

Anatomical considerations in the aetiology of fronto-ethmoidal mucoceles

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SUMMARY

Aetiological factors in the formation of fronto-ethmoidal mucoceles are examined in 80 patients. The degree and duration of obstruction and the absence of alternative drainage routes are important in the development of this condition but to investigate the mechanism of bone resorption and mucocele expansion, PGE2 levels have been measured in the mucosa from mucoceles and normal frontal sinuses. Significantly greater levels of PGE2 were demonstrated in the mucocele mucosa. Whilst aetiological factors can be defined in 71 %, the largest single group has no known cause and it is likely that they represent a vulnerable population in whom there is a degree of intrinsic narrowing and tortuosity of the fronto-nasal duct with total obstruction produced by minor sub-clinical inflammatory changes.

INTRODUCTION

Despite experimental and clinical investigation, the aetiology of fronto-ethmoidal mucoceles remains obscure. A number of factors have been described but questions remain. Why is it that every patient who experiences midfacial trauma, has nasal polyps, sinus surgery or chronic sinusitis does not develop a mucocele? Why is it that even in the presence of these conditions which affect more than one sinus, patients rarely develop bilateral mucoceles? Clearly more than straight-forward blockage of the frontonasal duct is involved.

SURGICAL ANATOMY

The configuration and drainage of the frontal sinus is variable. The sinus may be compartmentalised by incomplete bony septa but a complete intersinus septum is usually present. (One hundred cadaver examinations undertaken by the author have demonstrated that 90 % of intersinus septa are complete.) Supernumerary sinuses are extremely common and normally drain independently by separate ostia communicating with the frontal region of the middle meatus and separate pneumatization of the horizontal portion is not uncommon.

Considerable variation exists in the manner by which the sinus communicates

with the nasal cavity and is directly related to the embryology. When it arises as a direct extension of the whole recess, it may open by an ostium into the anterior part of the middle meatus. When the sinus arises from one of the furrows or from one of the cells of the infundibulum, a frontonasal duct is present. Therefore, the sinus may drain via the duct alone, separate from the infundibulum ethmoidale or partly by both routes. The length, diameter and tortuosity of the duct varies considerably and therefore in those with a long serpentine course and encroached upon by a neighbouring anterior ethmoidal cell, the slightest swelling of the mucosa will cause occlusion.

METHOD AND MATERIALS

Eighty patients with fronto-ethmoidal mucoceles were treated between 1962-1983 by Professor D.F.N. Harrison at the Royal National Throat, Nose and Ear Hospital. The cases were examined with particular reference to relevant aetiological factors and the time interval between these factors and presentation with the mucocele. In all cases patients underwent a modified Lynch-Howarth approach, radical fronto-ethmoidectomy (including opening of the frontal intersinus septum) and the majority had insertion of a large fenestrated (1 cm diameter) silastic tube from the frontal sinus into the nasal cavity, which was removed at a later date in out-patients. In all cases, there was no evidence of acute infection, the contents of the mucocele being sterile to culture.

RESULTS

There were 48 men and 32 women, their ages ranging from 13-81, with an average of 53.5 years. There was an average of 35 months follow-up (all patients with less than six months follow-up being included), with right and left sides equally affected. 90% had a large fenestrated indwelling silastic tube which was left in place an average of five months.

Aetiological factors

Relevant aetiological factors were sought and seven groups defined. These included direct serious trauma involving fracture of facial bones, nasal polyps untreated or removed surgically, frontal sinusitis treated medically or surgically, a miscellaneous group which included osteomas and maxillary sinus surgery for cysts, and those in whom no aetiological factor could be determined. The polyps had been removed intranasally whereas surgical treatment of frontal sinusitis was in all cases by external fronto-ethmoidectomy.

The results are presented in Table 1. Whilst aetiological factors can be defined in 71%, the largest single group has no known cause but is representative of the entire group in both distribution of sex and age. When the time interval between aetiology and presentation is considered it is significantly longer in those in whom

Table 1. Aetiological factors in the development of frontoethmoidal mucocoeles.

	aetiological factors						
	none	trauma	polyps no surgery	polyps surgery	infection anti- biotics	infection surgery	other
number	23	9	12	9	8	13	6
%	29	11	15	11	10	16	8
male %	65	55	66	77	50	46	50
female %	35	45	34	23	50	54	50
age range	24-81	20-59	37-70	46-70	18-63	42-80	39-55
average age	55	42	52	56	39	60	49
time interval (yrs)	-	8-30	-	.25-30	.17-8	14-57	9-15
average time (yrs)	-	21	-	12.5	1.8	29	12

trauma or surgery for infection or polyps occurs when compared with the group in whom infection had been treated conservatively with antibiotics ($p = 0.000$, $p = 0.000$ and $p = 0.02$ respectively). In addition infection treated by surgery is associated with a significantly longer interval than polyps treated by surgery ($p = 0.0003$)

Prostaglandin estimation

Mucous membrane lining the fronto-ethmoidal mucocoeles has been analysed for levels of PGE₂ (ng/mg wet tissue) using the technique described by Harris et al. (1973). These levels have been compared with those obtained from mucous membrane taken from apparently normal frontal sinuses opened during craniotomy procedures for non-infective conditions and the results (Table 2) show significantly higher levels of PGE₂ in the mucocele tissue.

Table 2. Results of prostaglandin estimations.

prostaglandin levels (ng PGE ₂ /mg wet tissue)	
normals	mucoceles
14.82	23.20
14.82	24.00
16.00	24.01
16.18	29.58
21.20	40.40
25.76	44.10
	49.86
	59.02
n = 6	n = 8
range = 14.82-25.76	23.20-59.02
mean = 18.13	36.77
p = <0.001	

DISCUSSION

A number of aetiological factors are commonly quoted in the literature on fronto-ethmoidal mucoceles. These may be broadly divided into those related to obstruction of the frontonasal duct and those associated with inflammation. Polyps, trauma, surgery and tumours comprise the obstructive group, infection, increased mucus secretion, cystic degeneration and allergy the inflammatory group (Bordley and Bosley, 1973; Canalis et al., 1973; Dobie, 1983; Finn et al., 1981; Howarth, 1921; Kastenbauer, 1967; Lund and Lloyd, 1983; Palubinskas and Davis, 1959; Schenck et al., 1974; Schuknecht and Lindsay, 1949; Sellars and De Villiers, 1981). However, no attention has been paid to the group in whom no factor can be defined. Experimental studies using animal models have been largely inconclusive. Schenck et al. (1974) were unable to produce a mucocele by simple obstruction of the fronto-nasal duct in dogs but found a mucus-containing cyst partially filling the sinus when mucoperiosteum was stripped in addition to obstruction which they did not believe constituted a true mucocele. No analysis of aetiological factors has been possible on small series, often treated by a variety of people in a variety of ways. The series presented comprises patients treated by one person in exactly the same fashion and allows such an analysis.

It can be seen that each of these factors may be responsible and that there are some significant differences in time interval exist between the groups. A long period of time (23 years) separates trauma and surgery from presentation whereas when infection is treated by antibiotics, a significantly shorter time interval occurs (22 months) suggesting simply the presence of a sterile pyocele. The degree and duration of obstruction and the absence of alternative drainage routes via the ethmoids or through a deficient intersinus septum, is obviously important in the development of a mucocele but the characteristic bone resorption and expansion requires some other mechanism such as superadded inflammation possibly initiated by infection.

Histological examination of mucocele mucosa demonstrates the presence of chronic inflammation, fibrosis and a dynamic balance at the mucocele/bone interface where osteoclast and osteoblast activity results in osteolysis, new bone formation and sclerosis (Batsakis, 1979). The mucocele mucosa is capable of producing a bone-resorbing factor, PGE₂ in higher concentrations than found normally. Whilst it would be of value to examine a series of specimens from patients with acute and chronic frontal sinuses, to date insufficient numbers are available for statistical comparison. Further studies are in progress to confirm that mucosal fibroblasts are the principal source of the prostaglandin, to quantify other relevant substances such as collagenase and to examine the effects of mononuclear cell products, thereby demonstrating a similar mechanism to that established in the analogous situation of odontogenic cysts (Harvey et al, 1984). These results would suggest a mechanism for bone resorption mucocele expan-

sion associated with an inflammatory process at the mucocoele/bone interface. The capacity for prostaglandin synthesis by the lining emphasises the importance of removing all mucosa at operation. The creation of alternative drainage channels is achieved by opening the intersinus septum and insertion of a fenestrated silastic tube for as long as can be tolerated, the success of which is reflected in a low recurrence rate (Rubin et al., 1985).

The problem of the group in whom no aetiological factor can be determined remains. They constitute one of the largest sub-groups and do not differ in age or sex distribution from the group as a whole. Is it this group in whom cystic degeneration of a mucus gland occurs producing a dilated mucus-containing sac lined by sinus epithelium in accordance with Palubinskas and Davis (1959)? Is it, as Kastenbauer (1967) has suggested in the absence of any previous history, a consequence of a pathological process of pneumatisation? A total congenital anatomical obstruction is probably less likely than the possibility of a vulnerable population in whom there is a degree of intrinsic narrowing and tortuosity of the fronto-nasal duct with total obstruction produced by minor sub-clinical inflammatory changes.

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RÉSUMÉ

Les facteurs causatives dans la formation des mucocoeles du sinus fronto-ethmoidale sont examiné en 80 patients. Les degré et la durée de l'obstruction et l'absence du drain alternatif sont importants dans la développement d'une mucocoele mais pour étudier le mecanisme de la resorption d'os et l'expansion de la mucocoele, le prostaglandine, PGE₂, était mesuré dans les mucocoeles et les sinus frontales normales. Pendant que les facteurs causatives peuvent trouver en 71 %, le groupe le plus grand est sans facteurs causatives et c'est peut-être une population vulnérable pour qu'il exist un degré de limitation intrinsèque et la tortuosité du conduit fronto-nasale avec l'obstruction total produits par les petites changement inflammatoires.

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