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Optimizing Surgical Management of Acute Invasive Fungal Sinusitis

Original Investigation

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Abstract

Objective: Early surgical debridement is vital for favorable outcomes in acute invasive fungal sinusitis (AIFS). Our study aimed to propose guidelines with tailored, conservative surgical procedures based on areas of involvement and evaluate their usefulness in avoiding repeated debridement.

Methods: This retrospective observational study was conducted on 150 AIFS patients operated on with the proposed surgical guidelines from May to June 2021 at a tertiary care hospital. Data including demography, comorbidities, surgical procedures, revision surgery, and outcome were collected and analyzed.

Results: All 150 patients underwent bilateral endoscopic sinonasal debridement. Among them, 108 patients (72%) had current or recent coronavirus disease (COVID) infection. Ninety-two patients (61.3%) required additional procedures based on disease extent. Twenty patients (15.4%) required revision debridement because of progressive or recurrent disease. Mean age of this group was 46.15 (standard deviation ±11.2) years with a strong male predominance (9:1). Seventeen had diabetes mellitus, 12 suffered from active COVID-19 infection and six had received corticosteroids. None of the 31 patients who had recovered from COVID-19 or had no comorbidities required revision surgery. Age, gender, and comorbidities were not significant predictors for revision surgery. Fourteen patients (70%) underwent second surgery within one month of primary surgery. Predominant disease locations were alveolus and palate (55% each), and in 80% the site was uninvolved at primary surgery. The most common revision procedure was inferior partial maxillectomy (60%). At follow-up, all were asymptomatic with no evidence of disease.

Conclusion: The proposed surgical guidelines for AIFS allow for adequate surgical debridement with preservation of optimum functional status. Low revision surgery rates and good outcomes with minimal morbidity validate its usefulness.

Keywords: Fungal sinusitis, mucormycosis, endoscopy, surgery, debridement, revision surgery, guideline

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Introduction

Acute invasive fungal sinusitis (AIFS) is rapidly progressive and angioinvasive, and often a fatal fungal infection that usually affects immunocompromised or immunosuppressed patients. The high prevalence of diabetes mellitus and widespread unsupervised use of steroids, culminated in an unprecedented escalation of cases with AIFS in a short time during the second surge of the coronavirus disease-2019 (COVID-19) pandemic, posing a big challenge to otolaryngologists (1). Early diagnosis, adequate surgical debridement, reversal of immunocompromising factors, and prompt initiation of systemic antifungal therapy are vital for a good outcome in AIFS.

Early and aggressive surgical debridement is thought to be the reason for the reduction in mortality associated with early diagnosis of AIFS (2, 3). Opening all sinuses endoscopically irrespective of clinico-radiological involvement along with debridement of affected areas at the very first instance has been shown to avoid repeated surgery and provide good outcomes (4). The extent of the disease determines the amount of debridement required and the ability to achieve complete surgical clearance. The maxillary sinus is the most common sinus involved in AIFS and compared to other sinuses is more amenable to radical debridement (5). Any advanced disease here with signs of bony erosion, palatal involvement or extraparanasal sinus spread has been traditionally addressed with total or partial maxillectomy. Though associated with minimal complications, the morbidity associated with maxillectomy can be functionally incapacitating, compromising the quality of life, and subsequent adequate rehabilitation can be challenging. A tailored, more conservative debridement procedure based on the areas of involvement is necessary to address this problem. A recent report showed the benefit of using an appropriately designed palatal flap to effectively separate the oral and nasal cavities after bilateral inferior partial maxillectomy in a case of mucormycosis involving the maxilla and the alveolus (6). The effectiveness of such approaches in a large number of patients with maxillary sinus mucormycosis has not been evaluated to date. Also, there are no evidence-based guidelines regarding specific surgical procedures to be used for each affected site in different clinical scenarios.

Since the majority of the patients during the second wave had an active COVID-19 infection, the patient's general condition and the hazards of general anesthesia had to be balanced with the benefits of aggressive surgical debridement. Considering the large number of otolaryngologists with varying experience in rhinology involved in the management of the condition, comprehensive surgical guidelines were put forward and implemented in our department. The presented study aims to propose guidelines for the surgical management of AIFS and evaluate its usefulness in avoiding repeated debridement. Patient characteristics were also analyzed to determine any predictors of revision surgery.

Methods

Patients and Methodology

This was a retrospective observational study of all patients operated on for suspected AIFS and had a final histopathological confirmation of AIFS during the period from May to June 2021 at the otorhinolaryngology department of a tertiary care hospital in South India. The authors confirm that approval from Christian Medical College, Vellore, Institutional Review Board (IRB number: 14181, date: 28.07.2021) and informed consent from the patients were obtained before the commencement of the study. The surgical outcome measured was the need for any revision surgery.

Data Collection

Details regarding demography, comorbidities, surgical procedures performed, any revision surgery, the outcome at the time of discharge and at last follow-up were collected.

All patients underwent surgical debridement based on a tailored surgical protocol depending on the extent of clinical and radiological involvement at initial evaluation as given in Table 1. Bilateral paranasal sinuses were opened in all patients irrespective of involvement seen on imaging. The endoscopic sinonasal debridement (ESND) procedure included uncinectomy, wide middle meatal antrostomy, anterior and posterior ethmoidectomy, sphenoidotomy and frontal sinusotomy. If the frontal sinus was normal on imaging with a normal intraoperative frontal recess, opening of the frontal sinus was optional based on the expertise and comfort of the surgeon.

External incisions were avoided as far as possible and a sublabial approach was used for patients requiring partial or total maxillectomy. If the overlying palatal mucosa was healthy, preservation was performed by elevating a U-shaped posterior-based palatal mucoperiosteal flap up to the hard and soft palate junction, removal of the underlying diseased bone and securing the palatal flap to the gingival and buccal mucosa. Patients with orbital and intracranial symptoms were simultaneously evaluated and managed by ophthalmology and neurosurgical teams with appropriate interventions.

After surgical treatment, all patients received adequate, appropriate antifungal therapy with amphotericin B followed by oral posaconazole or with voriconazole depending on the organism. Simultaneously associated comorbidities and COVID infection were managed as required. Patients were postoperatively initiated on thrice daily saline nasal douching and prospectively followed up every two weeks until complete healing occurred. Thereafter, every patient was seen every

month until antifungal therapy was complete. Subsequently, follow-up was planned once in three months for up to one year after surgery. At each outpatient visit, a complete clinical examination and endoscopic assessment were performed and secretions and crusts were removed. Follow-up with imaging was performed only when recurrence or disease progression was suspected. Revision surgery was mandated in patients who presented with new or progressive clinical symptoms or endoscopic evidence of disease like unhealthy mucosa or granulations not responding to antifungal therapy. Patients who expired in the course of treatment were excluded from the analysis of surgical outcomes. Therapeutic success was clinically and endoscopically defined as patients who were asymptomatic at follow-up after completing the antifungal therapy and had no evidence of residual disease.

Statistical Analysis

All descriptive statistics were reported as counts and percentages for categorical variables and mean and standard deviation (SD) or median and interquartile range for normally and non-normally distributed data, respectively. For all correlational analyses, a two-sample t-test was done for normally distributed variables and the Mann–Whitney U test for skewed variables. The chi–square test was used to study the association between revision surgery and all categorical variables of patient characteristics. All statistical analyses were done using SPSS 21.0.

Results

A total of 150 patients underwent surgery for AIFS during the study period. Of these, 113 patients were male and 37 were female. Their ages ranged from 18 to 80, with a mean of 51 years.

The most common comorbidity was diabetes mellitus (129 patients, 86%). One hundred eight patients (72%) had current or recent COVID infection. Seventy-seven patients (51.3%) tested positive for reverse transcriptase-polymerase chain reaction of the nasopharyngeal swab for severe acute respiratory syndrome coronavirus-2 at presentation, while another 31 (20.7%) had recently recovered from COVID-19 infection. Fifty-seven (38%) patients had received systemic corticosteroids for COVID-19 infection. Other comorbidities seen were hypertension (44 patients, 29.3%) and chronic renal failure. Four patients did not have any comorbidities (Table 2).

The most common presenting complaints were facial (118 patients, 78.7%) and orbital (112 patients, 74.7%) symptoms. At presentation, 68 patients (45.3%) had palatal symptoms, 62 (41.3%) had headaches, 46 (30.7%) had nasal complaints, and 29 (19.3%) had neurological symptoms.

All patients underwent bilateral ESND. In 58 patients (38.7%), it was the only surgical procedure done. The remaining patients required additional procedures based on the extent of the disease. Thirty-four patients (22.7%) required septectomy and 33 (22%) required pterygopalatine fossa clearance. Other surgical procedures performed are shown in Table 3. Forty-five patients (30%) had varying extent of resection of palate and maxilla with only five of them undergoing total maxillectomy. Among these, palatal mucoperiosteal flap preservation was achieved in the 12 patients (26.7%) with normal-looking palatal mucosa.

Of the 109 patients (72.7%) who had positive growth on fungal culture, 99 (90.8%) grew zygomycetes with 95 of them being rhizopus. Ten patients (9.2%) had invasive aspergillosis. Of the 150 operated patients, 20 (13.3%) expired in the course of treatment due to AIFS or COVID-

Table 1. Guidelines for surgical resection in patients with AIFS

Indication	Surgical protocol
All cases of AIFS	Endoscopic sinonasal debridement
Involvement of septum	Partial or total septectomy
Involvement of turbinates	Turbinate resection
Unhealthy or discolored palatal mucosa with normal appearance of palatal bone both on imaging and intraoperatively	Wide local excision of palatal mucosa with preservation of palatal bone
Unhealthy palatal bone with surrounding healthy alveolus	Palatectomy
Unhealthy palatal bone with limited involvement of alveolus	Palatectomy with partial alveolectomy
Unhealthy palatal bone and alveolus	Inferior partial maxillectomy
Involvement of maxillary suprastructure	Subtotal or total maxillectomy
Involvement of premaxillary soft tissue	Debridement through a sublabial approach and Caldwell Luc clearance of maxilla.
Involvement of pterygopalatine fossa and infratemporal fossa	Clearance through a transantral route via a sublabial or medial maxillectomy approach
Involvement of skull base	DO NOT attempt debridement of this area

AIFS: Acute invasive fungal sinusitis

19-related complications. The surviving 130 patients were analyzed to evaluate the adequacy of surgical treatment. Of these, 20 patients (15.4%) required a revision debridement because of progressive or recurrent disease. The mean age of this group was 46.15 (SD ±11.21) years and there was a strong male predominance (9:1). In patients requiring revision surgery the main comorbidity was diabetes mellitus (17 patients, 85%). Active COVID-19 infection was seen in 12 (60%) and corticosteroid use in 6 (30%), as shown in Table 2. Patients without comorbidities and those who had recovered from prior COVID-19 infection did not require revision surgery. However, neither age or gender nor the presence of comorbidities was a significant risk factor for revision surgery (Table 2).

Of the patients requiring re-debridement, 13 (65%) had AIFS alone. Another 6 patients (30%) had AIFS and chronic granulomatous fungal sinusitis. One patient had a fungal ball along with AIFS.

The time interval between the primary and the revision surgeries ranged from 4 to 96 days (median 23). Fourteen patients (70%) underwent the second surgery within one month of the primary surgery. Among them, six underwent revision surgery within two weeks. The interval between the

Table 2. Baseline characteristics

	Primary surgery (n=150)	Revision surgery		
		Yes (n=20)	No (n=110)	p-value
Mean age (SD)	51±12.2	46.15±11.2	51±11.7	0.069
Gender				
Male	113 (75.3%)	18 (90%)	79 (71.8%)	0.100
Female	37 (24.7%)	2 (10%)	31 (28.2%)	
Comorbidities				
None	4 (2.7%)	0	4 (3.6%)	-
Diabetes mellitus	129 (86%)	17 (85%)	94 (85.5%)	0.9571
Hypertension	44 (29.3%)	2 (10%)	36 (32.7%)	0.5012
Chronic kidney disease	4 (2.7%)	0	2 (1.8%)	-
Active COVID-19	77 (51.3%)	12 (60%)	52 (47.3%)	0.4277
COVID-19 recovered	31 (20.7%)	0	28 (25.5%)	-
Corticosteroid use	57 (38%)	6 (30%)	41 (37.3%)	0.7285

SD: Standard deviation, COVID-19: Coronavirus disease-2019

Table 3. Primary surgical procedure

Surgery	No. of patients (n=150)		Patients requiring revision surgery	
	No.	%	No.	%
ESND alone	58	38.7	8	13.8
Wide local excision	12	8	1	8.3
Septectomy	34	22.7	4	11.8
Alveolectomy	2	1.3	1	50
Palatectomy	1	0.7	0	0
Inferior partial maxillectomy	16	10.7	1	6.3
Subtotal maxillectomy	9	6	1	11.1
Total maxillectomy	5	3.3	0	0
Palatal mucosa preservation	12	8	0	0
Premaxillary clearance	11	7.3	2	18.2
Caldwell Luc	23	15.3	5	21.7
PPF clearance	33	22	6	18.2
ITF clearance	12	8	2	16.7
Tooth extraction	4	2.7	1	25

ESND: Endoscopic sinonasal debridement, PPF: Pterygopalatine fossa, ITF: Infratemporal fossa

Table 4. Surgical procedures in patients with revision surgery

Revision cases	First surgery	Site of recurrence	New/ old site	Revision surgery
1	ESND	Alveolus, palate PMS, ITF, zygoma	N	STM, PMP, PMS, ITF clearance, zygoma debridement
2	ESND	Alveolus	N	IPM, PMP, TE
3	ESND	Palate	N	Palatectomy
4	ESND	Alveolus	N	IPM, PMP
5	ESND	Palate	N	IPM
6	ESND	Palate	N	IPM
7	ESND	Palate, zygoma	N	IPM, PMP, TE, zygoma debridement
8	ESND	Maxilla	O	TM, PMP
9	ESND, WLE	Alveolus, PPF	N	IPM, PPF clearance
10	ESND, septectomy	Alveolus, palate	N	TM, PMP
11	ESND, septectomy	Alveolus	N	IPM, PMP, TE
12	ESND, septectomy	Alveolus	N	Alveolectomy, PMP, TE
13	ESND, Caldwell Luc	Frontal bone	N	Frontal debridement
14	ESND, PPF clearance	Alveolus, palate	N	IPM
15	ESND, PPF clearance	PPF	O	Caldwell Luc, PPF, ITF clearance
16	ESND, Caldwell Luc, TE	Alveolus	O	STM, PMP
17	ESND, Caldwell Luc, PMS, PPF, ITF clearance	Palate, alveolus	N	IPM
18	ESND, Caldwell Luc, PPF, ITF clearance	Palate	N	IPM, PMP
19	ESND, Caldwell Luc, PMS, PPF clearance	Palate	N	IPM, PMP
20	ESND, alveolectomy, septectomy, PPF clearance	Palate, alveolus	N	IPM, STM, PPF, ITF clearance

ESND: Endoscopic sinonasal debridement, PMS: Premaxillary space, ITF: Infratemporal fossa, PPF: Pterygopalatine fossa, WLE: Wide local excision, TE: Tooth extraction, IPM: Inferior partial maxillectomy, STM: Subtotal maxillectomy, TM: Total maxillectomy, PMP: Palatal mucosa preservation

primary and revision surgeries was between 1–2 months in four patients and more than two months in two patients.

In a majority (16 patients, 80%), the site requiring revision surgery was previously uninvolved, and the most common locations were the alveolus and the palate (11 patients, 55% each). Two patients had disease in the pterygopalatine fossa and the zygoma, whereas the premaxillary tissue, the infratemporal fossa and the frontal bone showed pathology in one patient each. Among the 42 patients who had tailored, conservative resection of the palate and the maxilla, only four patients (9.5%) required revision surgery. None of the patients in whom the palatal mucosal flap was preserved needed a second surgery.

The most common procedure performed during revision surgery was inferior partial maxillectomy (12 patients, 60%). Three patients required subtotal maxillectomy and two required total maxillectomy. Other surgical procedures are shown in Table 4. In 11 patients (55%), palatal mucosal preservation could be achieved.

The site of recurrent disease showed involvement during primary surgery clinically in four (20%) and radiologically in only two (10%) patients. On reviewing the previous clinical reports and radiological images, the primary surgery performed based on the protocol described above was found to be appropriate in 17 patients (85%) who required revision debridement. In the remaining three patients, the areas where the disease was missed during initial surgery were the pterygopalatine fossa, the infratemporal fossa, the alveolus and the premaxillary soft tissue.

The mean follow-up duration was 6.86 months, and 78.5% of the patients had a follow-up period exceeding six months. At the last visit, all patients who had revision surgery were asymptomatic and had well-healed sinus cavities with no evidence of disease. Mild cheek swelling and forehead swelling were noticed at the last visit in one patient each. Seven patients had minor dehiscence of the palatal mucosal flap. The presented series showed an overall survival of 86.7%.

Discussion

Though endoscopic debridement of the paranasal sinuses is the primary treatment for AIFS, a delicate balance needs to be maintained between being too aggressive while at the

same time performing a thorough and adequate debridement. Retaining normal tissues to the extent possible with the help of good clinical judgment collaborated with imaging will help accelerate surgical recovery and optimize postoperative quality of life. Our study showed that with adherence to the surgical guidelines described above, only 20 patients (15.4%) required a revision debridement. In most of these (16 patients, 80%), the site requiring revision surgery was at a previously uninvolved site, the most common locations being the alveolus and the palate (11 patients, 55% each). Accordingly, the most common surgical procedure performed at revision surgery was varying types of maxillectomy depending on the extent of involvement. Palatal mucoperiosteal flap preservation could be achieved in 55% of the patients.

The study period was during the second wave of the COVID-19 pandemic which witnessed a sudden escalation of patients with AIFS and this explains the high number of cases in our series. Endoscopic debridement has been reported as an independent positive prognostic factor for survival in AIFS (7). This could be attributed to earlier tissue diagnosis, reduced fungal burden, better antifungal delivery following necrotic tissue removal, and improved postoperative sinonasal monitoring (8). In a previous study done at our institution on 51 patients, 11.8% of patients with radiological evidence of paranasal sinus disease only on one side were found to have bilateral disease on histopathology when all the sinuses were sampled (4). Unlike other types of fungal sinusitis where radiological changes are prominent, since AIFS tends to spread along vascular channels, changes in the paranasal sinuses are minimal in the initial stages of the disease. Hence bilateral sinonasal debridement was adopted as the standard basic procedure for all cases irrespective of the presence of clinico-radiological disease. In 38.7% of the cases, this was the only surgical procedure required since there was no extraparanasal spread.

The most common additional surgical procedure done was septectomy. More than one-fifth of the patients requiring pterygopalatine fossa clearance points to an increased occurrence of the disease in the area which may act as a primary reservoir for subsequent intraorbital and intracranial spread (8, 9).

Once AIFS extends beyond the sinonasal cavity especially when associated with orbital and intracranial extension, complete removal is sometimes not possible and may lead to serious morbidity and life-threatening postoperative complications. In a study by Roxbury et al. (10), looking at surgical resection and short-term survival, even patients with incomplete surgical resection of disease had a higher survival rate compared with those who were treated with medical therapy alone. Hence in all patients with AIFS, the feasibility of surgical resection should be considered aiming at complete surgical resection whenever possible. However, in cases with advanced disease when a surgical cure is less likely, it is important to assess the prognosis, consider the benefits versus the risks of the procedure, and determine the extent of surgical removal.

In addition to clinical and endoscopic examination, radiological assessment aids in determining the disease extension and clinical decision-making. Early computed tomography (CT) findings like unilateral sinus mucosal thickening are very nonspecific (11). Since the disease spreads by vascular invasion, it can cross bony partitions without any associated bone erosion and involve adjacent areas like the pterygopalatine fossa, the infratemporal fossa, the orbit and the premaxillary soft tissue. This extraparanasal spread may be evident as loss of orbital or periantral fat planes and later soft tissue infiltration. Fat stranding is considered an early sign of AIFS and radiographic evidence of bone destruction is seen in later stages (11, 12). Similarly, loss of contrast enhancement on Gadolinium-enhanced magnetic resonance imaging (MRI) is indicative of tissue infarction secondary to angioinvasion and vascular thrombosis (13). While CT acts as a roadmap for surgery and is ideal for the evaluation of bony erosions, MRI is better for soft tissue abnormalities and superior in the evaluation of vascular occlusions, intraorbital, intracranial and cavernous sinus involvements (8). MRI is also useful in the early detection of skull base osteomyelitis, with early detection of bone marrow infiltration (14). Diffusion-weighted imaging helps better delineate the formation of any abscess (15).

Debridement of necrotic sinonasal tissue is advised until bleeding is seen and often repeat surgical debridements are needed (7). In a study by Gardner et al. (16), the average number of debridements (or surgical procedures) required was 2.45. Nam et al. (13), in a study on AIFS with extrasinonasal involvement, reported the median number of operations as two (range, 1–5 times) with 52.0% of the patients undergoing surgery more than once. Despite adopting more conservative procedures, only 15.4% of the patients in our series required a revision debridement and none of them required more than one revision surgery.

Most of the patients in the cohort had a good outcome, even in cases where a complete clearance could not be achieved due to proximity to vital structures. 84.6% of the cases did not require any further surgical debridement. That revision surgery was not required for the patients in whom the palatal mucosal flap was preserved, and the rate of a second surgery was less than 10% among those with tailored resection of the palate and the maxilla suggest that the disease location-specific conservative approach does not affect the prognosis adversely.

The majority of the patients requiring a revision underwent surgery within one month. 80% of the patients showing disease at a new location suggests subclinical, radiologically

nonevident involvement which has become overt over time. This shows the importance of close follow-up with detailed clinical and endoscopic examination especially in the first two months after surgery. In high-risk individuals, the fungal spores in the nose and the paranasal sinuses germinate and the fungal hyphae tend to invade the adjacent mucosa, the blood vessels and the bone. Vascular invasion leads to thrombosis, tissue infarction, and later acute neutrophilic tissue infiltrates with rapid tissue necrosis which may not be evident on initial imaging (17). When clinically evident, surgical debridement of this necrotic tissue is vital to reduce the fungal load and improve the tissue penetration of antifungal agents (13, 18). So, any suspicion of new signs or clinical progression when on antifungal therapy warrants imaging and tissue sampling.

Four patients underwent revision surgery for disease progression after an appropriate primary surgery. However, in two of these patients, the involvement was not radiologically evident initially, suggesting radiology may lag behind clinical signs. In three patients, the primary surgery was inadequate and the areas missed were the pterygopalatine fossa, the infratemporal fossa, the alveolus and the premaxillary soft tissue. This highlights the importance of paying special attention to these areas while assessing patients with AIFS.

Inferior partial maxillectomy (12 patients) predominated the revision surgical procedures followed by subtotal maxillectomy in three patients and total maxillectomy in two. This can be attributed to the fact that the maxillary sinus is the most commonly involved sinus in AIFS and any extraparanasal sinus spread here can be addressed surgically with less morbidity and favorable results than the other sinuses. Also, prior pterygopalatine fossa involvement with angioinvasion may progress to areas supplied by the internal maxillary artery. However, the palatal mucoperiosteal flap was preserved in a majority of these patients. This allowed for maintaining the oronasal separation and thereby facilitated prompt rehabilitation. Even in the few patients who later developed minor dehiscence, normal swallowing and intelligible speech without any significant nasal aspiration could be achieved without compromising the prognosis. Our conservative approach tailored to resect only the diseased segmental unit complemented with preservation of a palatal mucoperiosteal flap helped avoid nuances of a large postoperative defect and achieve optimal postoperative physiological function in a single stage.

Conclusion

Our study highlights the feasibility of a tailored surgical approach in patients with AIFS based on the extent of the involvement. The proposed surgical guidelines allow for adequate surgical debridement while at the same time preserving optimum functional status. Patients requiring revision surgery had disease at a new site rather than a residual lesion. The low rate of revision surgery and good outcomes with minimal morbidity validate the usefulness of the proposed surgical guidelines in deciding the extent of surgical resection in the management of AIFS.

Ethics Committee Approval: All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Christian Medical College, Vellore, Institutional Review Board approval was obtained before the commencement of the study (IRB number: 14181, date: 28.07.2021).

Informed Consent: Informed consent was obtained from the patients included in the study.

Authorship Contributions

Surgical and Medical Practices: L.V., R.K., L.M.C., G.R., S.R., D.S.S.S., K.P.P.A., M.T., J.S.M., G.M.V., V.R., Concept: L.V., R.K., L.M.C., G.R., S.R., D.S.S.S., K.P.P.A., M.T., J.S.M., G.M.V., V.R., Design: L.V., L.M.C., G.R., S.R., D.S.S.S., K.P.P.A., M.T., J.S.M., G.M.V., V.R., Data Collection and/or Processing: L.V., R.K., L.M.C., G.R., S.R., D.S.S.S., K.P.P.A., M.T., J.S.M., G.M.V., V.R., Analysis and/or Interpretation: L.V., R.K., L.M.C., G.R., S.R., D.S.S.S., K.P.P.A., M.T., J.S.M., G.M.V., V.R., Literature Search: L.V., R.K., L.M.C., G.R., S.R., D.S.S.S., K.P.P.A., M.T., J.S.M., G.M.V., V.R., Writing: L.V., R.K., L.M.C., G.R., S.R., D.S.S.S., K.P.P.A., M.T., J.S.M., G.M.V., V.R.

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Main Points

- Though early and aggressive surgical debridement has a key role in the management of acute invasive fungal sinusitis (AIFS), the associated morbidity can often be functionally incapacitating, compromising the quality of life.
- Using the proposed tailored surgical approach, only 15.4% of the patients required a revision debridement with the site requiring revision being previously uninvolved in 80%.
- Age, gender, and presence of comorbidities were not significant risk factors for revision surgery.
- The most common sites of recurrent disease were the alveolus and the palate (11 patients, 55% each).
- Palatal mucoperiosteal flap preservation could be achieved in 55% of the patients who underwent maxillectomy.
- The low rate of revision surgery and good outcome with minimal morbidity validate the usefulness of the proposed surgical guidelines in deciding the extent of surgical resection in the management of AIFS.

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