Silent sinus syndrome: systematic review and proposal of definition, diagnosis and management

Cecilia Rosso1, Alberto Maria Saibene1, Giovanni Felisati2, Carlotta Pipolo2

1 Department of Otorhinolaryngology, Santi Paolo e Carlo Hospital, Università degli Studi di Milano, Milan, Italy; 2 Department of Otorhinolaryngology, Santi Paolo e Carlo Hospital, Department of Health Sciences, Università degli Studi di Milano, Milan, Italy

SUMMARY
Silent sinus syndrome (SSS) is a rare disease consisting of a collapse of maxillary sinus walls with concomitant orbital floor descent. Due to its rarity, the literature highlights some confusion on its definition, diagnosis and management. A PRISMA-compliant systematic review was performed on SSS with focus on definition, diagnosis and therapeutic management. Twenty-eight studies were selected, with 276 patients evaluated. The analysis revealed that the leading definition of SSS includes evidence of both enophthalmos and maxillary atelectasia. Although the definition of SSS accepts only spontaneous sinus collapse, the presence of sinonasal diseases and history of facial trauma are starting to be included in the criteria. Most studies (n = 21) considered CT scans satisfactory for diagnosis of SSS, while 7 also performed MR. The majority of SSS were successfully treated with isolated functional endoscopic sinus surgery (n = 17), sparing orbital reconstruction as a rescue procedure in case of non-satisfactory long-term resolution of signs. Although the literature is starting to coordinate on diagnosis of SSS, our review revealed the necessity of consensus on its definition and management.

KEY WORDS: silent sinus syndrome, maxillary atelectasia, enophthalmos, imploding antrum syndrome, silent sinus syndrome management

Introduction
Silent sinus syndrome (SSS) or imploding antrum syndrome is a very rare condition, usually consisting of asymptomatic spontaneous collapse of the sinus walls and floor of the orbit. Due to its rarity, the literature has often
highlighted the confusion around its definition, diagnosis and proper management. The aetiology of SSS remains controversial. Patients typically deny preexisting sinus disease or orbital-facial trauma. Most authors postulate that collapse of the inferior orbital wall is induced by negative pressure generated by resorption of gas after acute trauma. Some authors believe that collapse may occur during the first or second decade of life. Clinical appearance usually consists in asymptomatic enophthalmos and altered facial appearance. Nevertheless, diplopia, sinusitis, rhinorrhea, post-nasal drip, facial pressure, or pain may also be present.

SSS and Chronic Maxillary sinus Atelectasis (CMA) are terms which have been used interchangeably; the latter can be defined as a persistent and progressive decrease in maxillary sinus volume secondary to inward bowing of the antral walls. Some authors define CMA as SSS, while others sustain that the two are separate clinical entities. For example, according to Endo et al., it is possible to consider three stages of CMA: the last, group III, is defined by clinical facial deformity with the onset of ocular disturbances, and may be also defined as SSS. Brandt et al. also argued that SSS should be considered a subtype of CMA.

The original definition of SSS dates to 1994 and included only spontaneous enophthalmos not associated with prior trauma or surgery. Nevertheless, many authors have started accepting wider inclusion criteria. CMA, for instance, can present as neurological symptoms (idiopathic, post-traumatic, and iatrogenic) and sustain that they should be included in the definition of SSS.

Treatment is also a subject under continuous re-evaluation. At first, surgical treatment consisted in Caldwell-Luc sinus surgery with inferior meatoctomy and concurrent transconjunctival repair of the orbital floor. In 1993, Blackwell et al. described endoscopic maxillary antrostomy (FESS: functional endoscopic sinus surgery) in conjunction with transconjunctival orbital floor repair (OR) in three patients and reported resolution of maxillary disease on follow-up.

Our systematic review retrieved 28 original articles, the most required diagnostic criteria were hypoglobus (15 studies), while post-traumatic, facial asymmetry and diplopia evidences were less required (respectively, in 3, 3 and 1 studies) as seen in Table II. Moreover, 7 studies did not directly define diagnostic criteria, which were extrapolated from the manuscript.

Discussion

SSS is a relatively rare disease that most ENT specialists and ophthalmologists know as an entity, but the sporadic evidence leads to ambiguity on many of its aspects, from definition, to diagnostic criteria to treatment.

Definition

Our systematic review revealed that among the 28 studies evaluated, the most required diagnostic criteria were evidence of enophthalmos (25 studies) and maxillary atelectasia (MA) (23 studies) and hypoglobus (15 studies), while post-traumatic, facial asymmetry and diplopia evidences were less required (respectively, in 3, 3 and 1 studies) as seen in Table II. Moreover, 7 studies did not directly define diagnostic criteria, which were extrapolated from the manuscript.

Nine studies included patients with sinonasal symptoms; 6 included post-traumatic cases, and 1 had post-surgical SSS (Tab. I). Twenty studies diagnosed SSS with CT alone, while 7 performed both CT and MR imaging. One study did not define what imaging was performed (Tab. I).

Surgical approaches consisted in combined FESS and OR in 72 patients, mostly in a one-step surgery. Four studies performed both types of timing-changes (one step or two steps 6 months apart), deciding according to the individual case. FESS alone was performed in 116 patients; other less common therapies were a wait & see approach (57 patients), OR alone (8 patients) and antibiotic therapy (1 patient) (Tab. I). A study by Khon et al. did not define their therapeutical approach in the 22-patient case series.

All patients had clinical resolution (CR) or clinical improvement (CI). Only Lin and Brown reported 2 patients who had FESS surgery alone that did not resolve enophthalmos, who then underwent subsequent OR. Complications are reported in Table I.

Figure 1. PRISMA flow-chart.

To shed light on these controversies, we performed a systematic review of the literature on SSS, with particular focus on definition, diagnosis and surgical approach.

Materials and methods

A PRISMA-compliant systematic literature review was carried out in December 2020 on the Web of Science, PubMed and Scopus databases, using a search strategy for “(Silent Sinus) AND (Maxillary)” and “(Silent Sinus Syndrome) AND (Maxillary)”. We included studies focused on SSS with the following criteria.

Inclusion criteria

• Age 1-100 years.
• Silent sinus syndrome (SSS).
• Chronic maxillary atelectasis (CMA).

Exclusion criteria

• Studies whose main purpose was unrelated to SSS characteristics and management.
• No human patients involved.
• Language other than English, Italian, French, German and Spanish.
• Article accepted but not published.
• Article type: case reports with less than 3 patients, reviews, comments, letters to the editor, book chapters.

Population, Intervention, Comparison, Outcomes, and Study (PICOS) criteria

PICOS criteria for the present review were as follows:

• Patients with CMA or SSS diagnosis.
• Intervention: evaluation of definition, diagnostic criteria and treatment.
• Comparison: comparison of different definitions, diagnosis and therapeutical options (FESS + OR, FESS alone, OR alone, antibiotic therapy, wait & see).
• Outcome: proposal of shared definition, diagnostic criteria and treatment.
• Study design: Retrospective case studies and case series (more than 3 patients) were enrolled in the review.

Data extraction and quality assessment

Two of the authors (CR and CP) independently screened the retrieved studies based on title and abstract; when uncertainty existed in the abstract evaluation, we retrieved and assessed the full text. After completion of all searches, duplicates were removed. Evaluation through full-text screening was then carried out. Critical appraisal led to the selection of 28 studies (Fig. 1). Both retrospective and prospective studies were included, while case reports and small case series were excluded because of their intrinsically lower level of evidence (the minimum number of patients was arbitrarily set at 3). Published reviews on SSS were similarly excluded, but their reference list was reviewed to identify possible additional studies. A manual search in the reference lists of these articles was performed to identify potentially relevant papers missed during the database search. Differing opinions were resolved by consensus between the two authors. Data extracted and analysed included study design, sample size, mean patient age, diagnostic criteria, associated factors, instrumental diagnosis, surgical approach and timeline, outcomes, complications and follow-up time.

Results

The systematic review retrieved 28 original articles (26,27,30,31,32,34-37). Twenty-one were retrospective case studies (RCS), while 7 were case reports reporting at least 3 cases. A total of 276 patients were evaluated with a mean of 9.8 cases per study (range 3-57). Mean age was 40.4 years, although 3 papers did not report the age of participants (Tab I). There was a wide variety of diagnostic criteria among studies (Tab. II). The most frequently required findings for diagnosis were evidence of enophthalmos (En) (25 studies), maxillary atelectasia (MA) (23 studies) and hypoglobus (15 studies), while post-traumatic, facial asymmetry and diplopia evidences were less required (respectively, in 3, 3 and 1 studies) as seen in Table II. Moreover, 7 studies did not directly define diagnostic criteria, which were extrapolated from the manuscript.
| Study (year) | Study design | Sample size | Mean age (range) in years | Diagnostic criteria | Associated factors | Diagnosis | Surgical approach | Surgical timeline | Outcome | Complications | Follow-up (months) |
|-------------|--------------|-------------|---------------------------|---------------------|--------------------|-----------|-----------------|-----------------|---------|--------------|-------------------|
| Behbehani 8 (2006) | RCS | 5 | 36.7 (32-42) | En Hypeglobus MA | Post-traumatic (1) Chronic sinusitis (4) | CT scans | FESS and OR (5) | One step (5) | 100% CI or CR | Residual 1mm En (2) | Transient infraorbital hypoaesthesia (1) | 24 |
| Bossalesi 9 (2009) | Case reports | 4 | 42 (38-40) | En Opaqued maxillary sinus Absence of major sinus pathology Absence of previous trauma, surgery or congenital facial deformity | Chronic sinusitis (2) | End CT MR | FESS and OR (4) | One step (4) | 100% CR | None | 12-24 |
| Brown 10 (2017) | RCS and review | 6 | 43 (35-52) | En MA Hypeglobus | Chronic sinusitis (1) Post-traumatic (6) | CT | FESS (1) OR (1) FESS and OR (4) | One step (1) Two steps (3) | 100% CI | Residual 2 mm En (1) minor diplopia (1) | Not defined |
| Chantia 11 (2014) | RCS | 13 | 34 (13-61) | En MA Hypeglobus | Chronic sinusitis (5) | CT | FESS (13) | N/A | 100% CI | Orbital breach (2) | 30 |
| Chavez-Montoya 12 (2017) | RCS | 3 | 44 (37-48) | En MA Opaqued maxillary sinus | Nasal polyposis (1) | CT | FESS (1) FESS and OR (1) Wait & see (1) | One step (1) | 100% CI | - | 24 |
| Clarke 13 (2015) | Case reports | 3 | 36.3 (25-45) | Not defined | En Hypeglobus Low pressure in maxillary sinus | - | CT | FESS + OR (9) | One step (3) | 100% CI | None | Not defined |
| Clarke 14 (2019) | RCS | 13 | 38 (25-53) | Not defined | En Hypeglobus Orbital floor resorption MA | - | CT | FESS + OR (13) | One step (13) | 100% CI | None | Not defined |
| Cobb 15 (2012) | Case reports | 3 | 44 (30-60) | En MA Facial asymmetry | Post-traumatic (2) Post-surgical (1) | CT MR | FESS and OR (3) | One step (2) Two steps (1) | 100% CI | None | 12 (1) 36 (1) 48 (1) |
| De Derodot 16 (2017) | RCS | 4 | 44 (12-60) | En MA Absence of sinonasal symptoms | - | CT | FESS (3) FESS and OR (1) | Two steps (1) | 100% CI | Slight enophthalmos in some patients (No. not defined) | Not defined |
| Eysjor 17 (2018) | RCS | 16 | 42.37 (20-60) | En MA Absence of trauma or sinusitis | - | CT MR | FESS (16) | N/A | Ongoing follow-up | Ongoing |
| Farreti 18 (2017) | RCS and review | 6 | 10 (7-14) | En Absence of sinonasitis Remodeling of orbital floor at CT/MR scans | - | CT MR | FESS (6) | N/A | 100% CR | Residual headache (1) | 18-135 |
| Freiser 19 (2020) | RCS | 57 | 12.5 (3.7-18) | Not defined | En Hypeglobus MA | - | CT MR | FESS (18) Wall & see (38) | N/A | 100% CI or CR | Not defined | Not defined |
| Gaudino 20 (2013) | RCS | 6 | 44 (22-67) | En Diplopia Opaqued sinus MA | - | CT MR | FESS (1) FESS and OR (2) Wall & see (3) | One step (1) Two steps (1) | 2 FESS: no significant CI 2 FESS and OR: CI | Not defined | Not defined |

continues ▶
| Study (year) | Study design | Sample size | Mean age (range) in years | Diagnostic criteria | Associated factors | Diagnosis | Surgical approach | Surgical timeline | Outcome | Complications | Follow-up (months) |
|-------------|--------------|-------------|---------------------------|---------------------|--------------------|-----------|------------------|-----------------|---------|---------------|-------------------|
| Illner **(2002)** | RCS | 5 | 47 (19-65) | Not defined | En Hypoglobus | En Hypoglobus | Maxillary sinus completely developed | FESS (3) | Antibiotic therapy (1) | Wait & see (1) | N/A | Not defined | Not defined |
| Kashima * (2016) | RCS | 11 | 39.5 (23-62) | Not defined | Not defined | MA | En Hypoglobus | Not defined | FESS and OR (11) | One step (1) | 100% CI | Residual enophthalmos (1) | 9 |
| Kohn **(2013)** | RCS | 22 | 41.2 (22-70) | En Hypoglobus | En Hypoglobus | MA | Orbital changes at CT scans | CT/MR | Not defined | Not defined | Not defined | Not defined | Not defined |
| Korn **(2009)** | Case reports | 5 | | Not defined | En Hypoglobus | MA | Orbital floor resorption | CT/MR | Not defined | Not defined | Not defined | Not defined | Not defined |
| Lee * (2018) | Case reports | 3 | 44.6 (37-55) | Not defined | MA | En Hypoglobus | Orbital floor remodeling | CT/MR | Post-traumatic (1) | FESS (1) | OR (1) | Wait & see (1) | 100% CI | Not defined |
| Lin * (2015) | RCS | 9 | | Not defined | MA | En Hypoglobus | Orbital floor remodeling | CT/MR | Post-traumatic (1) | FESS (7) | FESS and OR (2) | Two steps (2) | 2 FESS alone did not resolve enophthalmos and so underwent OR | None | 21.4 |
| Martinez-Capoccioni **(2016)** | RCS | 20 | 44.2 (28-67) | Not defined | En and/or Hypoglobus | Endoscopic findings of MA | Altered facial appearance | CT/MR | Nasal obstruction (9) | FESS (15) | OR (6) | Wait & see (6) | N/A | 100% CI | None | 6-18 |
| Rose * (2003) | RCS | 14 | 41.3 (25-78) | Not defined | En Hypoglobus | En Hypoglobus | Maxillary contraction and orbital enlargement at CT scans | CT/MR | Not defined | OR (6) | Wait & see (6) | N/A | 100% CI | None | 5-33 |
| Sesenna * (2010) | Case reports | 3 | 39 (28-46) | En Hypoglobus | En Hypoglobus | En Hypoglobus | Maxillary sinus trauma and congenital deformities | CT/MR | Not defined | FESS and OR (3) | One step (2) | 100% CI | None | 10-16 |
| Sivasubramaniam * (2011) | RCS | 18 | Not defined (19-54) | Not defined | En and/or Hypoglobus | MA | Orbital floor remodeling at CT scans | CT/MR | Not defined | FESS (18) | N/A | 78% CI | Residual enophthalmos (1) | 15-120 |
| Thomas **(2003)** | RCS | 4 | 32 (27-35) | Not defined | En Hypoglobus | En Hypoglobus | Maxillary sinus | CT/MR | FESS and OR (2) | FESS (2) | Two steps (2) | 100% CI | Residual enophthalmos after FESS alone (2) which required second step surgery with OR | None | Not defined |

Table I. Baseline data of studies included (follows).
considering post-traumatic cases not definable as SSS due to their lack of spontaneous development. Nevertheless, a retrospective analysis of 6 cases and literature review showed how traumatic SSS management follows the same principles as for spontaneous SSS. In fact, our analysis revealed that recent papers started to include enophthalmos with MA secondary to traumatic events in the group of SSS, explaining that clinical and radiological presentations are comparable, as well as surgical treatment.

Moreover, the association of SSS with sinonasal symptoms is debated. Ten studies considered the evidence of sinonasal symptoms as an exclusion criterion because of the relevance was to investigate maxillary bony walls and high signal peripheral; muscles and optic nerve; enophtalmos and maxillary atelectasia; possible resorption of the orbital floor. Nevertheless, 7 groups also considered it useful to add MR scans (Tab. I) to evaluate: dislocation of extra and intra-conal fat, extrinsic ocular muscles and optic nerve; differentiation between mixed signal central secretions and high signal peripheral; thick edematous mucosal lining within the maxillary sinus. Diagnostic proposition: Only CT scan is required. MR imaging can be associated in selected cases, and specifically to evaluate a marked hypoglobus. We propose to add evaluation of extracranial muscle movement and potential diplopia at first ENT clinical evaluation, in order to select symptomatic and therefore the most critical cases.

Treatment: The review also showed disagreement on management strategies. Seventeen authors proposed combined FESS and OR surgery as the leading therapy to obtain resolution of anatomical impairment and diplopia, if present. Among these, the majority (n = 9) performed both the procedures simultaneously, while 4 preferred to first carry out FESS surgery and to observe a possible progressive improvement of the enophthalmos to decide whether or not to perform additional OR. Eventually, 3 studies performed FESS and either simultaneous or delayed OR according to the criticality of the case (Tab. III).

The reasons which guide each surgical team towards one choice or another are multiple. The main factor is undoubtedly the severity of enophthalmos and hypoglobus, although no study defined a quantitative cut-off which could help in the surgical decision. OR approach is supported by the fact that, although there have been reports of resolution of the progression of enophthalmos by antrostomy alone, it is unclear whether other aesthetic deformities caused by SSS as hypoglobus or superior sulcus deformity also respond. Behbehani et al. believe that delaying orbital implant placement in cases with significant enophthalmos and hypoglobus is unjustified since complications like diplopia or infection are rare with this procedure. Furthermore, simultaneous implant placement also obviates the need for additional anaesthesia and hospitalisation. Cobb et al. maintain that FESS alone may stop the descent of the orbital wall, but there would be no reason to expect that the position of the orbital floor, and thus the globe, would be reversed. On the contrary, Thomas et al. support delayed repair of the orbital floor as in some patients enophthalmos improves with antrostomy alone. Moreover, OR has not been shown to provide any significant restoration in the orbital muscle functions, and because of that diplopia is not corrected.

A total of 116 patients underwent FESS surgery alone, being considered as a necessary and sufficient procedure to resolve MA and enophthalamos. If we consider the entire case series of the review, FESS alone appears as the leading therapeutic choice, with only 7 reporting residual enophthalamos (6%) and OR required in 4% of cases (3.4%). Moreover, Numa et al. undertook a review of 84 cases and concluded that for patients with SSS diagnosis, uncincotomy alone may be sufficient. FESS + OR follows with 72 cases treated with this management. Wait & see (57 patients) may be a valid alternative in asymptomatic cases or young population. OR alone (8 patients) and antibiotic therapy (1 patient) remain marginal therapeutic options.

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A total of 116 patients underwent FESS surgery alone, being considered as a necessary and sufficient procedure to resolve MA and enophthalamos. If we consider the entire case series of the review, FESS alone appears as the leading therapeutic choice, with only 7 reporting residual enophthalamos (6%), and 4 requiring subsequent OR (3.4%). Moreover, Numa et al. undertook a review of 84 cases and concluded that for patients with SSS diagnosis, uncincotomy alone may be sufficient. FESS + OR follows with 72 cases treated with this management. Wait & see (57 patients) may be a valid alternative in asymptomatic cases or young population. OR alone (8 patients) and antibiotic therapy (1 patient) remain marginal therapeutic options.

This leads us to the conclusion that most of SSS may be successfully treated with isolated FESS surgery, sparing OR as a rescue procedure in case of non-satisfactory resolution of enophthalamos or diplopia.

TREATMENT PROPOSAL: FESS is the leading treatment for SSS and orbital reconstruction should be performed only in selected and symptomatic cases or, if needed, in a second approach when no resolution is seen. The proposed timepoint for a potential postponed OR, according to the literature, is 6 months. Our review clearly shows the need to develop consensus regarding the definition of SSS and most of all its management. Even if the literature has started to find marginal consensus in recent years, it appears necessary to define shared diagnostic criteria, as well as a shared approach to the best treatment choices with the lowest rate of invasiveness and morbidity. The literature would also
Acknowledgements
We gratefully thank the Librarians from the Università degli Studi di Milano, Biblioteca del Polo Centrale. Without their help, we would not have been able to locate and analyse a significant number of the studies included in this systematic review.

Conflict of interest statement
The authors declare no conflict of interest.

Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Author contributions
CR made a substantial contribution to the conception and design of the article, to the acquisition, analysis and interpretation of data. AMS and GF critically revised the article and gave the final approval of the version to be published. GP made a substantial contribution to the conception and design of the article and gave the final approval of the version to be published.

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Table II. Summary of diagnostic criteria for SSS.

| Study (year) | En | Hypoglobus | MA | Specified maxillary sinus | No previous trauma, surgery or congenital deformities | No sinonasal symptoms | Post-traumatic | Facial asymmetry | Diplopia | Orbital floor remodeling at CT |
|--------------|----|-------------|----|----------------------------|-------------------------------------------------|------------------------|--------------|-----------------|---------|-----------------------------|
| Behbehani et al. (2006) | X | X | X | X | X |
| Bossolesi et al. (2008) | X | X | X | X |
| Brown et al. (2017) | X | X |
| Chetta et al. (2014) | X |
| Chavez-Montoya et al. (2017) | X | X |
| Clarin et al. (2015) | X | X |
| Clarin et al. (2019) | X | X |
| Cobb et al. (2012) | X |
| De Doro et al. (2017) | X | X | X |
| Eyigor et al. (2016) | X | X |
| Farretti et al. (2017) | X | X | X |
| Freier et al. (2020) | X | X |
| Gaudino et al. (2013) | X | X | X |
| Hrer et al. (2002) | X | X |
| Kasthma et al. (2016) | X | X | X |
| Kohn et al. (2013) | X | X |
| Korn et al. (2009) | X |
| Lee et al. (2018) | X | X | X |
| Liu et al. (2015) | X | X | X |
| Martinez-Capoccioni et al. (2016) | X |
| Rose et al. (2003) | X | X |
| Sesenna et al. (2010) | X | X | X |
| Sivasubramaniam et al. (2011) | X | X | X |
| Thomas et al. (2003) | X | X | X |
| Vanden Meer et al. (2001) | X | X | X |
| Virgin et al. (2008) | X | X |
| Wan et al. (2000) | X | X | X |
| Wise et al. (2007) | X | X |
| TOTAL | 7 |

Table III. Summary of therapeutic strategies for SSS.

| Study (year) | FESS + OR | FESS | OR | Wait & see | Antibiotic therapy |
|--------------|-----------|------|----|------------|-------------------|
| Behbehani et al. (2006) | X (5) | | | | |
| Bossolesi et al. (2008) | X (4) | | | X (1) | |
| Brown et al. (2017) | X (1) | X (1) | | | |
| Chetta et al. (2014) | X (13) | | | | |
| Chavez-Montoya et al. (2016) | X (1) | X (1) | | | X (1) |
| Clarin et al. (2015) | X (9) | | | | |
| Clarin et al. (2019) | X (13) | | | | |
| Cobb et al. (2012) | X (3) | | | | |
| De Doro et al. (2017) | X (1) | X (2) | | | |
| Eyigor et al. (2016) | X (16) | | | | |
| Farretti et al. (2017) | X (6) | | | | |
| Freier et al. (2020) | X (19) | | | X (3) | |
| Gaudino et al. (2012) | X (2) | X (1) | | X (3) | |
| Hrer et al. (2002) | X (2) | X (1) | | X (1) | X (1) |
| Kasthma et al. (2016) | X (11) | | | | |
| Kohn et al. (2013) | - | - | - | - | - |
| Korn et al. (2009) | X (5) | | | | |
| Lee et al. (2018) | X (1) | X (1) | | X (1) | |
| Liu et al. (2015) | X (2) | X (7) | | | |
| Martinez-Capoccioni et al. (2016) | X (15) | | | X (5) | |
| Rose et al. (2003) | X (8) | | | X (8) | |
| Sesenna et al. (2010) | X (3) | | | | |
| Sivasubramaniam et al. (2011) | X (18) | | | | |
| Thomas et al. (2002) | X (2) | X (2) | | | |
| Vanden Meer et al. (2001) | X (4) | | | | |
| Virgin et al. (2008) | X (11) | X (4) | | | |
| Wan et al. (2000) | X (3) | | | | |
| Wise et al. (2007) | X (8) | X (3) | | | |
| TOTAL | 17 | 17 | 3 | 7 | 1 |

TOTAL PER CASES | 72 | 116 | 8 | 57 | 1 |

En: enophthalmos; MA: maxillary atelectasia.

Conclusions
Literature about SSS is controversial and confusing. Our systematic review illustrates that the leading definition of SSS includes the evidence of enophthalmos and maxillary atelectasia by CT. Hypoglobus, presence of sinonasal diseases and history of facial trauma may or may not be associated, although the clinical relevance and management seems to be comparable. FESS alone appears to be the first choice of treatment, since at post-operative follow-up, orbital floor retraction tends to spontaneously reverse with clinically satisfactory results.

Benefit from prospective studies on the best outcome in SSS management.

Table II. Summary of diagnostic criteria for SSS.

| Study (year) | En | Hypoglobus | MA | Specified maxillary sinus | No previous trauma, surgery or congenital deformities | No sinonasal symptoms | Post-traumatic | Facial asymmetry | Diplopia | Orbital floor remodeling at CT |
|--------------|----|-------------|----|----------------------------|-------------------------------------------------|------------------------|--------------|-----------------|---------|-----------------------------|
| Behbehani et al. (2006) | X | X | X | X | X |
| Bossolesi et al. (2008) | X | X | X | X |
| Brown et al. (2017) | X | X |
| Chetta et al. (2014) | X |
| Chavez-Montoya et al. (2017) | X | X |
| Clarin et al. (2015) | X | X |
| Clarin et al. (2019) | X | X |
| Cobb et al. (2012) | X |
| De Doro et al. (2017) | X | X | X |
| Eyigor et al. (2016) | X | X |
| Farretti et al. (2017) | X | X | X |
| Freier et al. (2020) | X | X |
| Gaudino et al. (2013) | X | X | X |
| Hrer et al. (2002) | X | X |
| Kasthma et al. (2016) | X | X | X |
| Kohn et al. (2013) | X | X |
| Korn et al. (2009) | X |
| Lee et al. (2018) | X | X | X |
| Liu et al. (2015) | X | X | X |
| Martinez-Capoccioni et al. (2016) | X | X |
| Rose et al. (2003) | X |
| Sesenna et al. (2010) | X | X | X |
| Sivasubramaniam et al. (2011) | X | X | X |
| Thomas et al. (2002) | X | X |
| Vanden Meer et al. (2001) | X |
| Virgin et al. (2008) | X |
| Wan et al. (2000) | X | X |
| Wise et al. (2007) | X | X |
| TOTAL | 7 |

TOTAL PER CASES | 72 | 116 | 8 | 57 | 1 |
