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ORIGINAL ARTICLE

Complicated acute rhinosinusitis in the pediatric population and the influence of COVID-19

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Abstract

Introduction and objectives: Complications of acute rhinosinusitis (ARS) are more common in children and are divided, in decreasing order of frequency, into orbital, intracranial, and bony. The aim is to analyze the impact of SARS-CoV-2 on complicated ARS at a tertiary children's hospital. **Methods:** A retrospective, observational study of a five-year period, categorized based on the SARS-CoV-2 pandemic into pre-COVID-19 (2018/2019), COVID-19 (2020/2021), and post-COVID-19 (2022). We included patients up to 18 years of age, who were admitted to the otorhinolaryngology (ENT) ward with ARS. Socio-demographic and clinical data were collected and analyzed. **Results:** Thirty-four children were admitted to our hospital with ARS. The incidence decreased during the COVID-19 period (n = 5) and increased in the post-COVID-19 period (n = 12). The mean Lund-Mackay score was 12.9, with no significant difference between periods. The rate of complications was 73.5% for orbital, 8.8% for intracranial, and 8.8% for bone complications. Orbital complications were more frequent in younger patients, while intracranial complications occurred more often in older children ($p < 0.05$). There were no intracranial complications in the pre-COVID-19 period and 66.7% of these occurred in the COVID-19 period. The leukocyte count and C-reactive protein (CRP) levels were higher in the nine patients requiring surgical treatment ($p < 0.013$ and $p < 0.014$), with the majority (55.6%) occurring in the post-COVID-19 period. **Discussion:** Consistent with other studies, we report an increase in severe infections since the COVID-19 pandemic. This increase could be related to the immunological impact of the social distancing measures implemented during the various lockdowns in our country throughout the first year of the SARS-CoV-2 pandemic.

Keywords: Rhinosinusitis. Sinusitis. SARS-CoV-2. Antimicrobial drug resistance.

Rinossinusite aguda complicada na população pediátrica e a influência da COVID-19

Resumo

Introdução e objetivos: As complicações da rinossinusite aguda (RSA) são mais frequentes nas crianças, e dividem-se, por ordem descrescente de frequência, em orbitárias, intracranianas e ósseas. O objetivo é analisar o impacto do SARS-CoV-2 na rinossinusite aguda complicada (RSA) num Hospital Pediátrico Terciário. **Métodos:** Estudo retrospetivo e observacional durante um período de cinco anos. Os doentes foram divididos em grupos pré-COVID (2018/2019), COVID (2020/2021) e pós-COVID (2022). Incluímos pacientes de até 18 anos, que foram admitidos na enfermaria de otorrinolaringologia por RSA. Os dados sociodemográficos e clínicos foram obtidos a partir do processo clínico. **Resultados:** Trinta e quatro crianças foram admitidas em internamento de otorrinolaringologia com RSA. A incidência diminuiu durante o período COVID (n = 5)

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e aumentou no período pós-COVID (n = 12). A média do Lund-Mackay foi de 12,9, sem diferença significativa entre períodos. A taxa de complicações foi de 73,5% para complicações orbitais, 8,8% para complicações intracranianas e 8,8% para ósseas. As complicações orbitais foram mais frequentes nos mais jovens, as intracranianas nos mais velhos (p < 0,05). Não houve complicações intracranianas no período pré-COVID e 66,7% delas ocorreram no período COVID. A contagem de leucócitos e a PCR foram mais elevadas nos 9 pacientes que necessitaram de cirurgia (p < 0,013 e p < 0,014), com a maioria (55,6%) ocorrendo no período pós-COVID. **Discussão:** De acordo com outros estudos, houve um aumento de infeções graves desde a pandemia de SARS-CoV-2. Esse aumento pode estar relacionado com o impacto imunológico das medidas de distanciamento social implementadas ao longo do primeiro ano da pandemia de SARS-CoV-2.

Palavras-chave: Rinossinusite. Sinusite. SARS-CoV-2. Resistencia aos antimicrobanos.

Introduction

Acute rhinosinusitis (ARS) in children is defined as the sudden onset of two or more of the following symptoms: nasal blockage/obstruction/congestion; or discolored nasal discharge; or cough (daytime and night-time) for less than 12 weeks. ARS encompasses viral ARS (common cold) and postviral ARS, but only a small percentage of postviral ARS cases are caused by bacteria (ABRS)[1].

Although complications of ARS have decreased in the era of antibiotic therapy (ABT), they are more frequent in children due to their greater bone and periosteum permeability and higher frequency of upper airway infections. Complications can be divided into orbital (OC), intracranial (IC), and osseous (BC). Orbital complications are the most common and can be classified according to Chandler's classification[2] (Table 1). Periorbital edema, proptosis, diplopia, reduced visual acuity, severe headache, neurological symptoms/signs, or frontal swelling should alert clinicians to a potential complication[3]. In younger patients, orbital complications are more frequent and typically arise from the ethmoid sinus, given its relatively advanced development compared to other sinuses. Intracranial complications are more prevalent in adolescence, often originating from the frontal and sphenoidal sinuses. In both scenarios, infection can propagate through bone defects such as anatomic sutures, dehiscence, or bone necrosis, as well as retrograde thrombophlebitis in avalvulated vessels[4].

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was declared a worldwide pandemic by the World Health Organization (WHO) on Mar 11, 2020. Since its outbreak, we have started to notice an increase in severity and the need for surgery among patients hospitalized with ARS. We therefore decided to analyze whether this perception had statistical significance and explore the possible explanations.

In this study, besides analyzing the impact of the SARS-CoV-2 pandemic on the incidence of ARS complications, we also review our experience with ARS complications in the pediatric population to gain insight into patterns of presentation, imaging, microbiological aspects, therapy, disease course, and outcomes.

Materials and methods

A retrospective, observational study conducted between January 2018 and December 2022. Patients up to 18 years of age, who were admitted to the otorhinolaryngology ward of a pediatric tertiary hospital for ARS, were included. Socio-demographic and clinical data was extracted from the electronic medical records. The statistical analysis of this data was performed using the Statistical Package for the Social Sciences (SPSS®), and p below 0.05 were considered statistically significant. Patients were divided into three groups based on the site of complication (OC, IC, and BC), age [Group one (nought to six years of age), Group two (seven to 12 years of age) and Group three (13 to 17 years of age)], and time period [pre-COVID-19 (2018 and 2019), COVID-19 (2020 and 2021), and post-COVID-19 (2022)].

Results

Epidemiology

Thirty-four children were admitted to the pediatric otorhinolaryngology department of our hospital due to ARS during this five-year period, and thirty-one (91%) were diagnosed with complicated ARS. The annual incidence is presented in (Fig. 1).

Out of these, 35.3% occurred in winter and 26.5% in summer. No gender differences were observed. The mean age of patients was nine years old (ranging from one to 17). The mean age of presentation was higher during the COVID-19 period (12.7 years), but this was not statistically significant (p = 0.27). All children had received the required Portuguese immunization scheme.

Table 1. Orbital complications classified according to Chandler's classification

Chandler's classification	Our sample
Preseptal cellulitis	32%
Orbital cellulitis = postseptal	23%
Subperiosteal abscess	15%
Orbital abscess	3%
Thrombosis of the cavernous sinus	0%

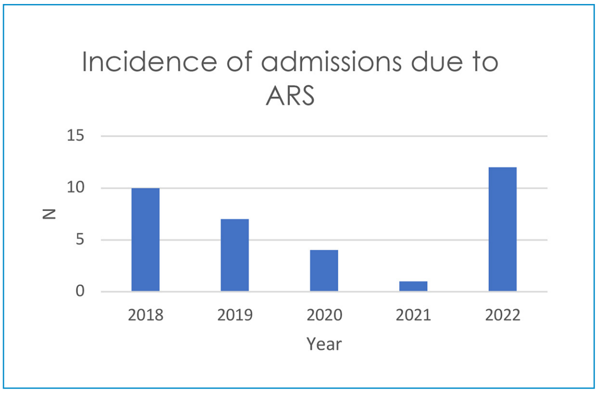

Figure 1. Annual incidence of admissions due to ARS during a five-year period.

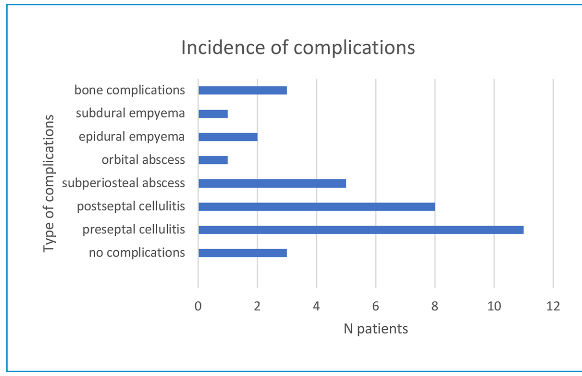

Figure 2. The incidence of complications.

Table 2. Mean age in relation to types of complications

Type of complications	Mean age (years)
OC	8.1
IC	12.7
BC	15
p	0.043

Complications

The incidence of complications is depicted in (Fig. 2). Most patients presented with OC (73.5%; n = 25), with the most common complication being preseptal cellulitis (Chandler I) (32.4%; n = 11). Only 8.3% of these OC cases occurred during the COVID-19 period. There was one BC case in each period. In contrast, most IC cases occurred during the COVID-19 period (66.7%; n = 2) and represented 40% of all complications during this period. Older children more frequently presented with OC and BC ($p < 0.05$) (Table 2).

The mean time before going to the emergency department was 6.9 days (ranging from one to 30) and was higher in the group without complications ($p = 0.018$). There were no significant differences related to time periods ($p = 0.671$). About 44.1% of the patients were already under ABT before admission, with 46.7% receiving amoxicillin clavulanate and 33.3% amoxicillin.

Symptoms/Signs (Table 3)

The most frequent clinical findings were rhinorrhea and palpebral edema, both of which were present in 88.2% of patients (palpebral edema was present in all OC and IC cases). Fever was documented in 83.3% of the 24 cases where it was registered, and headaches were present in 89.5% of the 19 cases where it was registered.

All ocular findings (proptosis, pain, limited extraocular movements, and visual impairment) were simultaneously present in 100% of patients with orbital abscesses, 40% of those with a subperiosteal abscess (SPA), and only 14% of those with orbital cellulitis. Among patients with proptosis, 42.9% had an SPA, 28.6% had orbital cellulitis, and the remainder had more severe complications. For those with limited extraocular movements, 45.5% had orbital cellulitis, 27.3% had an SPA, and the rest had more severe complications. A statistically significant association was found between limited extraocular movements and the need for surgery ($p = 0.028$).

Only one patient with IC exhibited altered mental status, seizures, and hemiparesis. None had meningeal irritation.

Complementary diagnostic methods and therapy

Blood tests

There were no significant differences in laboratory findings between the groups, although the values were lower in patients with no complications.

Table 3. Relationship between symptoms/signs, complication type, and the need for surgery

Complication	Fever	Rhinorrhea	Nasal Obst.	Cough	Headache	Edema	Proptosis	Limited oc. mov.	Visual acuity	Mental status	NRL Clinic	Surgery
Preseptal cel.	Absent	Yes	Yes	Absent	Yes	Yes	Absent	Absent	10/10	Absent	Absent	0
Preseptal cel.	Absent	Absent	Absent	No info	No info	Yes	Absent	Absent	9/10 wc	Absent	Absent	0
Preseptal cel.	Yes	Yes	Yes	Absent	Absent	Yes	Absent	Absent	No info	Absent	Absent	0
Preseptal cel.	Yes	Yes	Yes	Yes	No info	Yes	Absent	Absent	No info	Absent	Absent	0
Preseptal cel.	Yes	Yes	Yes	Yes	Yes	Yes	Absent	Absent	10/10	Absent	Absent	0
Preseptal cel.	Absent	Yes	Yes	No info	No info	Yes	Absent	Absent	No info	Absent	Absent	0
Preseptal cel.	Absent	Yes	Yes	No info	No info	Yes	Absent	Absent	No info	Absent	Absent	0
Preseptal cel.	Absent	Yes	Yes	Yes	Yes	Yes	Absent	Absent	8/10 wc	Absent	Absent	0
Preseptal cel.	Yes	Absent	Yes	No info	No info	Yes	Absent	Absent	No info	Absent	Absent	0
Preseptal cel.	Yes	Yes	Absent	Yes	No info	Yes	Absent	Absent	10/10	Absent	Absent	0
Preseptal cel.	Yes	Yes	Yes	No info	Yes	Yes	Absent	Absent	10/10	Absent	Absent	PtT + M.Ant + A.Etm
Orbital cel.	Yes	Yes	Yes	Yes	No info	Yes	Absent	Yes	10/10	Absent	Absent	0
Orbital cel.	Yes	Yes	Yes	Yes	No info	Yes	No info	Absent	No info	Absent	Absent	0
Orbital cel.	Absent	Yes	Yes	Absent	Yes	Yes	Yes	Yes	9/10	Absent	Absent	0
Orbital cel.	Absent	Yes	Yes	No info	No info	Yes	Yes	Yes	10/10	Absent	Absent	0
Orbital cel.	Yes	Yes	Yes	No info	No info	Yes	Absent	Absent	9/10	Absent	Absent	0
Orbital cel.	Yes	Yes	Yes	No info	Yes	Yes	Absent	Absent	10/10	Absent	Absent	0
Orbital cel.	Yes	Yes	Yes	No info	No info	Yes	Absent	Yes	10/10	Absent	Absent	0
Orbital cel.	Yes	Yes	Yes	No info	No info	Yes	Absent	Yes	10/10	Absent	Absent	PtT + M.Ant + A.Etm
SPA	Yes	Yes	Yes	Yes	No info	Yes	Yes	Yes	9/10	Absent	Absent	0
SPA	Absent	Absent	Absent	Yes	No info	Yes	Absent	Absent	No info	Absent	Absent	0

(Continues)

Table 3. Relationship between symptoms/signs, complication type, and the need for surgery (*continued*)

Complication	Fever	Rhinorrhea	Nasal obst.	Cough	Headache	Edema	Proptosis	Limited oc. mov.	Visual acuity	Mental status	NRL Clinic	Surgery
SPA	Yes	Yes	Yes	Absent	Absent	Yes	Absent	Absent	No info	Absent	Absent	0
SPA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10/10	Absent	Absent	M.Ant + DI + Abs_Oph
SPA	Yes	Yes	Absent	Absent	Yes	Yes	Yes	Yes	9/10	Absent	Absent	M.Ant + A.Etm + Abs_Oph
Orbital abs.	Yes	Yes	No info	No info	Yes	Yes	Yes	Yes	8/10	Absent	Absent	PtT + M.Ant + A.Etm + Abs_Oph
Epidural emp.	Yes	Yes	Yes	Yes	Yes	Yes	Absent	Absent	10/10	Absent	Absent	0
Epidural emp.	Yes	Yes	Yes	No info	Yes	Yes	Absent	Yes	10/10	Absent	Dizziness	M.Ant + A.Etm + P.Etm + Sph + DI
Subdural emp.	Absent	Yes	Yes	Absent	Yes	Yes	Absent	Yes	No info	Yes	T/C seizure	PtT + M.Ant + A.Etm + Cr
BC	Absent	Yes	Yes	No info	Yes	Yes	Absent	Absent	No info	Absent	Absent	0
BC	Yes	Yes	Yes	Yes	Yes	Absent	Absent	Absent	No info	Absent	Absent	M.Ant + A.Etm + DI
BC	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No info	No info	Absent	Absent	M.Ant + A.Etm + Abs_Oph

A: Etm.; Abs_Oph: abscess drainage performed by the Ophthalmology team; A.Etm: anterior ethmoidectomy; BC: bone complications; Cr: craniotomy performed by the Neurosurgery team; DI: draft I; epidural emp: epidural empyema; M.Ant: maxillary antrostomy; Nasal obst: nasal obstruction; No info: no information in the clinical records; NRL clinic: neurology clinic; orbital abs: orbital abscess; Orbital cel.: orbital cellulitis; P.Etm: posterior ethmoidectomy; Preseptal cel.: preseptal cellulitis; PtT: partial turbinectomy of the middle turbinates; SPA: subperiosteal abscess; Sph.: sphenoidotomy; subdural emp: subdural empyema; T/C seizure: tonic-clonic seizure; wc: with correction.

SARS-CoV-2 test

During the COVID-19 period, all tested negative (n = 5), but during the post-COVID-19 period, 6.7% (n = 1) tested positive and 13.3% (n = 2) had inconclusive results.

Microbiology

A total of 61.8% (n = 21) of patients did not collect a sample for microbiology. Among the 39% (n = 13) who did, no microorganisms were isolated in nine of the cases (five hemocultures, three pus samples, and one rhinorrhea sample). This could be because most patients were already on ABT. When positive, the isolated bacteria were *Staphylococcus aureus* (n = 2), with one multi-sensitive strain in the hemoculture of a patient with no complications and one multi-resistant strain (MRSA) in the rhinorrhea of a patient with cystic fibrosis and BC, as well as *Streptococcus milleri* (n = 2), with one in the rhinorrhea associated with a subdural empyema and one in the pus of the orbital abscess.

Imaging

Computed tomography (CT) scans were performed on 29 patients. The other five were assumed to have preseptal cellulitis based on clinical findings; four were ≤ two years of age; none of them needed surgery, and all recovered fully. The ethmoid sinus was affected in all patients and the frontal sinus was affected in 92.9% of patients. When divided by age group, the frontal sinus was affected in 100% of groups two and three, and it was also affected in all patients with BC and IC. The sphenoid sinus was affected in 60.7% of patients and in 70% of age group three (Table 4; Figs. 3 and 4). None had sinus thrombosis. The mean Lund-Mackay score was 12.9 (ranging from 3 to 24), with no significant difference observed between complication groups (p = 0.737) or time periods (p = 0.953).

Treatment

Medical therapy

All patients were treated with a combination of intravenous ABT, systemic corticosteroid (methylprednisolone in a weaning regimen), nasal steroid (mometasone), and nasal decongestant (phenylephrine). The most frequent ABT association was ceftriaxone/clindamycin, followed by ceftriaxone/metronidazole and ceftriaxone.

Surgery

A total of 29% (n = 9) of patients with complicated ARS required endoscopic sinus surgery (ESS) during hospitalization. The most commonly performed procedure was maxillary antrostomy combined with ethmoidectomy (88.9%). Among the patients who underwent surgery, 44.4% (n = 4) had only ESS. The remaining 55.6% (n = 5) required a combined approach. One of these cases involved neurosurgery performing a craniotomy to drain an epidural empyema and the others involved Ophthalmology (two with SPA, one with an orbital abscess, and one with a palpebral abscess) (Table 3).

Most (66.7%) of the surgeries occurred during the post-COVID-19 period following the increase in incidence that was observed during this period (Fig. 5). The need for surgical treatment varied significantly between the different time periods (p = 0.039).

Laboratory findings (CRP and leukocyte counts) were significantly higher in the group that required ESS (CRP p = 0.014, leukocytes p = 0.013). Although not statistically significant (p = 0.130), the Lund-Mackay score was also higher in the group that needed ESS. No patients in age group one required surgical treatment. BC and IC had higher rates of ESS (p = 0.017) (Fig. 6).

The average length of stay was 12.5 days (ranging from two to 46 days), although it was significantly longer for patients with IC and BC, as well as those admitted during the COVID-19 period (Table 5; Figs. 7 and 8).

No recurrences were observed within the first 30 days after discharge.

Discussion

Orbital complications

OC are the most frequent type of complications (74-85%) in pediatric patients with ARS[4,5]. In our hospital, both inpatients and outpatients diagnosed with ocular complications of ARS are observed by the Ophthalmology team, which determines the frequency of observation according to the type of complication. Preseptal cellulitis (Chandler Type I) is typically considered the most common OC (80-90%)[6] and the same observation was made in our study, where it was also the most frequent complication, although the percentage was lower (45.8%). This reduced number might be associated with the fact that outpatients were not included in our study and we usually manage most cases of preseptal cellulitis in the outpatient clinic. Only one patient (9.1%) with preseptal cellulitis required ESS

Table 4. Involvement percentage of each paranasal sinus

Paranasal sinus	% of patients with sinusitis
Ethmoid	100
Frontal	92.9
Maxillary	89.3
Sphenoid	60.7

Figure 3. CT scan, saggital view, with an ARS complicated with Pott's puffy tumor.

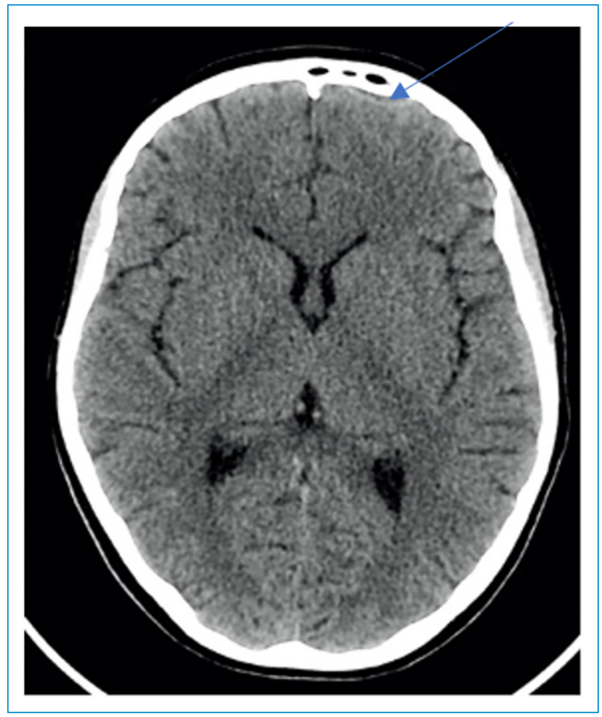

Figure 4. CT scan, axial view, with an ARS complicated with an epidural empyema (arrow).

on the 12th day of admission due to lack of improvement with medical treatment. This patient was older (12 years old), with significant leukocytosis ($22 \times 10^3/\mu L$) and CRP levels (15 mg/dL) upon admission. The presence of periorbital edema can complicate the diagnosis of postseptal involvement, so a CT scan is recommended in those cases. It is also recommended in cases of proptosis, ophthalmoplegia, pain with external ocular movement, deteriorating visual acuity, or central symptoms (i.e., altered mental status, seizures, or focal neurologic deficits)[7,8]. CT scanning is not necessary in the absence of these signs, as most patients with periorbital cellulitis will respond to ABT. A failure to respond may indicate the progression of the infection. Therefore, patients showing no improvement or deterioration after 24–36 hours, or those with a fluctuating fever not resolving within 36 hours, require a CT scan[7]. In our study, the cases in which we chose not to perform imaging tests were assumed to be preseptal cellulitis after evaluation by Ophthalmology. Although we cannot completely rule out the possibility of postseptal involvement, there were no prognostic implications, as the patients responded favorably to ABT, showing improvement within the first 24 hours. The literature[8-11] reports that many patients with orbital cellulitis respond well to non-surgical management, and the same trend was observed in our patients, with 87.5% (n = 7) being treated with medical therapy alone, and only one patient requiring ESS. This patient also had significant leukocytosis ($33 \times 10^3/\mu L$) and CRP levels (26 mg/dL) on admission. Other types of orbital complications represent a minority of the cases[5,12-16]. Among these, a subperiosteal abscess accounts for 9 to 28% of OC[14]. In our study, the incidence was 15%. Like orbital cellulitis, we only perform surgery at admission in patients with severe proptosis, reduced visual acuity or motility, elevated intraocular pressure, or signs of concurrent intracranial involvement. Le et al. selected a cut-off size of 3.8 mL; if the SPA volume exceeds 3.8 mL, the likelihood of surgery is 71%[17]. In our study, the two SPAs that required surgery had abscess volumes of 3.7 mL and 4.4 mL, while the SPAs that did not require surgery had volumes of 2.6 mL, 3.4 mL, and 4.2 mL. With these

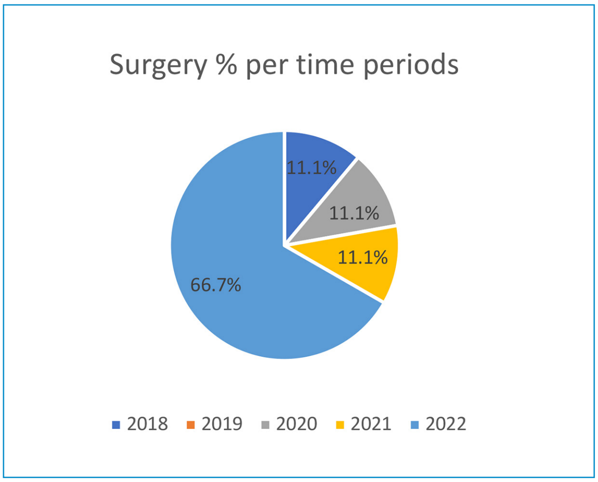

Figure 5. Variation in surgery performed across different time periods.

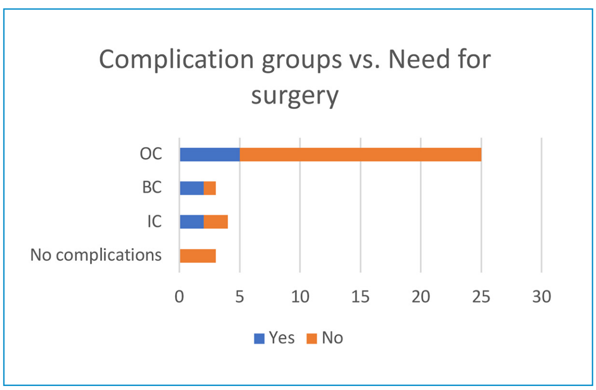

Figure 6. Surgery performed based on the type of complication.

results, we could not establish a definitive cut-off. Poor response after 24-48 hours of intravenous ABT also prompts surgical treatment[14]. Most of our patients (60%; n = 3) responded well to medical treatment and the other two (40%) required combined surgery (ENT plus Ophthalmology). As in the literature, we have published a few cases of orbital abscess, all of which involved surgical drainage[5,12,13].

We compared our results with those from another Portuguese hospital that analyzed postseptal orbital complications[18]. For this comparison, we only focused on our cases of postseptal orbital complications. The fact that they performed more surgeries (40% versus 29%) and had a higher sequelae rate (1.8% versus 0%) could be related to the difference in case types: we had more cases of postseptal cellulitis (57% versus 43.6%), while they had more orbital abscesses (18% versus 7%). Despite that, their length of stay was shorter (8.0 ± 5.0 days) compared to our 11 days, which may indicate that surgery accelerates recovery. They also found an association between worse complications and higher leukocyte counts.

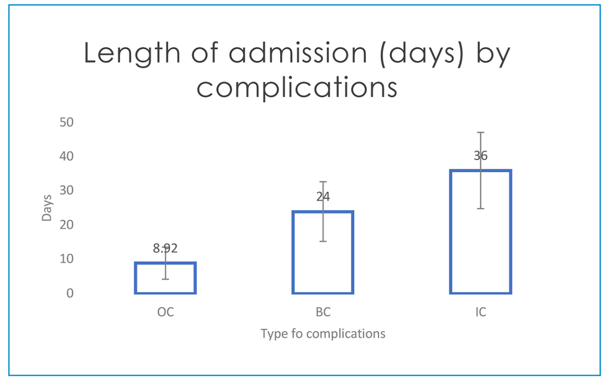

Figure 7. Length of admission according to type of complications.

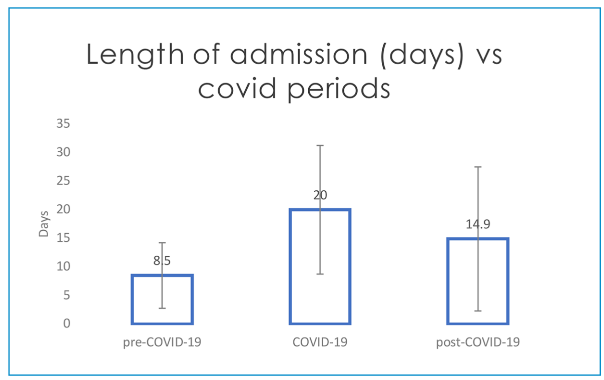

Figure 8. Length of admission according to time periods.

Intracranial complications

Children commonly exhibit a "silent" IC, which is why a high degree of suspicion is needed in cases of pediatric ARS, particularly in patients who do not respond well to medical therapy. In such cases, an MRI should be performed[19]. Neurological findings at presentation (i.e., changes to mental state, seizures, hemiparesis, dysarthria, facial droop, and neck stiffness) are associated with more severe complications (such as meningitis, encephalitis, cerebral abscess, subdural empyema, and sinus thrombosis) and, thus, worse outcomes[19]. In our study, two patients had a CT scan due to OC, which raised suspicions of intracranial involvement and prompted us to request an MRI, diagnosing an epidural empyema in one patient. The other had seizures and hemiparesis at presentation, prompting an MRI that diagnosed ARS and a subdural empyema.

Table 5. Mean length of stay according to age groups, complication groups, and time periods

Groups	Age	Complications	Time periods
Mean length of stay (days)	0-6 → 6.3 7-12 → 15.7 13-17 → 14.1	None → 7 OC → 8.9 IC → 36 BC → 24	Pre-COVID-19 → 8.5 COVID-19 → 20 Post-COVID-19 → 14.9
p	0.063	0.001	0.049

Patients with IC tend to be older. Germiller et al.[19] reported a mean age of 13.2 years and this might be related to frontal sinus involvement as it was already well developed in 95% of the patients with IC. In our study, all patients were ≥ 11 years old (mean age 12.7). As in the Germiller et al. study[19], epidural empyema was the most frequent form of IC. All our patients received a combination of intravenous third-generation cephalosporin along with clindamycin/metronidazole for four to six weeks. We did not use vancomycin, as reported in the literature[19,20]. ESS is recommended as a standard procedure for most IC patients, regardless of neurosurgical drainage, due to its low morbidity and potential to expedite clinical improvement[21]. We performed ESS in 66.7% of IC cases, with 33.3% (n = 1) of these cases also necessitating neurosurgical drainage for the patient with subdural empyema. We found longer hospital stays, with an average of 34.5 days (ranging from 24 to 46 days)[19,21,22]. Despite this, we report no long-term sequelae or instances of death. This could be attributed to our small sample size and the absence of severe IC cases such as intracranial abscesses.

Bone complications

BC have been on the rise in recent years, primarily due to improved diagnostic capabilities through imaging tests[23]. They are more prevalent in adolescents with extensively pneumatized and vascular diploe in the frontal sinus[24]. Patients typically exhibit edema in the frontal region (known as Pott's puffy tumor) because of infection spreading to the anterior wall. Involvement of the posterior wall can be associated with IC in a range of 29 to 85% of cases[25,26]. Treatment consists of ABT for a min of six weeks, associated with surgical debridement of the affected bone[27]. We reported three cases (9%), all involving the frontal sinus and affecting patients older than 11 years of age. One case involved a patient with cystic fibrosis who experienced an exacerbation of chronic rhinosinusitis with nasal polyps, in which MRSA was isolated. Although the F508del/F508del mutation was identified, the patient had not yet started taking Orkambi® at the time of this infection. Another case was associated with an epidural empyema. Both of these cases required ESS and were the only ones treated with vancomycin. The third case involved a patient with frontal screws as a risk factor but responded well to medical therapy. None of the cases required bone debridement and all patients have recovered well.

SARS-CoV-2

During the COVID-19 period, the incidence of hospitalizations in patients with ARS decreased (n = 5), probably due to social distancing. Older children, who were more likely to interact despite distancing measures, were more affected. This is in line with the increased rate of severe complications (IC and BC) recorded during this period. Social lockdowns, which could potentially delay access to medical care resulting in patients presenting with worse clinical signs, are not supported by our results, as we observed no difference in the various analyzed periods. As published by Pei-Wen Wu et al.,[28] we also observed an increased incidence of ARS complications (n = 12) in the post-COVID-19 period, during which most surgeries (66.7%) took place. Immune alterations due to reduced antigenic stimulation in the autumn/winter of 2020–2021, along with more resistant microorganisms due to the overuse of broad-spectrum ABT and steroids in the treatment of COVID-19, might explain the rise in complicated infections that we observed during this period[29-31].

Microbiology and antibiotics

Regarding microbiology, we had only four isolates, limiting our ability to make statistical inferences. This highlights an area for improvement in our clinical practice, with a focus on tailoring antibiotic therapy based on susceptibility testing to prevent antibiotic misuse and to attempt to correlate specific microorganisms with particular complications. Since cultures take time to grow, patients initially begin treatment empirically. We based our ABT on the susceptibility patterns of bacteria commonly isolated in complicated ARS from most studies, which aligned with our few isolates. Ceftriaxone alone was used almost exclusively for preseptal complications, given its broad-spectrum activity against gram-positive and gram-negative aerobes. Our patients with postseptal cellulitis, abscesses, or IC/BC received a combination of ceftriaxone and an antibiotic with anaerobic coverage, as anaerobes are frequently associated with this infection but are difficult to isolate, which is similar to another study conducted on the same population[18]. The choice between clindamycin and metronidazole was left to the discretion of the attending physician, as both penetrate well into most tissues, including abscess contents. Clindamycin acts against MRSA but requires high doses for adequate penetration into the central nervous system.

Conclusion

With the increased availability of imaging, diagnosis, and treatment of ARS, complications can be identified earlier, greatly impacting the outcomes. Ocular complications remain the most frequently diagnosed complication and tend to be identified early in the course, as patients usually seek medical care due to objective alterations found during physical examination. In contrast, although rarer, IC tend to present as silent complications and can pose a challenging diagnostic scenario, often requiring a multidisciplinary approach. Inflammatory markers appear to have a positive correlation with the need for surgery. Consistent with other studies, we report an increase in severe infections since the COVID-19 pandemic. This increase could be related to the immunological impact of the social distancing measures implemented during the various lockdowns in our country throughout the first year of the SARS-CoV-2 pandemic.

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Author contributions

F. Bartolomeu: conceptualized and designed the study, collected data, and wrote the article. J. Fonseca Neves: assisted in designing the study and provided expertise in pediatric otolaryngology. B. Ramada: performed the statistical analysis, and validated the findings. H. Figueiredo: assisted with data collection. S. Chaves: managed the literature search. A. Miguéis: formatted the manuscript for submission. J. Miguéis: reviewed and approved the final version of the manuscript for publication.

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Conflicts of interest

None.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The study does not involve patient personal data nor requires ethical approval. The SAGER guidelines do not apply.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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