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ORIGINAL ARTICLE

Non-malignant lesions involving the paranasal sinuses and anterior skull base

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KEYWORDS
Paranasal sinuses;
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Abstract
Background and objectives: Lesions involving the paranasal sinuses and the anterior cranial base at the same time are not unusual. These diseases have different features. The aim of this study is to set out the particularities of the non-malignant lesions involving both zones.
Material and methods: Retrospective study of 32 patients between 1986 and 2007 diagnosed with: non-malignant tumours (31.2%), tumour-like lesions (3.1%), fibrous-osseous lesions (12.5%), congenital or acquired malformations (18.7%), and infectious diseases (34.3%). We analyse the diagnostic imaging, the treatment, and the pathogen mechanism.
Results: Only 6 of 43 osteomas involved the paranasal sinuses and anterior cranial fossa (13.04%): 3 cases have developed meningitis and 1 developed a pneumocephalus. Two cases are meningiomas: 1 was asymptomatic and the other one caused destruction of the subtotal frontal bone. A giant haemangioma associated with Klippel-Trenaunay syndrome is treated by combined craniofacial approach. The fibrous-osseous lesions were specifically fibrous dysplasia and affected the ethmoides. The encephalocele were predominating in the malformations group, 2 were diagnosed after repeated meningitis. Eleven cases are inclluded by infection: 10 cases caused osteomyelitis and the eleventh is a patient with a mucormycosis. Surgery has been used in 84.3%of the cases: frontal craniotomy 37%, combined craniofacial approach 18.5%, sub-frontal approach 18.5%, osteoplastic technique 18.5%, lateronasal approach 3.7%, endonasal microscopic resection 3.7%
Conclusions: In this study the diagnosis, extension, and surgical management were supported in the imaging. A closed separation between the anterior cranial fossa and the sinus is necessary after the resection. The reconstruction was performed using a pedicled pericranial flap and titanium mesh in most of the cases.

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PALABRAS CLAVE
Senos paranasales;
Base de cráneo;
Enfermedades no malignas

Lesiones no malignas que implican a senos paranasales y fosa craneal anterior

Resumen
Introducción y objetivos: No son raras las lesiones que implican conjuntamente el territorio nasoparanasal y la fosa craneal anterior. Son enfermedades de distinta naturaleza. El objetivo de este trabajo es exponer las peculiaridades con las que alteraciones no malignas afectan a ambas regiones.
Métodos: Definimos los criterios de inclusión y exclusión. Se incluyen 32 casos (1986-2007): tumores benignos (31,2 %), seudotumores (3,1 %), trastornos fibroóseos (12,5 %), malformaciones congénitas o adquiridas (18,7 %) y enfermedades infecciosas (34,3 %). Se analizan los medios de diagnóstico por imagen, el mecanismo patogénico evolutivo y el tratamiento.
Resultados: De 43 osteomas considerados, 6 afectaban a la fosa craneal anterior (13,04 %); 3 desarrollaron paquimeningitis y uno, neumoencéfalo. De 2 meningiomas, uno era asintomático y el otro producía destrucción subtotal del hueso frontal. Un hemangioma gigante, dentro de un síndrome de Klippel Trenaunay, se trata por tratamiento combinado craneofacial. Los trastornos fibroóseos son específicamente displasias fibrosas, afectan al techo del etmoides. En malformaciones, predominan los meningoencefaloceles, de los que 2 se diagnosticaron tras meningitis recidivantes. De 11 pacientes incluidos por infecciones, 10 tenían en común el desarrollo de osteomielitis frontal, el undécimo es una paciente con mucormicosis. Realizamos tratamiento quirúrgico en el 84,3 % craneotomía frontal (37 %), tratamiento combinado craneofacial (18,5 %), tratamiento subfrontal (18,5 %), técnica osteoplástica (18,5 %), tratamiento paralateronasal (3,7 %) y cirugía microscópica endonasal (3,7 %).
Conclusiones: El diagnóstico, la extensión lesional y la planificación del tratamiento se apoyan principalmente en estudios de imagen. El objetivo principal del tratamiento, tras la resolución de las lesiones, es la separación estanca de FCA y senos. El colgajo pediculado de pericráneo y la osteosíntesis con miniplacas son de elección en el tiempo de reconstrucción.

Introduction

Otorhinolaryngological processes involving the anterior cranial fossa (ACF) are generally malignant tumours. These frequently invade the ACF, with possible involvement of the meninges and/or cerebral tissue. The invasion occurs either due to the originating site (as in the case of olfactory neuroblastoma) or because they spread to the skull base from the nasoparanasal territory.

In this paper, we propose to highlight the diversity, peculiarities and frequency with which non-malignant nasoparanasal diseases affect the ACF. These conditions, taken individually, are unusual but, if the various types are added together, they come to a considerable number. They usually pose serious difficulties in diagnosis, therapeutic indication, and treatment execution.

The purpose of this paper is not to relate the distribution by gender, age ranges, or a detailed clinical description of the various processes as these are perfectly well known and have been extensively published in classical and current articles.[1-6] We intend to set out the wide range of illnesses potentially involving 2 regions simultaneously, the pathogenic mechanism for their combined natural history and the treatment system used.

Careful consideration has been given to the inclusion and exclusion criteria, which have fundamentally been chosen to make the paper as homogeneous as possible. The cases we included are: benign tumours, pseudotumours, fibro-osseal disorders, congenital or acquired malformations, and infectious complications.

In the discussion section below, reference will be made to several facts that led us to analyze these illnesses as a single group. Is there any rationale for appropriate joint publication of apparently heterogeneous cases? We decided to consider them together as they share the site in which the condition arises; they always trigger largely similar signs and symptoms; in all cases, imaging studies are of decisive importance to determine the scope; and because there are similarities in the design of the surgical techniques to be used, both in exeresis and in repair stages.

Methods

This study covers a total of 32 cases treated by the authors (1986-2007). They are patients with non-malignant nasoparanasal illnesses involving their ACF, either simultaneously or in the course of its natural history. The techniques mainly used have been computerized tomography (CT) scans and conventional radiology images; occasionally, magnetic resonance imaging (MRI) and/or angiography have been used and, in a couple of cases, scintigraphy as they were fundamental for the diagnosis, as well as for the study of the extension and treatment design. The following inclusion and exclusion criteria were applied.

The ACF was deemed to be involved when the disease studied caused destruction of the bony walls separating the cranial cavity of the nasal fossae or the paranasal sinuses. In this situation, the central nervous system (CNS) is frequently

Table Analysis of the 32 cases treated by the authors

Clinical cases				CNS lesions		Surgical treatment		Reinterventions
Benign tumours	10 (31.2%)	Osteoma	6	Pachymeningitis	3	Sub-frontal treatment	4	
		Meningioma	2	Pneumoencephalus	1	Osteoplastic technique	3	
		Haemangioma	1	Loss of eyesight	1	Frontal craniotomy	1	
		JNA	1			Combined treatment	1	
Pseudotumours	1 (3.1%)	Mucocele	1		0	Osteoplastic technique	1	
Fibro-osseal disorder	4 (12.5%)	Fibrous dysplasia	4		0	Combined treatment	2	1
						Sub-frontal treatment	1	
						Paralateronasal	1	
Malformations	6 (18.7%)	Meningo-encephalocele	4	Meningitis 4		Combined treatment	2	
		Fistula	2			Intranasal treatment	1	
Infectious diseases	11 (34.3%)	Osteomyelitis	10	Extradural abscess	2	Craniotomy on demand	9	3
		Mucormycosis	1	Meningitis	1	Osteoplastic technique	1	
				Cerebral abscess	1			
				Global (death)	1			
	N=32			14 (43.7%)		27 (84.3%)		4 (6.6%)

CNS indicates central nervous system; JNA, juvenile nasopharyngeal angiofibroma.

involved, although meningeal or cerebral lesions were not an essential criterion for inclusion of the case.

We included benign tumours (31.2%), pseudotumours (3.1%), fibro-osseal disorders (12.5%), congenital or acquired malformations (18.7%), and infectious diseases (34.3%) (Table).

Malignant tumours were excluded. We also excluded situations arising out of complications following a nasoparanasal or neurosurgical procedure, such as iatrogenic fistulae of the cerebrospinal fluid (CSF), septic situations in the CNS after surgery, etc.

In each group of illnesses, we included the cases only when they involved the ACF, discarding those with the same diagnosis if they did not meet this or any other of the inclusion criteria. For example, out of a total of 43 osteomas considered, only 6 affected the ACF (13.04%); of the 7 frontoethmoidal mucoceles reviewed, only 1 patient met the inclusion criteria; 1 patient with osteomyelitis of the frontal sinus was excluded because it occurred post-surgically (the infection occurred in the reconstruction of a frontal craniotomy).

The surgical techniques used, referred to in detail below, are the normal ones in craniofacial surgery. We currently immobilize the cranium with a twin-support bone puncture headrest. We used a Midas Rex® compressed-gas turbine to drive the self-braking craniotome, the piercing saw and the duraguard saw. For osteosynthesis, we occasionally used silk or steel thread and usually titanium miniplaques; to hold the craniotomy flap, we currently use Craniofix®.

Results

Benign tumours

The cases included amounted to 10: 6 frontal osteomas, 2 frontal meningiomas, 1 haemangioma, and 1 juvenile nasopharyngeal angiofibroma.

1. Pachymeningitis was present in 3 of the osteomas; in 2 cases, it was caused by destruction of the posterior table of the frontal sinus and in the other, in which the tumour obstructed the infundibulum, it was due to sinusitis and diffusion into the ACF, with slight erosion of the bony wall.

   Since the tumour produced a small dehiscence on the posterior wall of the sinus in one of the other frontal osteomas, it led to the onset of a pneumoencephalus

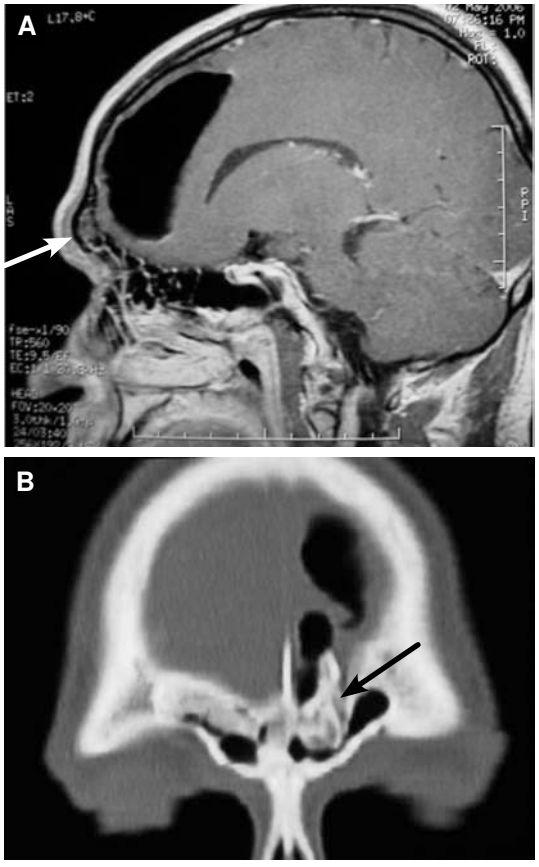

Figure 1 In the sagittal (A) and coronal (B) computerized tomography scans, the arrow indicates the osteoma producing the pneumoencephalus.

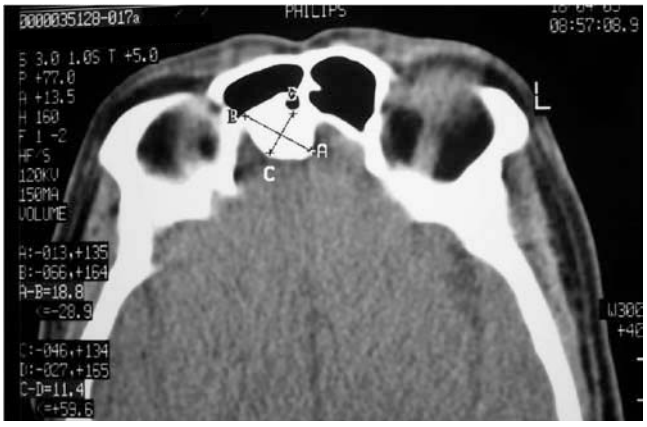

Figure 2 Axial computerized tomography scan of an osteoma of the posterior table of the frontal sinus. It is growing specifically towards the anterior cranial fossa. Its main axis (A-B) measures 18.8 mm, and its perpendicular (C-D) 11.4 mm.

through admission of air into the ACF through a valve effect (Figure 1). In a fifth case, there was major destruction of the posterior table and massive bilateral invasion of the orbits, including loss of sight in one eye. The sixth case was an asymptomatic bone tumour (incidentaloma), seated on the posterior table of the frontal sinus and growing solely towards the cranial cavity (Figure 2).

In all cases, the conventional radiology images and the CT scan clearly showed the tumour's topographical distribution. The involvement of the CNS was clear in the images from the pneumoencephalus case and was confirmed in the rest during the procedure.

Three cases were operated on using the frontal sinus osteoplastic technique, 2 with a sub-frontal approach (basal bifrontal), and the sixth was subjected to a wide frontal craniotomy.

2. The 2 meningiomas were delimited using CT and MRI scans. One was an extraordinarily large tumour originating in the frontal sinuses, causing major external deformity and widely destroying the bone structure of these sinuses (Figure 3); after resection, complex reconstruction was required on the dura mater (fascia graft plus pediculate pericranial flap) and the cranial vault (cleft cranial vault). The other was an meningioma arising out of the floor of the ACF, affecting the left frontal sinus in its growth. Its treatment was initially surgical, via the sub-frontal route.
3. One of the cases was extremely rare: a giant haemangioma within a Klippel-Trenaunay syndrome. CT, MRI, angioMRI, and angiography (for embolization) determined its extension and the vascularization of the neoformation (Figure 4). The tumour occupied a considerable space within the superstructure and mesostructure of the face, and largely destroyed the anterior skull base. Surgery required a combined craniofacial approach.
4. The juvenile nasopharyngeal angiofibroma we included is topographically a type I tumour and clinically a type III Sánchez Marle tumour.[7] It occupied the cavum, choanae, nasal fossae, posterior ethmoid, and the sphenoidal sinus on the right, with intromission into and compression of the cavernous sinus. It penetrated extensively into the ACF. He was operated on at another centre, where an unspecified combined lateral treatment was applied. We saw the patient at the ER 1 year after the procedure due to a relapse with massive epistaxis. We are unaware of the patient's subsequent progress.

Pseudotumours

Only 1 idiopathic frontal mucocele (without any history of trauma, surgery, or sepsis) met the inclusion criteria. It appeared clinically with exophthalmia/laterophthalmia. The CT imaging detected penetration into the ACF through compression of the posterior wall of the sinus. The osteoplastic technique was used in the procedure.

Fibro-osseal disorders

We considered 4 cases of ethmoidal or nasofrontoethmoidal fibrous dysplasia. In all of them, using conventional x-rays and CT, it was possible to identify more or less extensive involvement of the *lamina cribosa* and the roof of the ethmoid, with displacement of the dysplasic mass into the ACF. The procedure used on 2 of the cases was a combined craniofacial technique[8] (one of them with a diagnosis of osteoma had been operated on twice previously and an external frontoethmoidectomy

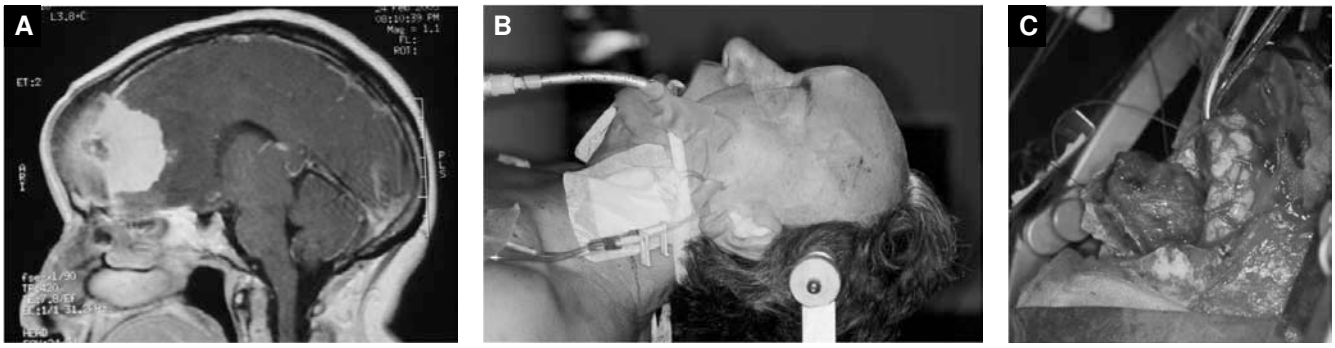

Figure 3 A. Sagittal magnetic resonance image of a large frontal meningioma. B and C. Exposure of the meningioma.

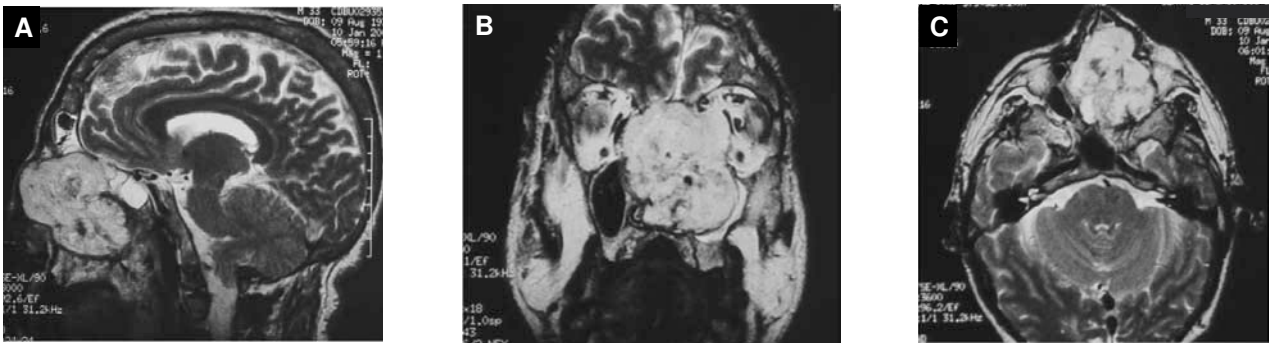

Figure 4 Craniofacial angioma in a case of Klippel-Trenaunay syndrome.

had been performed) (Figure 5), and another was treated using a sub-frontal procedure; 3 patients were lesion-free, with follow-up ranging from 22 months to 20 years. The fourth case, operated on using a paralateronasal procedure with microscopic/endoscopic support, has an ethmoidal-sphenoidal remnant of dysplasia that has not increased during the 5 years of follow-up.

Congenital or acquired malformations

We have 6 cases involving malformations: 4 patients with meningoencephalocele and 2 with CSF fistulae.

Of the meningoencephalocele cases, 3 occurred in children and 1 in an adult. In 2 of the children, the diagnosis was reached after recurrent meningitis; in 1, in addition to standard imaging techniques, a scintigraphy examination was performed (Figure 6). Of these meningoencephaloceles, 2 were operated on using a combined treatment,[9] the adult was subjected to an endonasal technique, the fourth did not accept treatment and we are unaware of the subsequent status.

Of the 2 patients with cranionasal fistulae and liquorrhea, 1 is idiopathic, possibly congenital; he developed meningitis 3 times prior to diagnosis. The other case was due to trauma and was diagnosed 2 years after the accident causing the trauma when meningitis occurred after a sinonasal cold. Only in this second case did we obtain reliable topographical assistance through the CT scans. Both received treatment through frontal craniotomy.

Infectious diseases

The most frequent lesion was osteomyelitis of the frontal sinus. Of the 11 patients included due to infection, 10 shared this symptom of osteomyelitis of the frontal sinus,[6] while the eleventh presented mucormycosis. CT scans were the imaging technique most commonly used.

1. In 2 patients there was co-existence of frontal sinusitis and osteomyelitis with bone damage, including the anterior and posterior tables of the frontal sinuses. Despite the endocranial invasion, there was no involvement of the CNS. No Pott's puffy tumours were seen. In both patients, the osteomyelitic bone was extirpated as required, with reconstruction and exclusion/cranialization of the frontal sinus.
2. Five patients had Pott's puffy tumour (Figure 7), with osteomyelitis of the anterior table and lesion of the posterior table. Of these, 2 were admitted through the emergency room with fever and stupor; in 1 case, the existence of bacterial meningitis was confirmed and, in the other, extradural abscess and pachymeningitis. A third presented slow progression; on the CT scan and during the procedure, lysis of the frontal sinus was observed due to osteomyelitis and extradural abscess. The other 2 patients with Pott's puffy tumour showed no involvement of the CNS.

   In all 5, in addition to antibiotic treatment, the osteomyelitic bone was extirpated as required, with

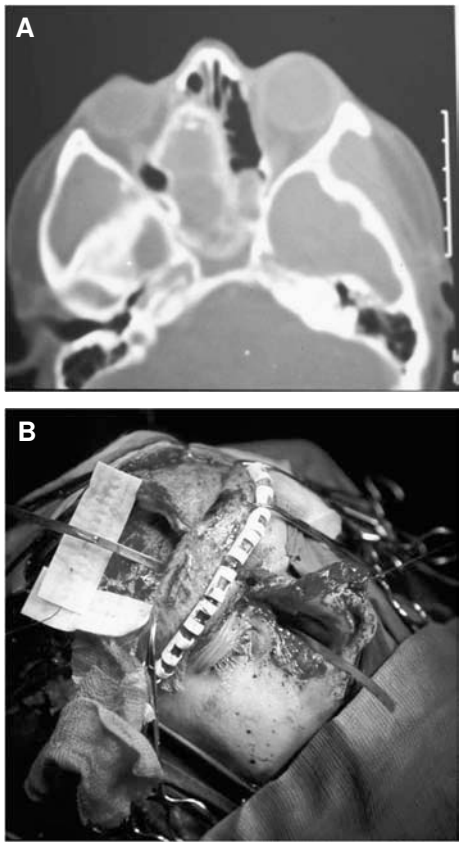

Figure 5 A. Computerized tomography scan showing fibrous dysplasia of the ethmoid. B. Combined craniofacial treatment to resect a relapsed fibrous dysplasia of the ethmoid (1986), possibly the first combined craniofacial treatment published by a Spanish author.[8]

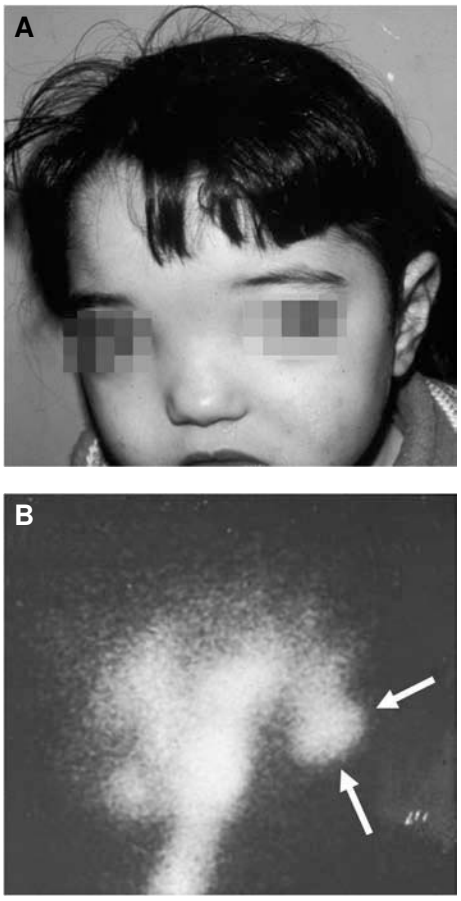

Figure 6 A. Note the severe hypertelorism in a girl with meningoencephalocele.[9] B. The malformation (arrows) is clearly observed in the technetium 99m scintigraphy.

reconstruction and exclusion/cranialization of the frontal sinus. One required reintervention.

3. Due to their special characteristics, we feel it is appropriate to individualize the 3 remaining cases of osteomyelitis.

   One was a young female patient with acquired immunodeficiency syndrome. She presented with acute frontal sinusitis, osteomyelitis and Pott's puffy tumour (Figure 8). Minimal confluent areas of frontal osteomyelitis were observed on CT scans. As treatment, the osteomyelitic bone was resected and treated with antibiotics after an antibiogram. The condition recurred 1 month later and a second procedure had to be scheduled. The patient remains asymptomatic after 6 months' follow-up.

   One patient who presented ASA triad (Ferdinand Vidal's disease) had previously been operated 3 times using nasal endoscopic surgery, but continued to have a frontal sinus obstructed with purulent content. Subtotal destruction of the roof of the orbit occurred due to osteomyelitis (Figure 9) and there was erosion of the posterior table of the frontal sinus with communication into the ACF. After a first procedure, he had a relapse with purulent accumulation in the orbit and severe exophthalmia. During the reintervention, the roof of the orbit was reconstructed with a pediculate pericranial flap. The patient continues to be asymptomatic after 20 months of follow-up.

   In a chronic left frontal sinusitis, a cerebral abscess developed in the right frontal lobe. To explain the pathogenesis of this case, we have suggested a route that begins with the confirmed osteomyelitic destruction of the posterior wall of the left frontal sinus, followed by an asymptomatic bilateral extradural abscess, giving rise to a frontal cerebral abscess on the other side. The patient was operated on using a sub-frontal approach; the cerebral abscess remitted with puncture and aspiration together with medical treatment.[10]

4. A 68-year-old female diabetic, under treatment for acute sinusitis, was admitted as she did not respond to treatment and after onset of epistaxis and bilateral exophthalmia. Biopsy samples were taken from blackish necrotic masses in both nasal fossae and a diagnosis of mucormycosis was established. The CT scan revealed extensive invasion of both orbits and the ACF. She was treated with amphotericin. She died 12 days after admission.

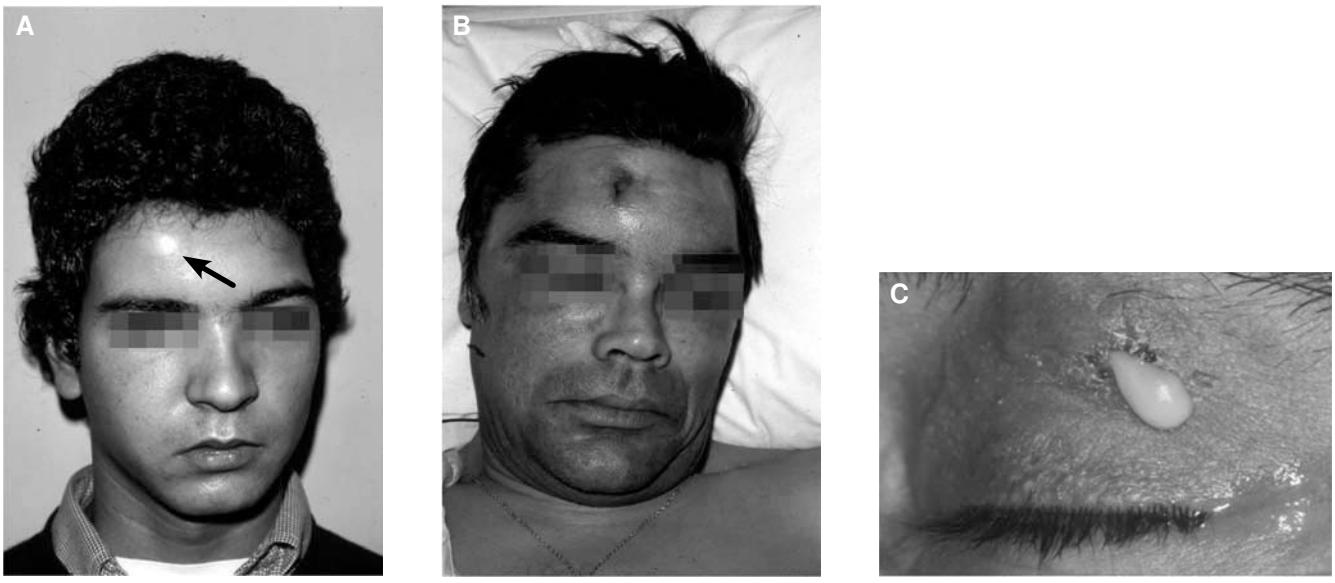

Figure 7 A. The arrow points to a Pott's puffy tumour in a 17-year-old male. B. Stuporous patient in a case of osteomyelitis with a fistulized Pott's puffy tumour complicate by meningitis. C. Fistulized Pott's puffy tumour, showing purulent secretion between the eyebrow and the upper eyelid.

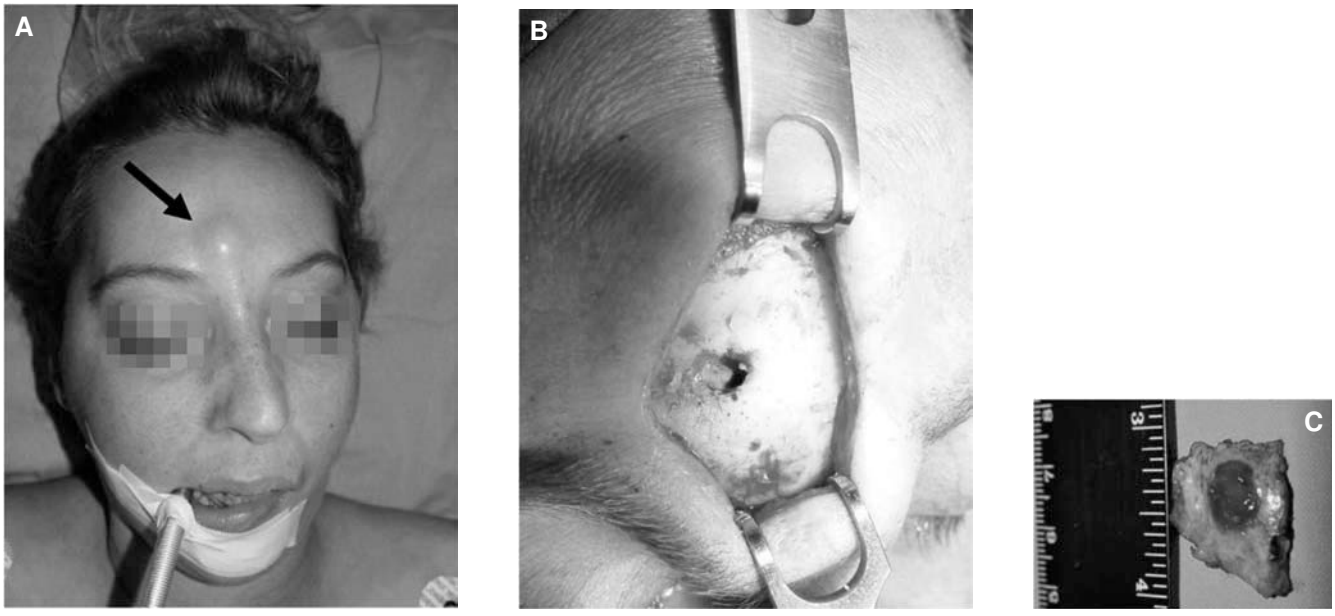

Figure 8 Young patient with AIDS. A. The arrow shows the Pott's puffy tumour. B. Osteomyelitic lysis of the frontal sinus. C. Specimen after extraction of the injured bone.

In all cases, the CT scans and, complementarily, conventional radiology were the imaging systems chosen to define the scope of the disease. In addition, other methods have been used from time to time and MRI studies were useful to qualify the CNS lesions, where present.

Of the 32 cases presented, 14 (43.7%) had lesions in the CNS, arising due to infection of the structures originating in germs from the nasal fossae and the paranasal sinuses (meningitis, extradural abscess, cerebral abscess). The exception is the pneumoencephalus case (Figure 1), in which the alteration of the CNS is mechanical and not due to the infectious component.

We performed surgery in 27 cases (84.3%): 10 frontal craniotomy on demand (37%), 5 with a combined craniofacial treatment (18.5%), 5 with sub-frontal treatment (18.5%), 5 with the osteoplastic technique on the frontal sinus (18.5%), 1 with paralateronasal treatment (3.7%), and 1 with intranasal microscopic surgery (3.7%).

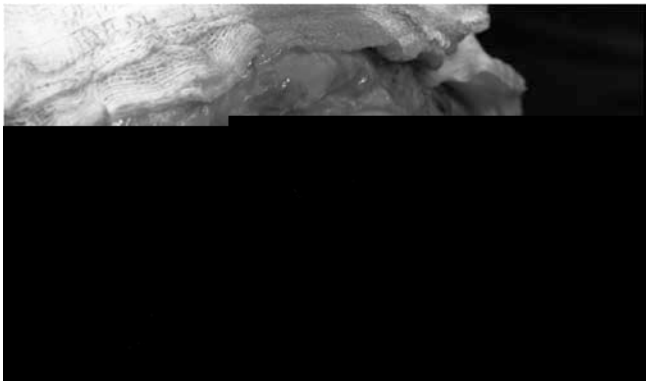

Figure 9 Osteomyelitis of the frontal sinus in a Fardinand Vidal syndrome. The eyeball can be seen from the anterior cranial fossa through the major destruction of the roof of the orbit.

In 12 cases, the procedure was performed through a bitemporal coronal incision; in 13, a unilateral or bilateral ciliary incision; in 1, a paralateronasal incision; and other incisions in one other.

For reconstruction, we used a pediculate pericranial flap in 11 cases; we carried out obstruction of the frontonasal duct and cranialization of the frontal sinus in 12 cases; reconstruction of the posterior wall of the frontal sinus and the osteoplastic flap, maintaining natural aeration of the sinus in 7 cases; repair required cleft cranial vault in 6 cases, and an intranasal repair in 1 case. Osteosynthesis was habitually achieved with titanium miniplaques and craniotomies have lately been resolved with Craniofix® on the orifices left by the craniotome.

Discussion

In the literature reviewed, we have not found any paper gathering patients with the same characteristics as those required for inclusion in this series. The question may be raised as to whether the joint publication of apparently heterogeneous cases can justified or is appropriate. We feel that there is such a rationale and this is defended in the next 4 paragraphs.

In classical anatomy, the sinuses and the ACF are well defined and are paired in clinical practice. In the study of the diseases affecting the frontal or ethmoid sinuses or the nasal fossae, one of the main concerns is to determine whether or not the lesion includes the skull base. Many of the entities we studied are treated by otorhinolaryngologists or neurosurgeons without regard for specialities, but the correct procedure would be for joint treatment taking into account both viewpoints.

In all these illnesses, the natural history of the process and the clinical symptoms should be considered, but the imaging studies (mostly CT) are of fundamental relevance, since these give the main guidance as to the situation in each case. Without ignoring other helpful diagnostic methods, imaging considers both regions as complementary units.

In these processes, albeit not obligatorily, treatment is generally surgical, either using endoscopic surgery, or an osteoplastic technique on the frontal sinus, a subfrontal approach (basal bifrontal), frontal craniotomy, or a combined craniofacial approach. In these cases, the prognosis in terms of survival is better than in the treatment of malignant tumours in the same location; however, the functional prognosis, aesthetic outcome and the chances of creating morbidity are very similar.

In all of the treatment methods, one fact always appears as a constant and inescapable reality: resolving the illness necessarily requires achievement of total separation between both regions. Safely separating the nasoparanasal territory from the ACF is an imperative to avoid CSF fistulae, CNS infections or recurrences of the process.

Why exclude from this analysis malignant tumours and post-surgical complications affecting these regions? We consider it is appropriate to exclude these complaints as they have a different clinical profile an prognosis from what is being dealt with here.

Another point to be discussed is whether the involvement of the ACF in these processes forms part of a whole, namely the illness in question, and whether the ACF's participation should be considered as a complication of an otorhinolaryngological condition or if both possibilities are viable. Although the first hypothesis is the most appropriate in most cases, every patient needs to have an individual interpretation.

If we analyze the osteomas, we can see that, among our cases, 13.04% affected the ACF, a percentage that would undoubtedly be higher if the disease were left to run its course.[11] We have presented cases of intracranial infections produced by osteomas, similar to those in other published studies.[12-14] We included one rare case of pneumoencephalus (Figure 1), an entity for which there are also previous publications.[15-17] We tend to believe that ACF involvement is a complication of the progression of the osteoma, but this is not always so: in one of the cases, the tumour developed in the posterior table of the frontal sinus and grew solely towards the endocranium (Figure 2).

Frontal sinusitis is a frequent process with out-patient treatment for which we do not have reliable statistical data; for this reason, we are unable to calculate the percentage of sinusitis cases that end up affecting the ACF. In the infections included in this paper, we have seen that the anterior and posterior tables of the sinus are generally affected more or less simultaneously,[6] except for one case in which the bone lysis capriciously affected the posterior table and the roof of the orbit very extensively, yet leaving the anterior table practically unharmed (Figure 9). It is striking that no thrombophlebitis of the longitudinal sinus has been identified in any case.

The variety of surgical treatments used does not include nasal endoscopic treatment, a therapy used by several authors.[18,19] This technique has revolutionized the indication of treatments in the nasoparanasal territory when there are no lesions in the contents of the ACF[20] and also where these do exist, but only in selected cases.[21,22] It may be a method of choice in congenital or acquired malformations[23] and in the marsupialization of mucoceles. We feel that an occasional selected case in our series might have been treated with endoscopic surgery, but in the oldest cases this had not been performed well and in the most recent ones we think that the exeresis and reconstruction stages have

been more effective and safer with open procedures. The case of osteoma of the posterior table of the frontal sinus growing towards the ACF (Figure 2) was recently resolved using frontal craniotomy, as we were of the opinion that endoscopic resection would have been unfeasible, or at least more complex, and likelier to create morbidity.

We have used both bitemporal coronal or ciliary incisions without distinction, as both may be appropriate. Our current tendency, as in recent literature, is to use the coronal incision in most cases,[24] especially because it is essential to obtain a pericranial flap.

The most important thing in all the procedures is to ensure a perfect seal separating the ACF from the nasal fossae and paranasal sinuses. Like a majority of authors,[24,25] we feel that the pediculate pericranial flap is the best system in a high percentage of cases. This flap is simple, powerful and has guaranteed vascularization; we have generally used it to repair the defect in the ACF and, in one patient, for the reconstruction of the roof of the orbit. In most cases, it is the most suitable, ahead of the temporal muscle flap or free microvascular flaps. The exclusive use of pericranial flap, without any addition of autologous free bone or other materials, is very effective and shows no tendency towards dehiscence or infection.

When the lesion on the posterior wall of the frontal sinus is small, it can be repaired, and the structure of the frontal sinus preserved to allow natural ventilation.[26]

The most frequent morbidity encountered after the surgical procedure was infection. Unlike other ACF treatments in which penetration of the frontal sinuses is avoided,[27] in the cases we have studied penetration into the fossae or sinuses is constantly present and for this reason carefully planned antiseptic prophylaxis is required. Regard must also be had for other complications, the scrupulous rehabilitation of the face's appearance avoids anti-aesthetic results. The use of the most appropriate cutaneous incision, cleanly defined osteotomies (using a Midas Rex straight or protected saw) and the performance of precise osteosynthesis all generally provide a good aesthetic outcome.

In all cases, we considered it important to involve a neurosurgeon in the patient's treatment. A neurosurgeon's opinion on the need for and duration of a lumbar shunt, collaboration in the operation, where necessary, and participation in all stages of the post-operative follow-up help to ensure better progress for patients.

Conclusions

There is a considerable group of non-malignant diseases that simultaneously affect the nasoparanasal territory and the ACF. The most frequent are benign tumours and infections.

Imaging studies are essential for the diagnosis, analyzing extension and planning treatment.

The interpretation of the clinical situation and the design of therapy have to be approached jointly by the otorhinolaryngological and neurosurgery departments. The treatment of the different cases considered has many points in common. Both treatment and the reconstruction must be designed individually for each case.

The main goal of treatment is the perfect separation of the ACF and the nasoparanasal territory. Pediculate pericranial flaps and osteosynthesis with miniplaques are the techniques of choice for the reconstruction phase.

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