

Study on spontaneous cerebrospinal fluid rhinorrhoea: its aetiology and management

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Abstract

The aim of this study was to identify the common features in a study group of patients with spontaneous cerebrospinal fluid (CSF) rhinorrhoea, to develop a hypothesis to explain the cause of this condition and to investigate the outcome of surgical techniques adopted to repair the leak. In this retrospective study the authors have reviewed all the cases of spontaneous CSF leaks attending and receiving treatment from the otolaryngology department of Queen Elizabeth Hospital, Birmingham, from 1992 to 2002.

Of 34 patients with CSF leaks, 15 were spontaneous in nature and formed the study group. Of these 15 patients, 14 were female; with ages ranging from 37 to 70 years and a median age of 50 years. All the female patients were overweight with a body mass index (BMI) >24.9 and, of these, nine were considered obese with a BMI >30. It was attempted to identify common factors in the study group and it was evident that female sex, obesity and age played a key role in this condition.

The follow-up period ranged from two to 98 months. Thirteen patients were asymptomatic but two patients remained symptomatic, one of these despite repeated surgical intervention.

Key words: Cerebrospinal Fluid Rhinorrhoea, Endoscopy

Introduction

Cerebrospinal fluid (CSF) rhinorrhoea is a rare cause of watery nasal discharge. It indicates a communication between the nose and the subarachnoid space with breach of bone, dura and arachnoid layers.

It is most commonly traumatic and can occur as a result of disruption of the arachnoid and dura, raised CSF pressure or a bony defect.

Spontaneous CSF rhinorrhoea occurs in three to four per cent of all cases,¹ where normal pressure CSF leaks (55 per cent) outnumber the high pressure CSF leaks (45 per cent). It was first described by Miller,² who in 1826 reported a case of a boy who had a progressively enlarging head and recurrent bouts of profuse fluid discharge from his nose. The presence of a fistula was confirmed at necropsy. Up to 1969, fewer than 150 cases had been reported in the literature.³ The recent technique of extracranial repair was first described by Dohlman,⁴ since then many others have described the technique using both flaps and free grafts. Wigand⁵ and Stankiewicz⁶ were the first to report on endoscopic repair.

Pathophysiology

High-pressure CSF rhinorrhoea may be associated with a slow-growing tumour (84 per cent) or with hydrocephalus where the leak acts as a safety valve

to alleviate the increased intracranial pressure. In such cases repair of the leak must be in conjunction with the removal of the underlying pathology.⁷

In normal pressure leaks the following theories of aetiology are described:

- (1) Ommaya's theory of focal atrophy⁸ states that the contents of the cribriform plate or sella turcica are diminished in bulk due to ischaemia. The empty space becomes a pouch filled with CSF thus enabling the normal CSF pressure pulse to exert a focal and erosive effect;
- (2) rupture of the arachnoid sleeves passing through the cribriform plate with olfactory nerve filaments;⁹
- (3) persistent embryonic olfactory lumen;⁹
- (4) meningo-encephalocele.⁹

Maldevelopment of the diaphragma sellae may be an added factor. Normal CSF pressure is pulsatile and the pulsations are mainly due to respiratory and cardiac activity causing variations of 15–45 mm of CSF pressure.¹⁰

Constant pulsations of CSF on the lamina cribrosa cause distension of the subarachnoid pouches resulting in erosion of the bone and eventually leading to the establishment of a fistula.¹¹ Due to the intimate anatomical relationship between the subarachnoid space and the nasal cavity at the

lamina cribriosa, perforation of the pia arachnoid results in CSF rhinorrhoea.¹¹

Historically, CSF leaks have been repaired by an intracranial approach. This had the advantage of directly visualizing the fistula from above and assessing any co-existing intracranial pathology. Its disadvantages are those of craniotomy, with retraction on the frontal lobes causing a high incidence of anosmia, possible cerebral oedema and intracranial haemorrhage with resulting morbidity and mortality.^{12,13}

The upper part of the nose, especially the area above the superior turbinate, is difficult to approach but, with the advent of the nasendoscope and microscope, the area has become accessible and CSF leaks can be identified and repaired successfully with minimum morbidity and mortality. The aim of this study was to identify common features in the group of patients with spontaneous CSF leaks, to develop a hypothesis to explain the cause of this condition and to investigate the outcome of surgical techniques adopted to repair the leak.

Materials and methods

In this study the authors included the patients with spontaneous cerebrospinal fluid rhinorrhoea who attended the out-patients department of Otolaryngology and Head and Neck Surgery at Queen Elizabeth Hospital, Birmingham between September 1992 and November 2002. A total of 34 cases were identified who underwent repair for their CSF leaks. Patients with a history of head injury (traumatic) or with a history of any operation in the base of the skull and nasal roof (iatrogenic), prior to commencement of their CSF rhinorrhoea, were excluded. Fifteen patients were identified as having primary spontaneous CSF rhinorrhoea and were included in this study. Data collection included the patient's sex, age, weight, height, body mass index (BMI), complications, method of localization of defect, operative techniques, graft materials used during operation, post-operative and long-term follow-up results from the hospital records and telephone interview with the patient.

Results

Of the 15 cases of primary spontaneous CSF rhinorrhoea, 13 were female and two were male. Their ages ranged from 37 to 70 years with a median

age of 50 years. All 13 female patients were overweight (BMI >24.9) and of these nine were obese (BMI >30). One of the two male patients was obese, the remaining male patient was of normal BMI (normal BMI = 18.5–24.9 kg/m²) (Figure 1).

The Department of Health has published the UK BMI distribution for the general population for age and sex groups.¹⁴ In the general population, the incidence of obesity (BMI >30), within a similar age matched group to the present series, is 27 per cent, however, in the authors' group the incidence of obesity was 10/15 or 67 per cent. Additionally the incidence of obesity in the general population for all females is 22 per cent, the present series yielded obesity rates of nine out of 13, or 70 per cent.

The duration of leak varied from four weeks to six years. The weight of the patients varied from 70 to 116 kg and BMI was from 25–50. Four patients had a history of meningitis. One patient presented with left-sided hemiparesis with a large pneumoencephalocele in the right fronto-parietal region (by computed tomography (CT) and magnetic resonance imaging (MRI)). A frontal burr hole was used to evacuate the air but this reaccumulated.

Two patients were treated for perennial rhinitis for a duration of four years before CSF rhinorrhoea was considered. Eight patients had a primary repair and two patients had unsuccessful repair prior to attending the authors' department.

Four patients were identified with a meningocele/meningoencephalocele in the roof of the nasal cavity and one patient had a nasal glioma. One patient had a large occipital meningioma with signs of increased intracranial pressure and the localizing signs of tumour, which was successfully removed by the neurosurgeons by parietal craniotomy with subsequent improvement from the symptoms, but she developed spontaneous CSF rhinorrhoea six months after she had her initial surgery.

The nasal fluid of eight patients was tested for B2 transferrin (Tau protein) and all were positive. Glucose levels were measured in the nasal fluid in six patients and the level ranged from 3.33 mmol/l–3.8 mmol/l. Rigid endoscopy in the out-patient department revealed the leak and pathology in seven patients.

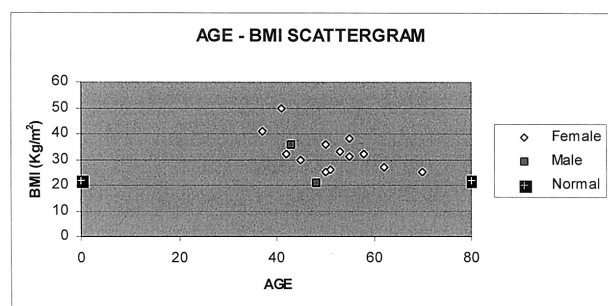


FIG. 1

Patient demographics: age and BMI.

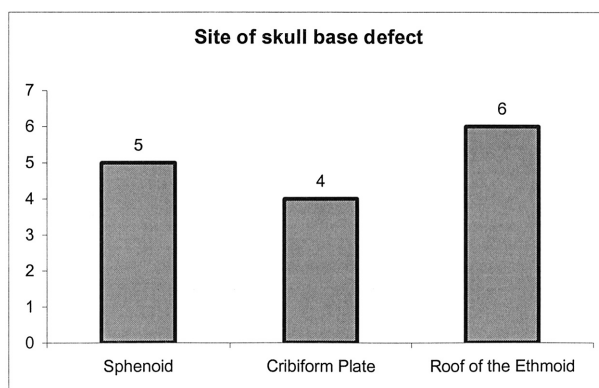


FIG. 2

Site of skull base defect.

CT or MRI delineated the bony dehiscence in 10 patients and was reported as normal in four patients. An isotope cysternogram was carried out in one patient, where it demonstrated a meningocele. Intrathecal metrizamide dye was used in one patient which only confirmed the findings of non-contrast CT. CT scan identified ventricular enlargement in one patient who also had a congenital cyst in the septum pellucidum removed by endoscopic cranial surgery through a frontal burr hole.

The site of the skull base defect detected per operation is shown in Figure 2.

Ten patients underwent endoscopic surgery for their repair of CSF leak, four were approached by external ethmoidectomy through a Howarth incision. Of the endoscopic group, three developed a recurrence, and two of these were subsequently approached via an external ethmoidectomy.

The type of material used for surgical repair of the defect is shown in Figure 3.

Lyostypt was used in all patients and Tisseal in 11. The nose was packed with bismuth and iodoform paraffin paste after the operation and kept *in situ* for three to seven days duration depending on the size of repair. Post-operative antibiotics were used in all patients. None had a lumbo-peritoneal shunt during the operative procedure. The follow-up period was from two to 98 months and 13 patients were cured of their symptoms and complications but two are still symptomatic, one of these despite a third attempt at repair.

Discussion

Obese female patients in their fifth and sixth decades are the most common group to suffer from spontaneous CSF rhinorrhoea. Despite the small sample size with a sex matched sample, an F-test statistical analysis of BMI revealed an F critical value of 2.5 with $p < 0.01$.

Intracranial pressure seems to be a crucial factor in developing CSF rhinorrhoea although in primary spontaneous cases it is not persistently high. Normal intracranial pressure is pulsatile and these pulsations imply continued brain perfusion. Normally the amplitude of cardiac pulse in the CSF pressure is 15 mmH₂O and combined respiratory and cardiac variation is about 45 mmH₂O.¹⁰

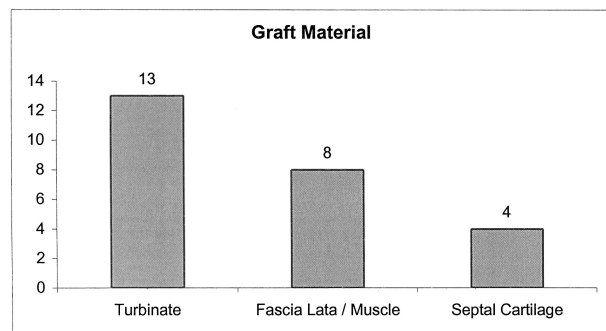


FIG. 3

Graft material used for repair.

In CSF pressure curves it is seen that increased right atrial pressure increases the cerebral venous pressure and thus, transiently, increases CSF pressure. These pulsatile variations of CSF pressure are higher in obese subjects than in their normal counterparts. Sugerma *et al.*^{15,16} postulated that central obesity raises intra-abdominal pressure, consequently increasing the pleural pressure and cardiac-filling pressure which in turn impedes the venous return from the brain leading to raised intracranial pressure. The authors speculate that the pulsatile variations of CSF pressure on the lamina cribrosa result in erosion of bone and protrusion of brain and/or meninges forming a meningocele and/or encephalocele. Therein pulsatile pressure finally causes rupture of the arachnoid without having the support of underlying bone leading to formation of a fistula. In this study the authors showed that four patients (five out of 15) with spontaneous CSF rhinorrhoea had an associated meningocele and/or encephalocele. These were recognized as a bluish polyp during nasendoscopy and were confirmed histologically from the biopsy performed during the closure of the leak.

The age of the study group of patients ranged from 37–70 years and the median was 50, these figures are similar to other studies.^{5,6}

Why is it that females in their fifth and sixth decades are at an increased risk of developing CSF rhinorrhoea? The possible explanation may be that the female bones are thinner than the male making them prone to erosion and with advancing age the thickness of female cranial bones decreases (Lippert¹⁷) whereas the thickness of male cranial bones increases with age, although this is not specific to the lamina cribrosa.

The percentage of spontaneous to total CSF rhinorrhoea is reported to be three to four per cent, but in this study the authors had a total of 34 patients with a CSF leak, of these 15 were spontaneous cases and the percentage was therefore 44 per cent.

In another study by Mao *et al.*,¹⁸ it was shown that 50 per cent were spontaneous (10 cases out of 20). Dodson *et al.*,¹³ showed that 31 per cent were spontaneous (nine spontaneous cases out of 29 cases). Hughes *et al.*,¹⁹ showed 35 per cent were spontaneous (six spontaneous leaks out of 17 patients). It may be a reflection of the small size of the study groups or possibly improvements in diagnostic techniques in nasendoscopy.

Much the largest group of CSF rhinorrhoea is traumatic (80 per cent) which heals with conservative treatment and does not warrant surgery.

Detection of beta-2 transferrin in the nasal fluid could be helpful for diagnosing the presence of CSF leaks. In the present series 80 per cent of patients were confirmed to have this protein in their nasal discharge. Although beta-2 transferrin can be a false positive in patients with inborn errors of metabolism of glycoprotein, chronic liver disease, or genetic variants of transferrin,²⁰ some authors believe that venous blood samples should be collected

simultaneously with the rhinorrhoea fluid; this was the present authors' practice.

Glucose estimation and oxidase testing of the nasal fluid may also be helpful. Nasendoscopy in the out-patient clinics was performed routinely to find the defect in the skull base but it could only be identified in 50 per cent of cases. CT scans and/or MRI also detected the bony defect in 66 per cent of patients, but they must be performed before any surgical intervention (especially coronal sections). The authors used intrathecal dyes or an isotope cysternogram only when there were difficulties in localizing the defect through endoscopy or CT scan, or in the case of recurrent leaks.

- **The aim of this study was to identify the common features in a study group of patients with spontaneous CSF rhinorrhoea, to develop a hypothesis to explain the cause of this condition and to investigate the outcome of surgical techniques adopted to repair the leak**
- **Female sex, obesity and age play a key role in this condition**

As a graft material the authors used mainly a combination of the turbinates (middle or inferior turbinate) and septal cartilage. The turbinates not only act as a unique composite graft, removing the turbinate from the side of the leak gives good exposure of the operative field. In the case of larger defects (>15 mm), the turbinates were reinforced with fascia lata and muscles from the thigh. Tisseal glue and Lyostypt were used as tissue adhesives together with routine use of per-operative antibiotics and a bismuth and iodoform paraffin paste pack in the nose.

In the present series the success rate after initial repair was 80 per cent. This increased to 86 per cent after the second attempt. None of the patients suffered from post-operative anosmia, transient hemi-paresis or frontal lobe abscess.

In both the diagnostic and operative steps the advent of the nasendoscope has played a key role in the management of CSF leaks. Previously the requirement for an intradural exposure frequently converted a small leak into an extensive one.

In conclusion, this study has shown that obese middle-aged women are more prone to spontaneous cerebrospinal fluid rhinorrhoea and that the surgical repair of choice is extracranial.

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