pneumatize the greater wings of the sphenoid (Fig. 4), reaching as far as the apex of the temporal bone and foraminae of ovale and rotundum (Peele, 1957). Extensive pneumatization increases sinus surface area thereby making an association with bony dehiscence more likely. The presence of recesses in a patient presenting with spontaneous CSF rhinorrhoea may, therefore, be significant. Their presence may herald a fistulous communication with the middle cranial fossa. It is unproven, however, whether such patients have an increased association with excessive sinus pneumatization compared to a control population.

In patients studied in this series, contrast CT imaging was found to be the most informative radiological technique. In all cases, scanning must include views of the anterior, middle and posterior cranial fossae inclusive of the inner ears. Isotope cisternography, should be employed in cases where the diagnosis remains in doubt. The presence of radioactive tracer on pledgets placed within the nasal cavity will, in such instances, confirm or refute the diagnosis.

Peroperatively, intrathecal injection of fluorescein dye (0.5–1 ml of a 5 per cent solution mixed in 20 ml of CSF or Hartman's solution) may help localize the fistula site (Montgomery, 1973). About 30 per cent of patients undergoing surgery without prior identification of the fistula site will require additional surgery (Ahmadi *et al.*, 1985). Radiology, therefore, has a vital role to play in the management of these patients. In many cases, however, conventional radiology can yield useful information. In particular, deviation of the crista galli, an anatomical structure seen on plain films, may signify leakage from the cribriform plate region. This is an important observation; the sign was present in one patient (Fig. 1) when positive contrast cisternography was negative. It is best demonstrated by coronal or axial CT. In addition, sites of bony dehiscence may also be identified by conventional radiology. Plain films may, therefore, still be informative and should be requested. Contrast CT imaging, however, remains the definitive radiological method for investigating patients presenting with spontaneous CSF rhinorrhoea.

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