Clinical and Radiologic Characteristics of the Imploding Antrum, or "Silent Sinus," Syndrome

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Objectives: To present the clinical and radiologic details of a series of patients with the imploding antrum, or silent sinus, syndrome, together with examples of the surgical findings and management.

Design: Retrospective, noncomparative case series.

Participants: Fourteen patients assessed in the Orbital Service at Moorfields Eye Hospital.

Main Outcome Measures: Changes of clinical signs, symptoms, and radiologic signs.

Results: Seven men and seven women, between the ages of 25 and 78 years (mean, 41.3 years), had unilateral enophthalmos, their having noted the anomaly for an average of 8 months (range, 1–36 months). All patients were nonsmokers. There was no evidence of progression of the condition in eight cases followed up for up to 63 months. On the affected side, there was 1 to 4 mm enophthalmos and up to 4 mm hypoglobus, with secondary narrowing of the vertical palpebral aperture in some cases, but no effect on visual function, and there was significant disturbance of ocular motility in only one case. The condition is characterized radiologically by a smooth inward bowing of the walls of the maxillary antrum on the affected side, with secondary enophthalmos and hypoglobus. In all 14 cases, the maxillary roof (orbital floor) was drawn downwards, and the medial and posterolateral walls of the maxilla were concave in 13 cases where it could be assessed. In one patient, there was associated inward collapse of the ipsilateral ethmoid complex. There was a patchy loss of mineral from the maxillary roof in 9 of 13 cases and, where the posterolateral maxillary wall was affected, there was a concomitant increase in the radiolucency (fat) of the pterygopalatine fossa. Some soft-tissue changes were present in the affected antrum in all 14 patients, and there was an air–fluid level in three patients. In 12 patients where septal deviation was present, this was to the affected side in 10 (83%), and an abnormally directed middle turbinate was also frequently observed (10 of 14 cases).

Conclusions: The silent sinus syndrome mainly presents as unilateral enophthalmos in younger people and has very characteristic clinical and radiologic signs with, in many cases, abnormal intranasal anatomic characteristics on the affected side. The condition may be exclusive to nonsmokers. The acute onset and long-term stability of the condition suggests that, although chronic and largely asymptomatic sinus disease may be the underlying cause, an acute event precipitates collapse of the orbital floor or (in fact) a widespread "implosion" of all antral walls resulting from maxillary atelectasis. Therefore, we prefer the term *imploding antrum syndrome*—describing the relatively acute, symptomatic, event—rather than the name *silent sinus syndrome*, which relates to a putative underlying mechanism. *Ophthalmology 2003;110:811–818 © 2003 by the American Academy of Ophthalmology.*

Chronic sinusitis, maxillary hypoplasia, maxillary sinus cysts, vasculitis, osteomyelitis, or malignant infiltration may cause a deficient orbital floor with secondary enophthalmos.[1] Enophthalmos resulting from spontaneous collapse of the maxillary antrum, which Soparkar et al[2] termed *silent sinus syndrome*, generally affects younger people who note a change in facial appearance—their symptoms often being a "drooping of the upper lid" or a "sinking down of the eye." The unilateral enophthalmos and hypoglobus are related to a smooth downward bowing of the orbital floor, which is thinned in some cases, and there is an ipsilateral loss of the maxillary antral volume.[2] The cause remains uncertain, although affected patients do not give a history of orbital trauma or chronic nasal and sinus disease. The volume deficiency of the affected orbit may be treated by placement of a subperiosteal implant on the affected orbital floor[3,4] or with sinus surgery.[5,6]

We present 14 patients with the condition—for which we prefer the term *imploding antrum syndrome*—and describe the very characteristic clinical and radiologic features.

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Patients and Methods

The clinical records were reviewed for all patients who, between 1990 and 2000, had been given a diagnosis of imploding antrum syndrome after attending the Orbital Clinic at Moorfields Eye

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Hospital. The presenting symptoms and signs were recorded and, in those not choosing surgical treatment, the natural history noted.

The radiologic changes on computed tomographic scans of the orbit (and sinuses, where available) were reviewed—independently of clinical details—by two radiologists (LH, IM).

Case Reports

Patient 4

A 42-year-old man was referred to the Orbital Clinic, having noted a rapidly progressive painless "dropping" of the right eye approximately 3 months before the clinic visit. With the exception of a brief episode of diplopia, he was otherwise asymptomatic and had no past medical problems, injuries, or surgery.

He had a Snellen acuity of 6/5 in either eye, with no optic neuropathy and no intraocular disease on either side. There was 2 mm of right relative enophthalmos and 4 mm of right hypoglobus, with a deep upper lid sulcus (Fig 1A), but no detectable limitation of ocular ductions. With the characteristic history and signs, and the absence of prior sinus disease, a diagnosis of imploding antrum syndrome was made—this being confirmed on a computed tomographic scan (Fig 1B).

The clinical signs remained unchanged over the next 6 months, and he was referred for endoscopic sinoscopy, which demonstrated a smooth inferior bowing of the orbital floor and a small orbital retention cyst on the maxillary floor. Biopsy of the maxillary sinus mucosa showed mild inflammatory changes only.

One year after presentation, there was no significant change in signs and he underwent subperiosteal implantation of a silicone block into the concavity in the orbital floor. The bone of the orbital floor was found to be almost completely absent, although the periosteum was healthy and intact (Fig 1C). After surgery, there remained 1 mm of right relative enophthalmos, although the hypoglobus and deep upper lid sulcus were both corrected and the patient was very satisfied with the result. There was no imbalance of ocular motility or loss of infraorbital nerve function, and there has been no recurrence of the symptoms at 2 years after surgery.

Patient 13

In May 2000, a 53-year-old man noted a painless "sinking" of his right eye, but both his wife and friends thought his appearance symmetrical. Over the next 3 months, there was progression of the condition, with greater enophthalmos and development of a deep upper sulcus, such that friends were passing spontaneous comment and his wife was encouraging medical investigation.

Clinical signs and radiologic investigations were typical for imploding antrum syndrome, and the right maxillary antrum was drained through a middle meatal antrostomy.

A retrospective review of photographs showed a clear progression from a normal appearance in March 2000 (Fig 2A), to a suggestion of upper eyelid skin-crease asymmetry in photographs from May 2000 (Fig 2B), to very evident signs by the end of the year (Fig 2C).

Patient 14

A 78-year-old man sought treatment for 8 months of binocular vertical diplopia and a change in appearance. The left eye showed 4 mm of left relative enophthalmos and 4 mm of hypoglobus with a very deep upper eyelid sulcus (Fig 3A), signs that were clearly absent on a photograph from 5 years before (Fig 3B). There was no history of nasal or sinus disease, and the patient had stopped pipe-smoking 15 years before.

The radiologic results were typical for imploding antrum syndrome, and the signs have been stable for 6 months.

Results

Clinical Features

Fourteen patients (seven men) between the ages of 25 and 78 years (mean, 41.3 years; median, 39 years) who had been symptomatic for between 1 and 36 months (mean, 8 months; median, 6.5 months; Table 1) were treated for imploding antrum syndrome. The right eye was affected in 8 of 14 (57%) cases.

All patients had noted a change in facial appearance, either a 'sunken eye' appearance or deepening of the upper lid sulcus, and six patients mentioned intermittent vague discomfort around the affected orbit. Two patients had infrequent brief episodes of diplopia and one had persistent upgaze diplopia. None had a history of ocular disease or injury, and all had good general health; apart from one patient with treated myxoedema and one with prostatic carcinoma in remission, none had a significant past medical history. All were nonsmokers (only one exsmoker of 15 years) and only two patients (patients 11 and 12; Table 1) had a history of one or two brief episodes of ipsilateral acute sinusitis in the teenage years. No patients had chronic sinus disease, although one patient (patient 11; Table 1) had a prior history of mild hayfever, but never required topical therapy.

Ocular function was normal in all cases and, in all but one case, there was no alteration in ocular motility or muscle balance. The average globe displacement was 2.8 mm of enophthalmos (range, 1–4 mm) and 2.2 mm of hypoglobus (range, 0–4 mm).

Eight unoperated patients have been followed up clinically for between 4 and 63 months, there having been no significant progression of the ocular signs in any of these cases.

Radiographic Features

The universal feature of the imploding antrum syndrome is the striking change in the bony walls of the maxillary antrum (Table 2). In every case, the antral roof (orbital floor) was depressed, being abnormally concave toward the antrum (Fig 4A); in the sagittal plane, this abnormal concavity generally was most marked in the middle third, behind the orbital margin (Fig 4B). In all 13 cases where the medial wall of the maxilla could be assessed, it showed an increased concavity toward the antrum, and the same was true of the lateral wall, but in four cases, the concavity affected mainly the posterior one third of the lateral wall (Fig 4C–E). Parts of the anterior wall of the antrum were concave, rather than normally convex, in the 10 of 12 cases in which it was visible.

The texture of the bony confines of the antrum showed more varied change. The roof was seen to be abnormally thickened in 3 of 12 cases, but thin in nine cases—of which four showed areas of apparent bone destruction (Fig 1B). In individual cases, thinning or thickness tended also to affect similarly the other antral walls.

The affected antrum was almost totally filled by abnormal soft-tissue density material in six cases (Fig 4C), and in the other six cases, the antral opacity was partial, with a medial aerated portion in continuity with the nasal cavity (Fig 4D). Three patients (patients 4, 7, and 12; Table 2) showed a fluid level within the antrum. Seven patients showed mild inflammatory changes in the ethmoid sinuses, and one patient (patient 11; Table 2) showed complete opacification and collapse of the ipsilateral ethmoid sinuses.

It is noteworthy that the nasal septum was displaced toward the affected antrum in most cases, this being marked in five patients and associated with contralateral concha bullosa in two patients

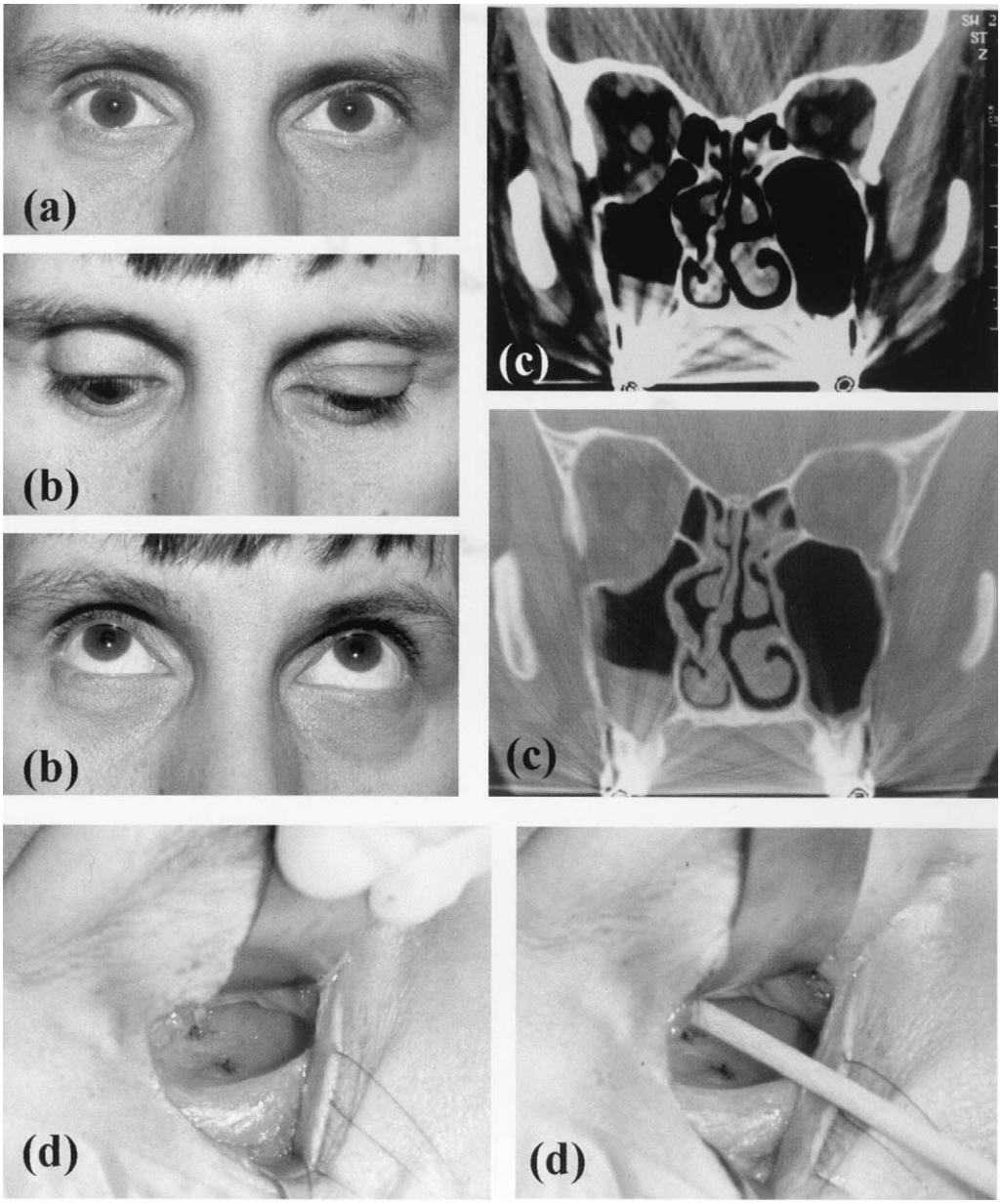


Figure 1. Patient 4. **A,** A 42-year-old man with right imploding antrum, showing enophthalmos, hypoglobus, and a deep upper eyelid sulcus, with (**B**) full vertical ductions. **C,** Coronal computed tomographic scan (bone and soft-tissue windows) showing features of imploding antrum. The right maxillary sinus is smaller than the left, because the roof and medial and lateral walls have collapsed centrally. Mineralization of the roof and lateral wall is markedly reduced. The central part of the nasal septum is deviated toward the imploded antrum, and the middle concha is rotated toward it. Soft-tissue density material (thickened mucosa, retained secretions, or both) is seen at the base of the antrum; there is minor contralateral mucosal thickening. There is a larger fat pad in the right infratemporal fossa. The optic nerve and inferior rectus muscle are markedly displaced downward; there is less marked descent of the medial and lateral recti. **D,** Marked concavity of the right orbital floor behind the normal rim, shown during surgery; the orange stick is placed to bridge the floor from the orbital apex to the rim and the arrow demonstrates the extent of the marked depression of the floor in its midportion.

(Fig 4F, G). In nine patients, it was associated with ipsilateral displacement of the middle turbinate, which occasionally showed marked lateral rotation of its lower part toward the osteomeatal complex of the affected side (Figs 1B and 4A), resulting in a wider nasal airspace on the affected side.

The inferior rectus always accompanied the globe in its descent, as did the medial rectus in four cases and the lateral rectus in three cases (Fig 1B).

Surgical Management

Six patients elected to undergo placement of a subperiosteal implant on the orbital floor. The orbital rim was exposed through either a subciliary blepharoplasty flap, or a lower-lid swinging flap, and the periosteum was raised widely across the orbital floor. In all cases, the floor had a markedly abnormal downward concavity (Fig 5A), but the periosteum was normal and the maxillary mucosa

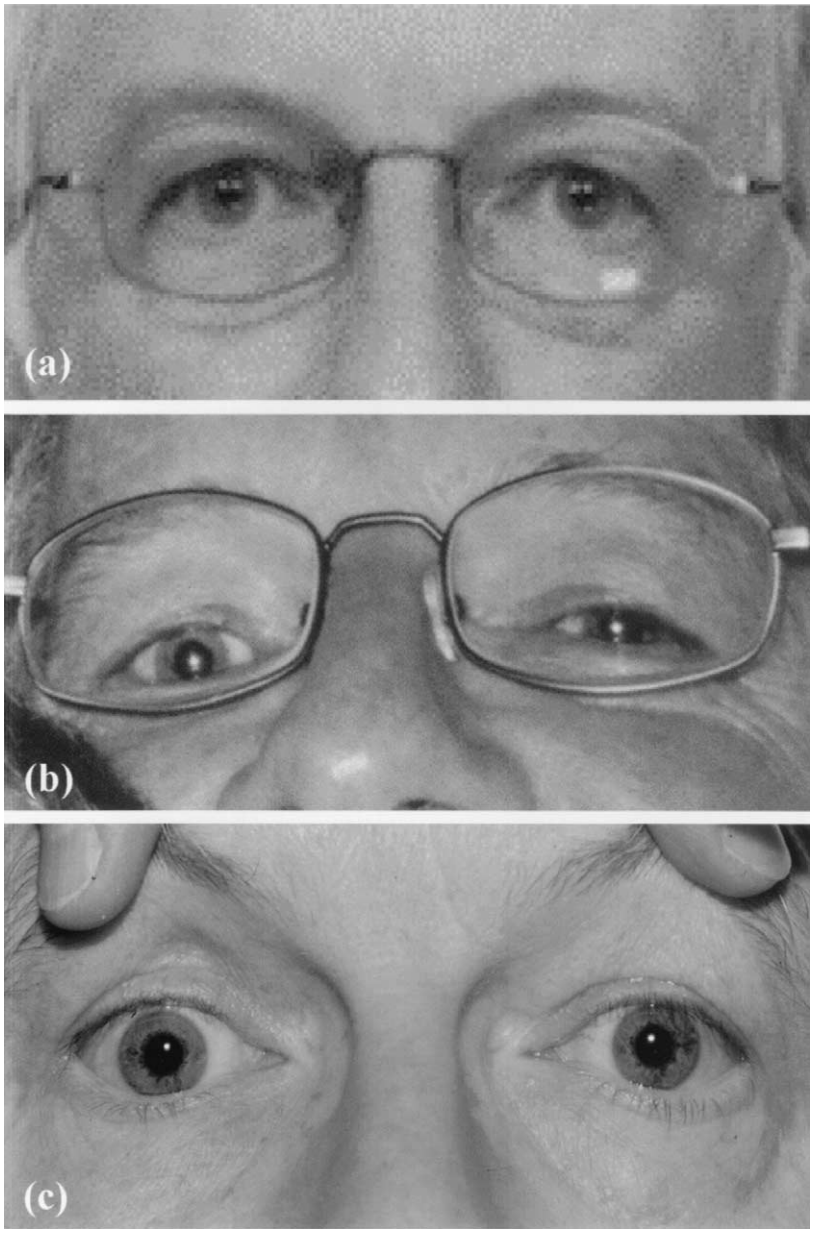


Figure 2. Patient 13. Evidence of progression of clinical signs of imploding antrum syndrome over a 9-month period. **A,** Normal symmetry of upper lid skinfold and lower lid and limbus relationship in March 2000. **B,** Suggestion of asymmetry of the upper eyelid skinfold and lower lid position at a time when only the patient was aware of changes in his appearance (May 2000). **C,** Clear signs of right enophthalmos and hypoglobus (December 2000). The quality of photographs (**A**) and (**B**) is limited because of spectacle wear and cropping from larger amateur photographs.

intact. A silicone block was then shaped to fit the concavity and placed into the defect (Fig 5B), the periosteum was closed with 5/0 polyglactin sutures, and the lateral canthotomy (or blepharoplasty flap) repaired using 6/0 polyglactin sutures.

All patients were pleased with the surgical result and had a marked reduction in their clinical signs, with no recurrence of symptoms at between 5 and 33 months after surgery.

Discussion

The pathognomonic clinical features of the imploding antrum, or silent sinus,[2] syndrome are spontaneous, fairly rapidly progressive, unilateral enophthalmos and hypoglobus resulting from a downward bowing of the orbital floor in the absence of significant symptomatic chronic sinonasal disease. In both the previously reported cases[2] and the present series, the condition would seem to present almost exclusively in the third through fifth decades of life, with symptoms resulting from an expansion of the orbital space. The condition appears nonprogressive in the long term.

The clinical similarities between our case series (Table 1) and that of Soparkar et al[2] are remarkable for: the age at presentation (Soparkar et al[2]: mean, 37 years [range, 29–46 years]; current series: mean, 41.3 years [range, 25–78

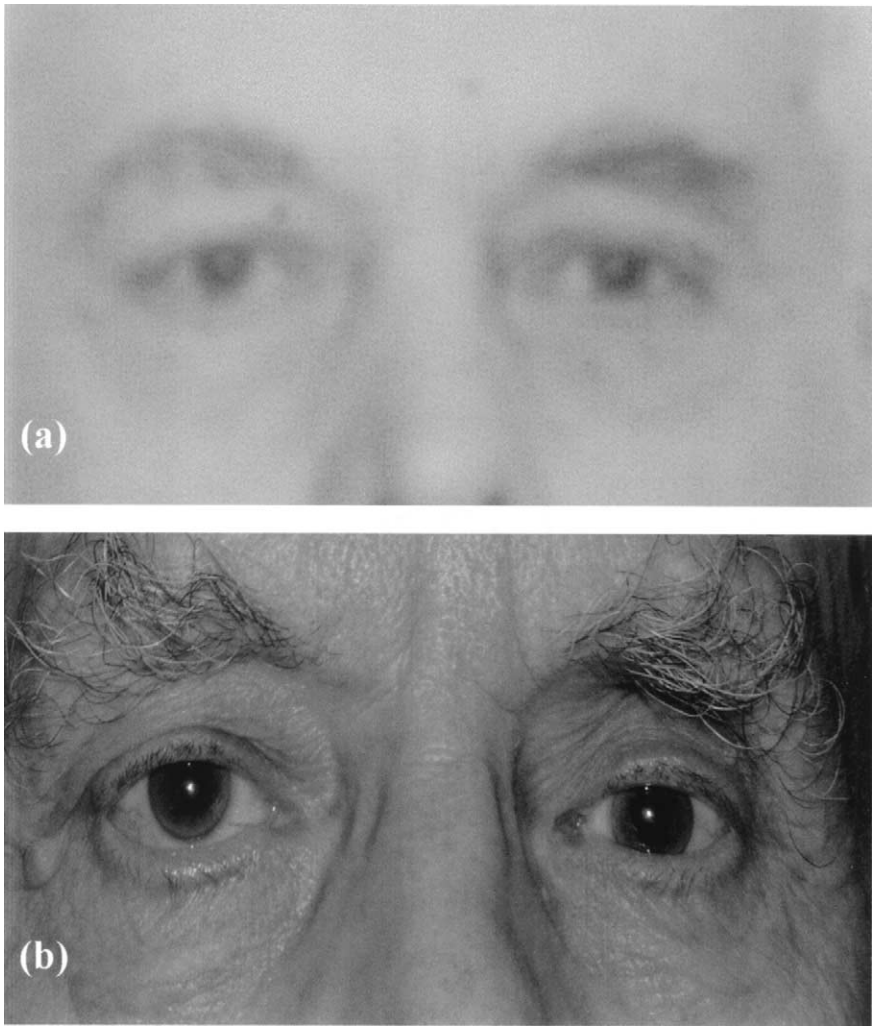


Figure 3. Patient 14. **A,** A patient with an 8-month vertical diplopia showing marked signs of left imploding antrum syndrome. **B,** There is no sign of the condition in a photograph taken 5 years before (limited quality because of size and quality of original photograph).

years]); the duration of symptoms (Soparkar et al[2]: mean, 3 months [range, 0.3–24 months]; current series: mean, 8 months (range, 1–36 months]); the absence of gender bias (Soparkar et al[2]: 8 of 14 men [57%]; current series: 7 of 14 men [50%]); and the slight predominance of right-sided disease (8 of 14 right eyes [57%] in both series). Likewise,

Table 1. Clinical Characteristics of 14 Patients with Imploding Antrum Syndrome

	Patient Number													
Characteristic	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Age at presentation (yrs)	42	48	31	42	39	39	39	45	35	31	25	32	53	78
Gender	M	F	F	M	M	M	F	F	F	M	F	F	M	M
Side affected	Right	Right	Right	Right	Left	Left	Right	Right	Right	Left	Left	Left	Right	Left
Duration of symptoms (mos)	5	4	7	3	36	3	1	6	12	3	7	8	8	8
Altered appearance	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pain	N	±	N	±	N	±	±	±	N	N	N	±	N	N
Diplopia extreme gaze	Right	N	N	N	N	N	N	N	N	Up	N	N	N	Y
Enophthalmos (mm)	4	U	3	2	3	4	2	2	4	1	3	2	3	4
Hypoglobus (mm)	2	U	2	4	2	2	3	0	2	3	0	3	1	4
Management: conservative (CON) or orbital floor implant (OFI)	OFI	CON	OFI	OFI	CON	OFI	OFI	CON	CON	CON	CON	OFI	CON	CON

CON = conservative; ± = mild; F = female; M = male; N = absent; OFI = orbital floor implant; U = unmeasured; Y = present.

TABLE 2. Radiographic Characteristics of 14 Patients with Imploding Antrum Syndrome

Characteristic	Patient Number													
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Side affected	Right	Right	Right	Right	Left	Left	Right	Right	Left	Right	Left	Left	Right	Left
Orbital radiology														
Displacement of orbital roof	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Depression of orbital floor	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hypoglobus	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Enophthalmos	Y	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y
Thickness of maxilla walls														
Roof (orbital floor)	U	D	D	L	D	I	I	L	L	I	D	D	U	L
Medial	U	Nl	D	D	D	I	I	Nl	L	D	D	N	D	D
Lateral	U	D	D	L	L	I	I	L	L	Nl	I	D	D	I
Anterior	U	Nl	D	Nl	L	I	Nl	I	D	Nl	I	Nl	D	I
Concavity of maxilla walls														
Medial	U	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lateral	U	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Anterior	U	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N
Sinus radiologic features														
Solid opacity in maxillary antrum	U	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Air–fluid level in maxillary antrum	U	N	N	Y	N	N	Y	N	U	N	N	Y	N	N
Disease of other sinuses	N	±	±	±	N	N	±	N	±	±	Y	±	N	N
Intranasal radiologic features														
Side to which nasal septum deviated	Right	Right	Right	Right	Nl	Left	Right	Right	Nl	Right	Left	Left	Right	Right
Lateral deviation or rotation (Ro) of ipsilateral middle turbinate	Dv	Ro	Nl	Dv	Nl	Dv	Dv	Dv	Nl	Ro	Ro	Dv	Nl	Ro

± = mild changes; D = decreased; Dv = lateral deviation; I = increased; L = loss of bone density; N = absent; Nl = normal; Ro = rotation; U = unassessable from scans; Y = present.

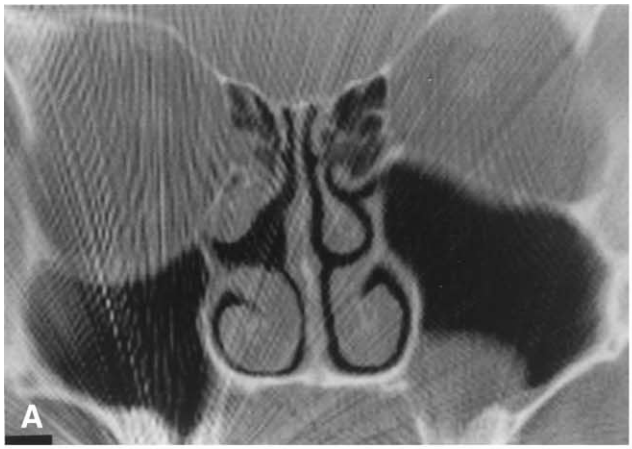
the extent of globe displacement is similar in the two groups—with average enophthalmos in the Soparkar et al series being 3 mm (range, 2–5 mm)[2] compared with 2.8 mm (range, 1–4 mm) in this series, and the Soparkar et al series reporting a mean hypoglobus of 3.4 mm (range, 2–6 mm)[2] compared with 2.2 mm (range, 0–4 mm) in our series.

The imploding antrum syndrome appears to be associated with extensive radiologic changes in all walls of the maxillary sinus (Table 2), the smoothly concave downward collapse of the orbital floor being entirely responsible for the secondary orbital signs. In contrast to Soparkar et al,[2] who reported "dramatic thinning or complete resorption of the orbital floor" in all patients, we found various changes in the maxillary walls—with thickening, generalized thinning, or focal loss of bone (Table 2). In addition, this study has demonstrated nasal septal deviation toward the involved side in 10 of 14 cases (reported in one half of those in the Soparkar et al[2] series and also in other reports[5,7]) and abnormalities of the ipsilateral middle turbinate[6,7] and osteomeatal complex in 10 of 14 cases. Patchy soft-tissue changes were present in all of the affected maxillary sinuses, but there was no widespread sinus disease. The presence of consolidation and collapse (implosion) of the ipsilateral ethmoid sinus in one patient is unique, but implies that the disease rarely may affect a neighboring ethmoid.[6]

In our patient series, the antral mucosal changes on radiologic examination, and the biopsies taken suggest mild chronic, but largely asymptomatic, sinus pathologic features—a clinically "silent" sinus disease; only two of our patients had brief episodes of ipsilateral acute sinusitis in their teenage years.

Soparkar et al[2] use the term *maxillary hypoplasia*, implying a congenital abnormality of the maxilla; we would, however, propose that the collapse (implosion or atelectasis[8–12]) of some or all of the antral walls occurs in a previously normal-sized maxillary sinus. The sudden onset and long-term stability of the condition suggests that, although asymptomatic sinus disease may be the underlying cause, an acute event precipitates collapse of the orbital floor or, more accurately, a widespread implosion of some or all of the antral walls. The symptomatic condition would, therefore, be better termed the *imploding antrum syndrome*—this reflecting the underlying acute process—rather than *silent sinus syndrome*, a term that merely indicates (rather cryptically) the putative state of the affected sinus.

Figure 4. Radiographic changes of the imploding antrum. **A,** Inward collapse of the roof and lateral wall and rotation of the middle turbinate. **B,** The thick orbital rim is not depressed. **C,** Demineralization and inward bowing of the lateral and anterior walls, with opacity of the sinus. **D,** In another case, the medial portion of the sinus is aerated. **E,** Involvement of only the posterior third of the lateral wall; note that on the healthy side, this part of the wall is also thinner. **F, G,** Deviation of nasal septum toward the imploding antrum, with a contralateral concha bullosa.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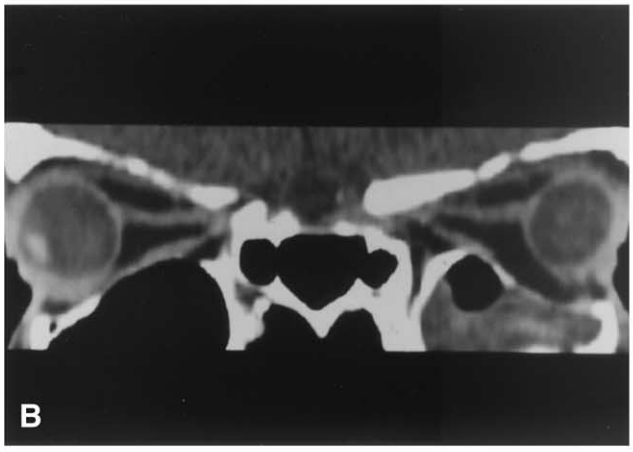
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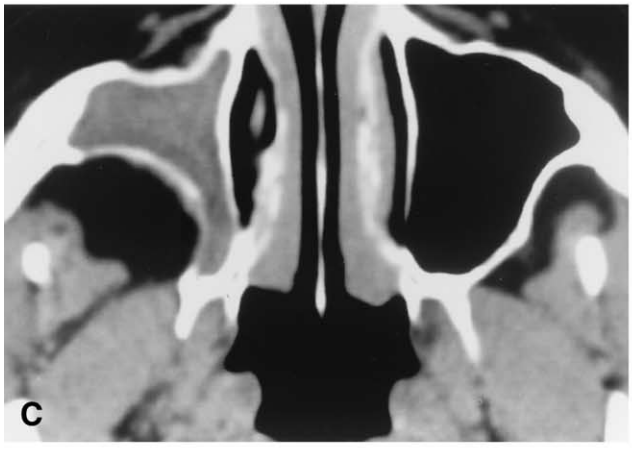
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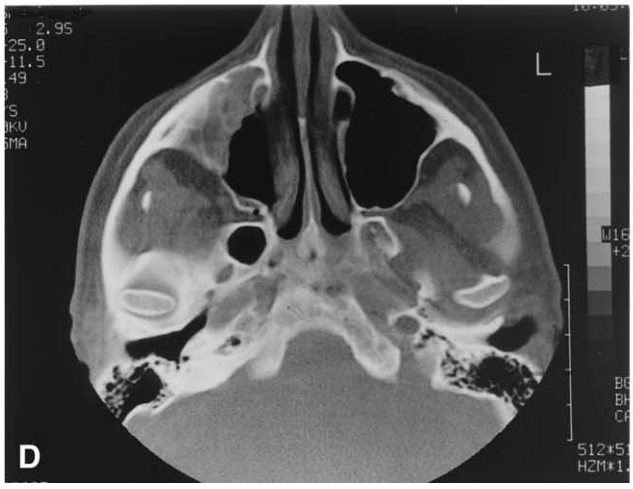
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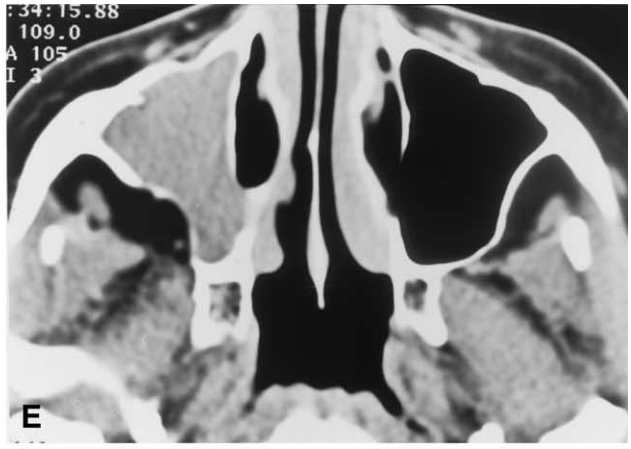
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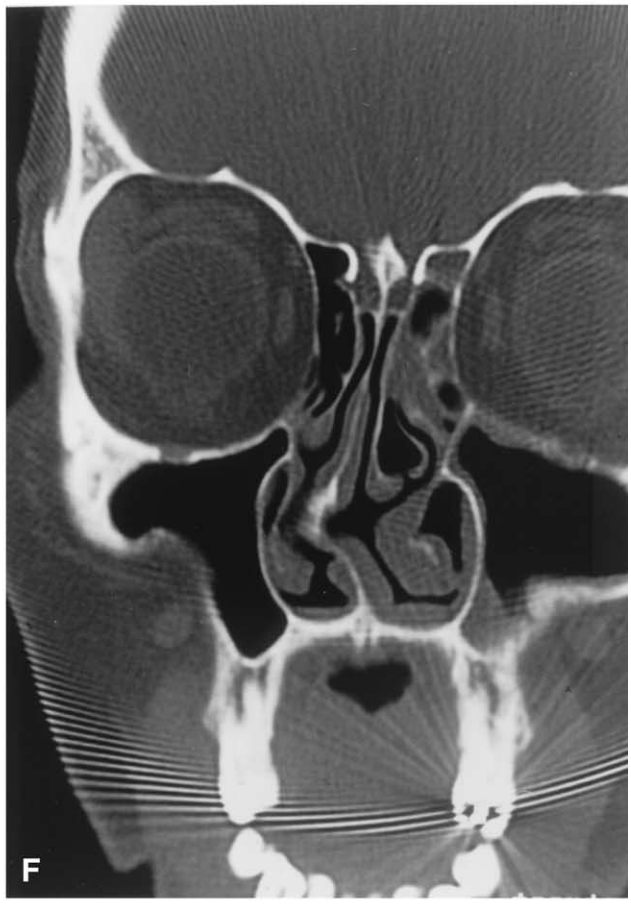
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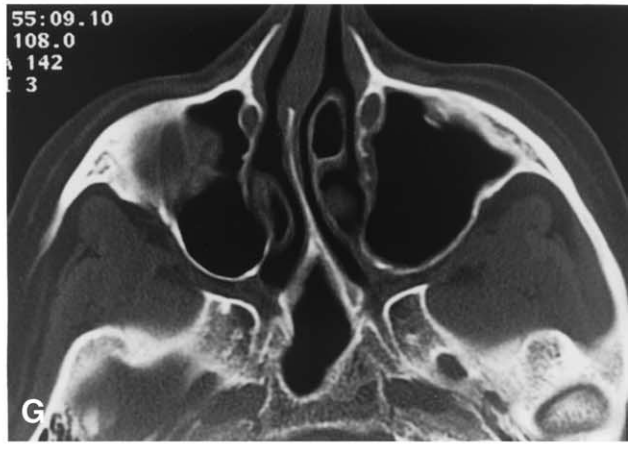
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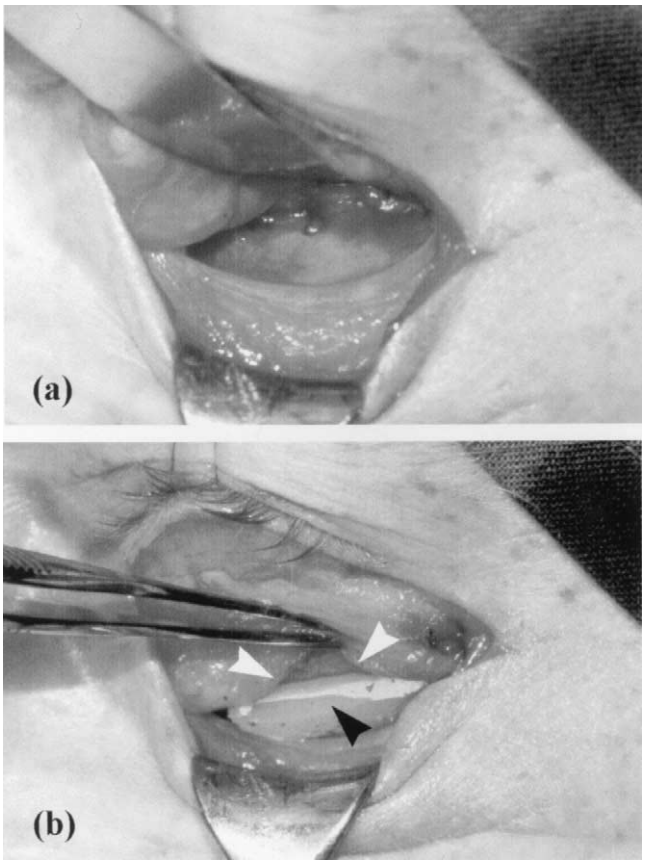

Figure 5. A, Abnormal downward-bowed orbital floor in the imploding antrum syndrome, demonstrated at the time of orbital volume enhancement. **B,** A silicone block (dark arrow), shaped to fit the depression in the orbital floor, is positioned under the orbital periosteum (light arrows).

The clinical and radiologic picture for the imploding antrum syndrome is, in practical terms, pathognomonic.

References

1. Cline RA, Rootman J. Enophthalmos: a clinical review. Ophthalmology 1984;91:229–37.
2. Soparkar CNS, Patrinely JR, Cuaycong MJ, et al. The silent sinus syndrome. A cause of spontaneous enophthalmos. Ophthalmology 1994;101:772–8.
3. Dailey RA, Cohen JI. Surgical repair of the silent sinus syndrome. Ophthal Plast Reconstr Surg 1995;11:261–8.
4. Durig J, Borruat FX, Jaques B. Silent sinus syndrome: an unusual cause of vertical diplopia. Klin Monatsbl Augenheilkd 1998;212:397–9.
5. Wan MK, Francis IC, Carter PR, et al. The spectrum of presentation of silent sinus syndrome. J Neuroophthalmol 2000;20:207–12.
6. Hunt SM, Tami TA. Sinusitis-induced enophthalmos: the silent sinus syndrome. Ear Nose Throat J 2000:79:576,579–81,584.
7. Gillman GS, Schaitkin BM, May M. Asymptomatic enophthalmos: the silent sinus syndrome. Am J Rhinology 1999;13:459–62.
8. Furin MJ, Zinreich SJ, Kennedy DW. The atelectatic maxillary sinus. Am J Rhinol 1991;5:79–83.
9. Antonelli PJ, Duvall AJ 3rd, Teitelbaum SL. Maxillary sinus atelectasis. Ann Otol Rhinol Laryngol 1992;101:977–81.
10. Blackwell KE, Goldberg RA, Calcaterra TC. Atelectasis of the maxillary sinus with enophthalmos and midface depression. Ann Otol Rhinol Laryngol 1993;102:429–32.
11. Kass ES, Salman S, Rubin PAD, et al. Chronic maxillary atelectasis. Ann Otol Rhinol Laryngol 1997;106:109–16.
12. Boyd JH, Yaffee K, Holds J. Maxillary sinus atelectasis with enophthalmos. Ann Otol Rhinol Laryngol 1998;107:34–9.