

## Endoscopic radical antrectomy: a permanent replacement for the Caldwell–Luc operation

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### Abstract

**Introduction:** Chronic inflammation of sinus mucosa is a multifactorial condition which sometimes results in irreversible pathological mucosal changes.

**Aims:** To evaluate the efficacy of endoscopic radical antrectomy in treating chronic, hyperplastic, eosinophilic sinusitis, and to compare this procedure with classical endoscopic middle meatal antrostomy.

**Materials and methods:** A randomised, controlled trial with parallel design was conducted between July 2000 and December 2004, including 119 patients who fulfilled the clinical, radiological and histopathological criteria for chronic, hyperplastic, eosinophilic sinusitis. Patients were randomly allocated to two treatment groups: classical endoscopic middle meatal antrostomy and endoscopic radical antrectomy. The main outcome measures were recorded in each subgroup at the time of the patient's last clinic visit. In each subgroup, these included subjective improvement and evaluation of the endoscopic appearance of the maxillary sinus.

**Results:** Thirty-two per cent of patients in the endoscopic middle meatal antrostomy group were considered surgical failures, compared with 14.5 per cent of the endoscopic radical antrectomy group. This was statistically significant ( $p = 0.023$ ). Unhealthy maxillary sinuses were significantly more prevalent in the endoscopic middle meatal antrostomy group ( $p = 0.029$ ).

**Conclusions:** In those patients fulfilling the criteria suggestive of chronic, irreversible sinonasal pathology, primary endoscopic radical antrectomy was significantly better than endoscopic middle meatal antrostomy, based on subjective and objective findings.

**Key words:** Maxillary Sinus; Endoscopic Surgical Procedures; Paranasal Sinuses

### Introduction

Since the advent of the endoscope, there has been a dramatic change, from radical to functional endoscopic endonasal procedures, in the operative treatment of chronic and recurrent maxillary sinusitis. Functional endoscopic sinus surgery (FESS) relies on one functional postulate and one technique. The functional postulate is based on the theory that the ostia of the maxillary sinuses are the key areas for pathogenesis of the disease and that their obstruction causes a cascade of pathological changes which eventually lead to chronic inflammation. Based on this theory, the surgical technique that opens such obstructed ostia should promote recovery of maxillary sinus epithelium and restoration of its function.<sup>1–5</sup>

However, this is not always or necessarily the case, and reducing the pathogenesis of sinusitis to a blocked ostiomeatal complex is an oversimplification of a complex issue.<sup>6</sup> One should not forget that allergic, environmental, endocrine,

bacteriological, genetic and other factors play a role in the pathogenesis and clinical course of sinusitis.<sup>7</sup> The end result of such a multifactorial condition is chronic inflammation of the sinus mucosa, with variable degrees of oedema, hyperplasia and metaplasia. In some cases, these pathological mucosal changes are considered irreversible, with persistent subjective and objective manifestations in spite of an adequate middle meatal antrostomy.<sup>4,8,9</sup> Therefore, failures do exist, and not all patients can be completely cured using endoscopic techniques aimed solely at promoting aeration with mucosal preservation. In these particular situations, complete removal of the diseased tissue from within the maxillary antrum is required to ensure complete recovery. Although this may be possible through an endoscopically created intranasal antrostomy, there are situations in which the extent of mucosal pathology and the degree of maxillary pneumatization may require an adjuvant, external procedure that provides full intrasinus visualisation.

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The purpose of the present study was to evaluate the effectiveness of endoscopic radical antrectomy in treating chronic, hyperplastic, maxillary sinusitis, and to compare this technique with a series of contemporaneous cases in which endoscopic middle meatal antrostomy was performed.

### Material and methods

A randomised, controlled trial with parallel design was conducted to evaluate the efficacy of the two different surgical procedures – namely, endoscopic middle meatal antrostomy and endoscopic radical antrectomy – for the treatment of chronic maxillary sinusitis. The study group comprised patients attending the department of otorhinolaryngology within the medical faculty, Alexandria University, between July 2000 and December 2004. The study protocol was approved by the medical faculty ethics committee of Alexandria University. Informed consent was obtained from all participating subjects prior to their inclusion.

The inclusion criteria were based on clinical manifestations, radiological findings and post-operative histopathological evaluation. All patients had a history (i.e. more than three months) of persistent or recurrent discoloured rhinorrhoea, accompanied by more than two of the following symptoms: nasal obstruction, headache, facial pain and anosmia, in spite of maximal medical therapy. Any history suggestive of allergy, asthma or aspirin sensitivity was documented. Any patient with a history suggestive of allergies also underwent allergy investigation with either skin prick or radioallergosorbent testing. The history was supported by endoscopic and radiological evidence of diffuse sinonasal polyposis with extensive involvement of the maxillary sinus. Only patients with nasal polyps of endoscopic grade three and with a Kennedy computed tomography (CT) staging of III or IV were included in the analysis (Figure 1).<sup>10,11</sup> According to the Kennedy staging system,<sup>11</sup> these criteria were associated with a significantly higher incidence of abnormal mucosal appearance within the surgical cavities post-operatively.

Patients were randomly allocated (by means of a sealed, opaque envelope system) into two treatment groups: classical endoscopic middle meatal antrostomy as part of FESS; and endoscopic radical antrectomy, through a combination of canine fossa puncture and an endonasal endoscopic procedure, with complete removal of maxillary sinus mucosa. All patients enrolled in the study were blinded to the treatment method throughout the study period. If a patient presented with bilateral sinus disease, both sides underwent the same procedure. The surgical procedures were performed by the participating authors who had more than five years experience in the field of FESS. In addition, all three surgeons had performed a sufficient number of both procedures prior to performing the trial to reduce the differential expertise bias.

The initial steps of the endoscopic procedures were similar in both groups. The technique was tailored,

according to the extent of the pathology, to include total ethmoidectomy with or without sphenoidotomy and frontal sinusotomy with complete removal of diseased mucosa. For the group approached solely through the endoscopic endonasal route, endoscopic middle meatal antrostomy was performed according to the technique described by Kennedy.<sup>11</sup> First, the maxillary ostium was identified visually using the 45° endoscope, or palpated using an oval spoon or a curved curette. The opening was extended posteriorly with cut-through forceps into the posterior fontanelle. Finally, it was extended inferiorly and anteriorly through removal of any residual uncinate process with Stammberger backbiting forceps. Under direct visualisation with both 45° and 70° telescopes, the diseased mucosa within the maxillary sinus was removed, using curved suction and curved forceps, as far as possible.

For the endoscopic radical antrectomy group, complete removal of the maxillary sinus mucosa required widening of the middle meatal antrostomy and an adjuvant canine fossa puncture. A mega-antrostomy was initially created by enlarging the opening at the expense of each of its dimensions except anteriorly. The antrostomy was enlarged posteriorly to the back wall of the maxillary sinus, inferiorly to the level of the inferior meatus (with resection of the middle part of the inferior turbinate) and superiorly to the orbital floor. The anterior wall of the maxillary sinus was then fenestrated through the canine fossa by applying the sinuscopy trocar and sheath to the superolateral aspect of the fossa with gentle pressure and rotating movement in a posterolateral direction. The mucosa was completely removed using straight and curved forceps introduced through either the canine fossa puncture or the mega-antrostomy, under direct 45° or 70° telescopic visualisation through the other route (Figure 2).

The operative data were reviewed, and inclusion was further restricted to cases with intra-operative endoscopic evidence of oedematous, polypoid or granular maxillary sinus mucosa which was proven histopathologically to be chronic, hyperplastic mucosal inflammation with predominant tissue eosinophilia.

Post-operative care was similar for all patients, consisting mainly of weekly endoscopic debridement, Wilson's solution for sinonasal irrigation, appropriate antibiotic therapy and local steroid preparations. These measures were continued throughout the healing period. Systemic, non-sedating antihistaminics and decongestants were also prescribed on an individual basis according to the patient's allergy status and the mucosal appearance on post-operative endoscopic examination. A minimum follow-up period of 12 months was a prerequisite for inclusion in the study. Our main outcome measures were recorded at the time of the patient's last clinic visit, and included subjective improvement based on the patient's pre-assessment questionnaire. A standardised questionnaire and assessment of complaints on a five-point ranking scale was used. The evaluated symptoms included nasal obstruction, rhinorrhoea

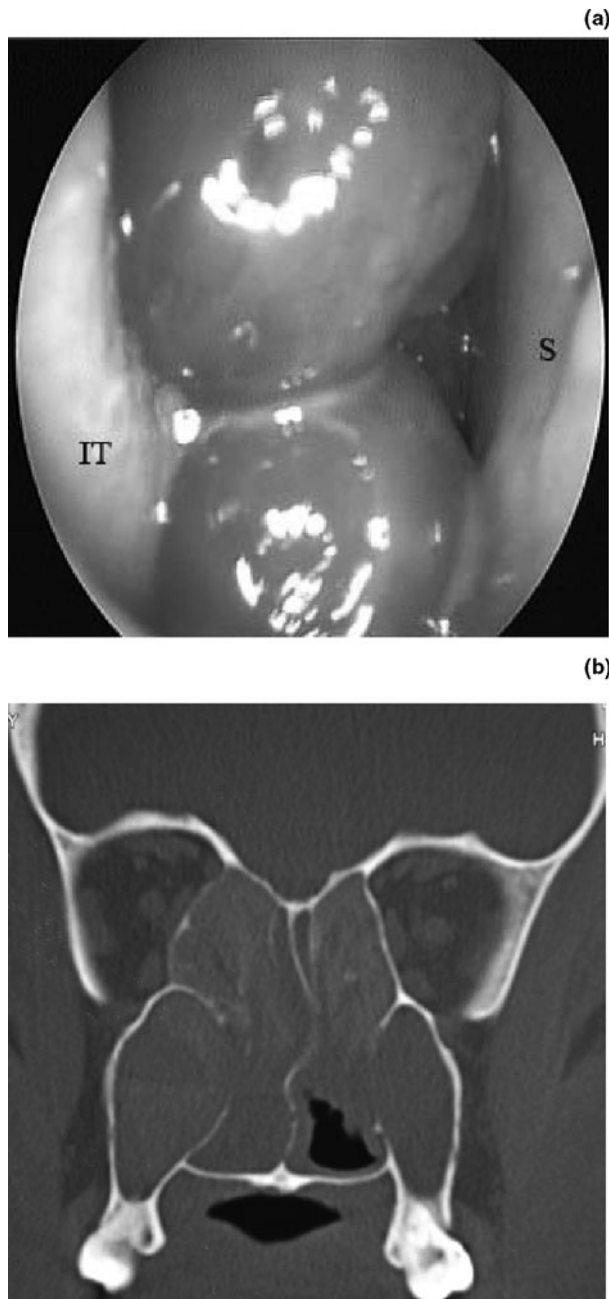


FIG. 1

Endoscopic and computed tomographic (CT) criteria for inclusion in the study. (a) Massive polyposis (grade 3). (b) Diffuse sinonasal polyposis (stage IV according to Kennedy CT staging system). IT = inferior turbinate; S = septum

and/or postnasal discharge, change in sense of smell, sinus pain and/or headache, and lower respiratory complaints. Patients rated their symptoms as follows: zero = none, one = mild, two = moderate, three = moderately severe and four = severe. Patients without improvement in two or more complaints of at least two ranking steps were considered surgical failures. The incidence of post-operative complications and the status of the maxillary sinus on post-operative endoscopic examination were also evaluated independently by two surgeons. Patients with persistent ethmoidal disease or ostial stenosis were excluded from the study.

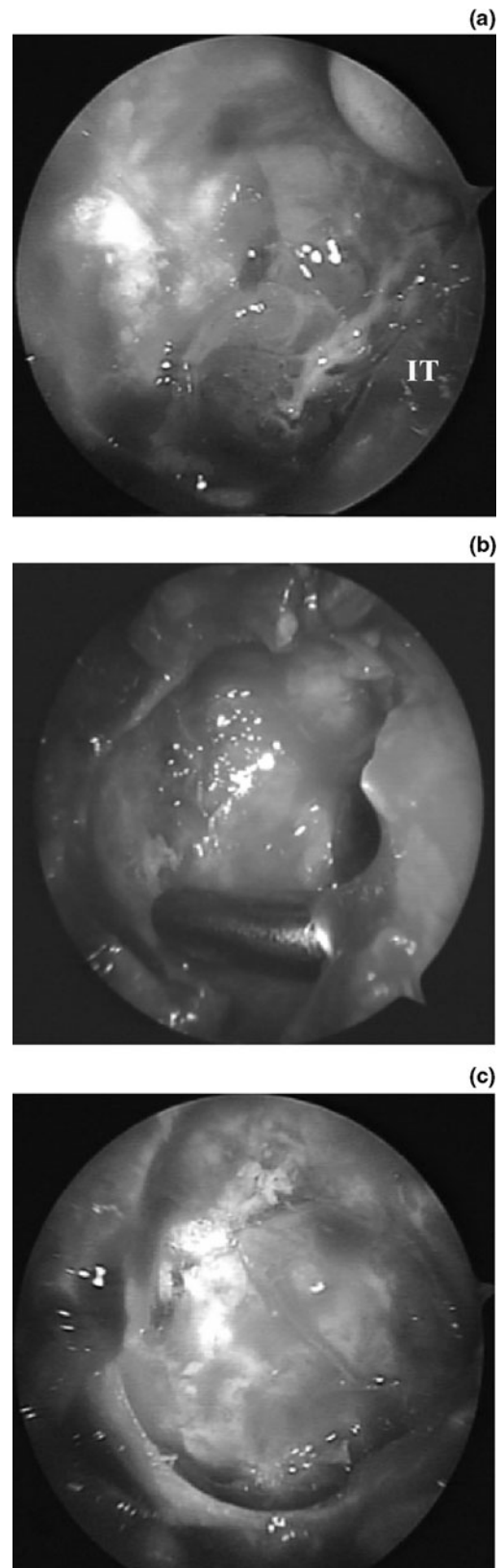


FIG. 2

Endoscopic radical antrectomy. (a) Left mega-antroostomy with evident mucosal oedema, suppuration and cyst formation within the maxillary sinus. (b) Curved suction introduced through canine fossa puncture under direct endoscopic visualisation through the mega-antroostomy. (c) Complete removal of maxillary sinus mucosa with resection of the inferior turbinate (IT).

## Results and analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences software (SPSS, Chicago, Illinois, USA). Patients' demographics and the association between surgical outcome and post-operative endoscopic maxillary sinus appearance were analysed using the chi-square test. Fisher's exact test was used to evaluate the relationship between the surgical procedure and the incidence of complications. Pre-operative versus post-operative differences were evaluated using the Wilcoxon signed rank test for the same group and the Mann–Whitney U test for comparisons of the two groups.

The significance of the obtained results was judged at the 5 per cent level. The power of the study was 0.63, based on the percentage of treatment success in the two groups at the 95 per cent confidence level.

One hundred and nineteen patients fulfilled the criteria for inclusion in the study. They were distributed into two groups: the endoscopic middle meatal antrostomy group (50 patients) and the endoscopic radical antrectomy group (69 patients). This cohort of 119 patients comprised 94 cases of bilateral maxillary sinusitis and 25 cases of unilateral maxillary sinusitis. Endoscopic middle meatal antrostomy was performed on 86 sides and endoscopic radical antrectomy on 127 sides. Fifty-two patients (43.7 per cent) were allergic to one or more of the most common airborne allergens, 42 patients (35.3 per cent) were asthmatic, and 24 patients had documented aspirin sensitivity (20.2 per cent). The two groups were well matched with regard to demographic, clinical and radiological data (Table I).

On pre-operative assessment, nasal obstruction and rhinorrhoea with and without postnasal discharge were reported by all patients. Other symptoms included headache and/or sinus-related pain (69.7 per cent), olfactory disturbances (58.8 per cent), and lower respiratory complaints (44.5 per cent). There was no statistically significant difference between the two groups regarding pre-operative scores for each symptom.

All pre-operative versus post-operative changes in chronic rhinosinusitis associated complaints reached

statistical significance in the endoscopic radical antrectomy group ( $p < 0.001$ ). In the endoscopic middle meatal antrostomy group, a statistically significant improvement ( $p < 0.001$ ) was seen in nasal obstruction, headache and smell disturbance, whereas rhinorrhoea and lower respiratory complaints did not show any significant post-operative change ( $p = 0.105$  and  $p = 0.781$ , respectively). Comparing the two groups, post-operative scores for nasal obstruction, rhinorrhoea and chest complaints were significantly less in the endoscopic radical antrectomy group (Table II). According to our definition of treatment success, 32 per cent of the endoscopic middle meatal antrostomy group patients were considered surgical failures, in comparison with 14.5 per cent of the endoscopic radical antrectomy group. This difference was also statistically significant ( $p = 0.023$ ).

The surgical outcome was further assessed through evaluation of the endoscopic appearance of the maxillary sinus in each subgroup. Accordingly, patients were divided into two groups: those with normal, healthy maxillary mucosa; and those showing oedema, polypoid changes, scarring or stagnant secretions within the maxillary sinus, in spite of a widely patent intranasal antrostomy (Figure 3). Unhealthy maxillary sinuses were significantly more prevalent in the endoscopic middle meatal antrostomy group ( $p = 0.029$ ). In both groups, a statistically significant correlation could also be demonstrated between post-operative endoscopic maxillary sinus appearance and surgical outcome (Table III).

Post-operative discomfort was insignificant in 66.4 per cent of patients, persistent for almost three weeks in 22.7 per cent and continuous for more than one month in 5.9 per cent. The addition of canine fossa puncture with complete removal of maxillary sinus mucosa did not significantly increase the rate of post-operative complications, except for temporary cheek oedema (Table IV).

## Discussion

In the last 30 years, following the work of Messerklinger, FESS has revolutionised the management of inflammatory sinus disorders. This mucosa-sparing technique is based on the principle of maintaining adequate ventilation and drainage in order to allow restoration of normal mucociliary function, even in cases of severe mucosal disease.<sup>12,13</sup>

Unfortunately, the benefits are not universal, and there has been an ongoing debate in the literature regarding the reversibility of sinonasal inflammatory mucosal pathology.<sup>14–16</sup> In a series of 24 patients with diffuse, previously unoperated polypoid rhinosinusitis who were subjected to FESS, only eight of the 39 maxillary sinuses involved demonstrated reversal of the mucosa to normal.<sup>17</sup> Moreover, mucosa might recover macroscopically but with incomplete or delayed restoration of effective mucociliary clearance.<sup>18</sup> Others stated that diseases such as allergic fungal sinusitis, nasal polyposis and chronic hyperplastic sinusitis rarely resolved with surgery alone and that such conditions required direct

TABLE I

DEMOGRAPHIC AND CLINICAL DATA FOR THE TWO STUDY GROUPS

Data	EMMA group (n)	ERA group (n)	<i>p</i>
<i>Age</i>			
Range (years)	22–67	20–63	0.574
Mean (years)	41.5 ± 12.4	40.3 ± 11.3	
<i>Sex</i>			
Male	28	40	0.83
Female	22	29	
<i>Co-morbidity</i>			
Allergy	22	30	0.955
Asthma	18	24	0.891
Aspirin sensitivity	10	14	0.969
<i>Radiological staging</i>			
III	11	9	0.197
IV	39	60	

EMMA = endoscopic middle meatal antrostomy; ERA = endoscopic radical antrectomy

TABLE II  
POST-OPERATIVE SYMPTOM SCORES FOR THE TWO STUDY GROUPS

Symptom	EMMA group (mean score $\pm$ SD)	ERA group (mean score $\pm$ SD)	<i>p</i>
Nasal obstruction	1.32 $\pm$ 0.82	0.75 $\pm$ 0.79	<0.001*
Nasal discharge	2.6 $\pm$ 1.47	0.84 $\pm$ 0.85	<0.0001*
Headache	0.7 $\pm$ 1.01	0.67 $\pm$ 0.8	0.887
Smell disorder	0.78 $\pm$ 0.93	0.7 $\pm$ 0.93	0.643
Chest complaints	1.36 $\pm$ 1.71	0.46 $\pm$ 0.85	0.018*

\*Statistically significant. EMMA = endoscopic middle meatal antrostomy; ERA = endoscopic radical antrectomy; SD = standard deviation

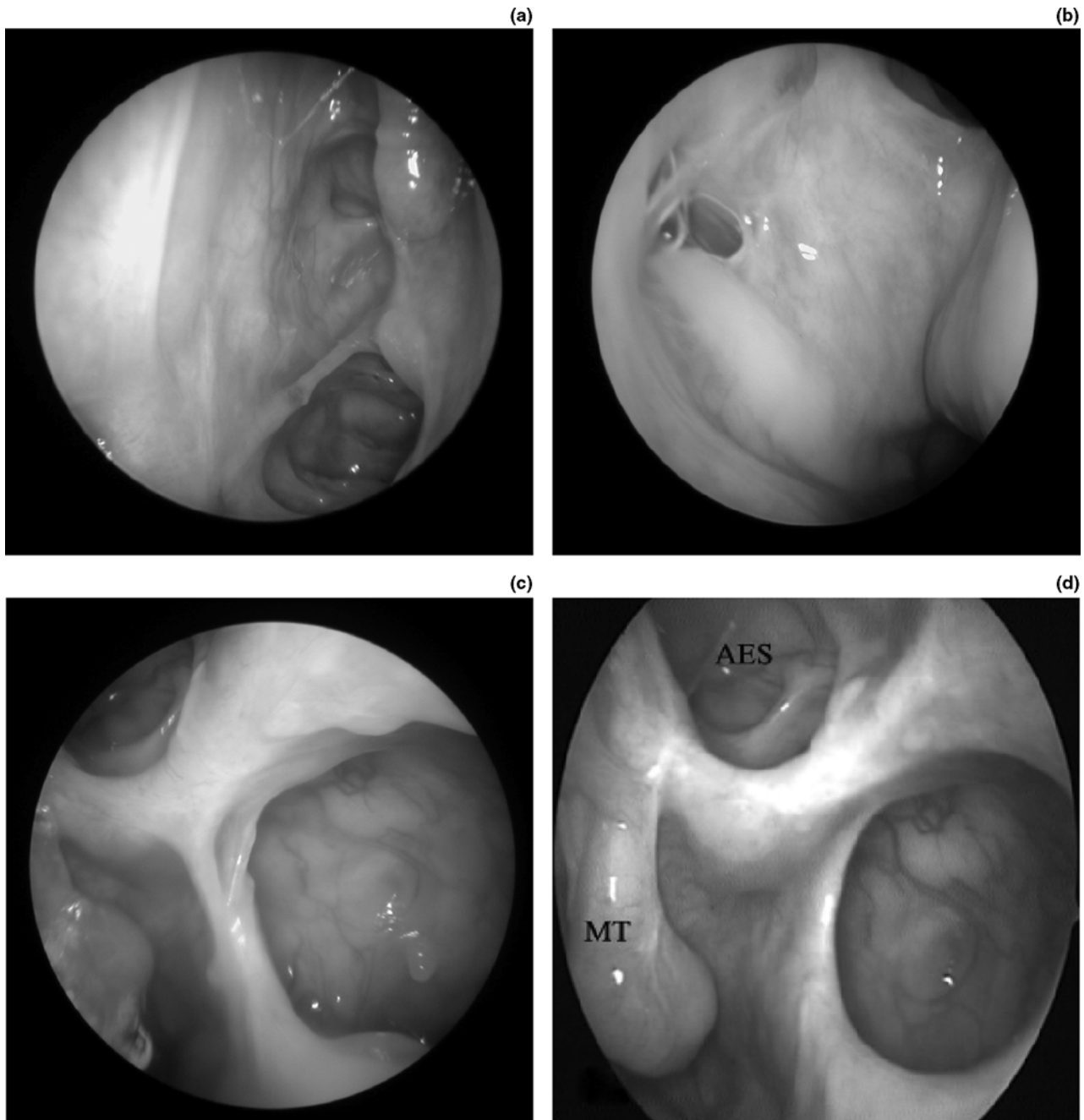


FIG. 3

Post-operative endoscopic appearance. (a) Healthy ethmoid cavity was a required inclusion criterion. (b) Right endoscopic middle meatal antrostomy, showing flow of discharge through the surgically created ostium. (c) & (d) Healthy appearance of the left maxillary sinus mucosa following left endoscopic radical antrectomy, two months (c) and 16 months (d) post-operatively. MT = middle turbinate; AES = anterior ethmoid sinus

TABLE III

RELATIONSHIP BETWEEN POST-OPERATIVE ENDOSCOPIC MAXILLARY SINUS APPEARANCE AND SURGICAL OUTCOME FOR EACH PROCEDURE

Surgical outcome	Maxillary sinus appearance (n)		p
	Normal	Abnormal*	
<i>EMMA group</i>			
Success	25	9	<0.01 <sup>†</sup>
Failure	4	12	
<i>ERA group</i>			
Success	51	8	<0.001 <sup>†</sup>
Failure	2	8	

\*Abnormal maxillary sinus status included oedema, polypoid changes, scarring or stagnant secretions within the maxillary sinus despite a widely patent intranasal antrostomy.

<sup>†</sup>Statistically significant. EMMA = endoscopic middle meatal antrostomy; ERA = endoscopic radical antrectomy

post-operative treatment of the pathological mucosa with topical medication.<sup>19</sup> This is usually the case for residual mucosa within the endoscopically created sphenoidal cavities which lies within the reach of any post-operative local medication. For the laterally positioned maxillary sinus, the available non-invasive delivery mechanisms are ineffective in providing an adequate post-operative anti-inflammatory effect in the residual mucosa. Another important factor is the anti-gravitational mucociliary elevator in the maxillary sinus. Its impairment in the early post-operative period, as a result of severe mucosal inflammation, will result in stagnation of secretions within the sinus cavity, leading to a persistent inflammatory state that will delay or totally impair the restoration of normal mucociliary function. Therefore, irreversibly diseased mucosa must sometimes be removed from the maxillary antrum in order to alleviate the patient's persistent complaint of thick or purulent postnasal discharge, despite a well performed endoscopic antrostomy.

It is still unclear exactly what constitutes irreversible mucosal damage, and what should be the pre-operative criteria of those patients requiring maximal mucosal removal. Computed tomography (CT) scanning is an important tool in the armamentarium of the physician treating chronic sinusitis. Wynn and Har-El<sup>20</sup> reported a recurrence rate of

TABLE IV

COMPLICATIONS OF EACH SURGICAL PROCEDURE

Complication	EMMA group (n)	ERA group (n)	p
<i>Temporary*</i>			
Cheek oedema	0	8	0.02 <sup>†</sup>
Cheek pain	4	8	0.759
Loss of teeth sensation	3	4	1
<i>Permanent</i>			
Loss of teeth sensation	0	4	0.138
Chronic cheek neuralgia	0	3	0.263

\*<3 weeks. <sup>†</sup>Statistically significant. EMMA = endoscopic middle meatal antrostomy; ERA = endoscopic radical antrectomy

60 per cent among patients who were objectively determined to have severe polyposis based only on radiological staging. However, there is general agreement that depending on CT appearances alone is by no means perfect, because of the difficulty in differentiating between opacification resulting from inspissated mucus and mucosal inflammation, which may have prognostic significance. Furthermore, Bassiouny *et al.*<sup>21</sup> stated that pre-operative CT scanning can be a reliable and valid indicator of the number of cilia in the paranasal sinuses prior to FESS but cannot predict the regenerative potential of cilia after surgery.

The gross, intra-operative appearance of maxillary sinus mucosa is another important indicator of disease severity. Few studies have graded the pathological state of the maxillary sinus mucosa. Terrier<sup>22</sup> classified the latter, according to endoscopic appearance, into five types, with type zero being normal, dry, transparent mucosa and type four being totally hyperplastic, productive mucosa. However, the majority of studies reporting successful outcomes following endoscopic middle meatal antrostomy with mucosal preservation do not mention the status of the maxillary sinus mucosa at the time of surgery.<sup>23,24</sup> In the present study, selection was restricted to those patients with clinical and histopathological evidence of chronic, hyperplastic, eosinophilic sinusitis. This particular disease subtype has been recently considered as a separate entity which is often associated with extensive intranasal pathology, multiple sinus infections and recurrent polyp formation requiring repeated surgery. It is considered the end result of various aetiological factors, including superantigen activation, fungal reaction and aspirin hypersensitivity.<sup>25,26</sup> Patients fulfilling the selection criteria were randomly allocated into two treatment groups to compare the subjective and objective outcomes, following endoscopic radical antrectomy and endoscopic middle meatal antrostomy. In both groups, all diseased sinuses were managed using the same technique, which ensured well ventilated sinuses without residual diseased mucosa. The only difference was the procedure applied to the maxillary sinus.

The second controversial issue is how to fully approach the maxillary sinus with the least possible complications. Surgical treatment for chronic maxillary sinusitis has challenged practitioners since Highmore described the maxillary antrum in 1650.<sup>27</sup> Throughout the early part of the twentieth century, the Caldwell-Luc approach through the anterior wall of the maxillary sinus was considered the primary choice in treating chronic and recurrent maxillary sinusitis. Advocates of the Caldwell-Luc procedure cite the advantages of excellent visualisation, while opponents cite a high complication rate, with morbidity ranging from less than 10 per cent to greater than 40 per cent.<sup>28,29</sup> Over the last decade, less radical interventions using an endoscopic endonasal approach have almost replaced the classical Caldwell-Luc procedure in the treatment of chronic and recurrent maxillary sinusitis. The classical endoscopic middle meatal antrostomy

provides access to the posteromedial compartment of the maxillary antrum. Widening the antrostomy to incorporate both the inferior and middle meatus with resection of the central portion of the inferior turbinate gives additional access to the floor and lateral wall of the antrum. However, the lateral and anteromedial recesses are inaccessible endoscopically, even with the use of a 70° lens and various curved instruments, without resection of the nasolacrimal duct as described in endoscopic medial maxillectomy. An alternative approach is through puncturing the canine fossa, which allows maximal mucosal removal under direct endoscopic visualisation through the intranasal antrostomy. However, canine fossa puncture is not without complications. Cheek swelling, dental numbness, facial numbness, tingling and pain were reported in up to 75 per cent of patients.<sup>30,31</sup> In our study, the proper placement of the trocar at the thin portion of the canine fossa – as determined by pre-operative CT scanning – markedly reduced the rate of post-operative neurological complications. Recently, Robinson and Wormald,<sup>32</sup> through cadaveric research, identified an entry point into the maxillary sinus at the transection of a vertical line drawn through the midpupillary line with a horizontal line through the floor of the nasal vestibule. They stated that following these landmarks potentially reduced the chance of neural injury while undertaking canine fossa puncture.

The re-establishment of maxillary sinus mucosa following complete removal is still controversial, despite various studies in animals and humans. Brownell<sup>33</sup> stated that ‘complete regeneration of the lining of the paranasal sinuses including ciliated columnar epithelium is the rule after operative removal of the original membrane’. In contrast, Hilding<sup>34</sup> reported sinus obliteration with scar tissue, with only exceptional cases of partial restitution and regeneration of lining epithelium, in animal models. Similar controversy has been raised in humans, with Goodman<sup>35</sup> suggesting postsurgical obliteration of the maxillary sinus with fibrous tissue. On the other hand, Forsgren *et al.*<sup>8</sup> compared the post-operative histopathological changes following Caldwell–Luc procedure and endoscopic middle meatal antrostomy, and reported reduced inflammatory cells and overall normalisation of the mucosa following complete mucosal removal. They concluded that the Caldwell–Luc procedure should be considered for asthmatic patients, especially those with severe polyposis. Furthermore, Penttilä *et al.*<sup>7</sup> reported a comparative study between Caldwell–Luc and endoscopic sinus surgery (ESS), with a five- to nine-year follow up. Among Caldwell–Luc patients, 82 per cent were asymptomatic; among ESS patients, 75 per cent. At seven to nine years, 20 per cent of ESS patients required re-operation and 28 per cent of these were failures. In our study, the superiority of endoscopic radical antrectomy was emphasised on clinical grounds. Complete mucosal removal was associated with statistically significantly lower post-operative scores for nasal obstruction, rhinorrhoea and lower respiratory complaints. Furthermore, the incidence of normal post-operative endoscopic appearance of maxillary antral mucosa, which was

correlated with symptomatic improvement, was significantly higher in the endoscopic radical antrectomy group. Assessment of the subjective outcome was based on a ranking scale for the sinusitis-related symptoms. This is similar to the five-point ranking scale questionnaire proposed by Damm *et al.*<sup>36</sup> These authors stated that treatment outcome research after FESS should focus on improvement of complaints and recovery of quality of life, instead of depending on the duration of patients’ complaints. According to their results, the definition of treatment success as an improvement in two or more complaints of at least two ranking steps was highly correlated with improvement in quality of life.<sup>36</sup>

- **Some cases of chronic hyperplastic maxillary sinusitis are irreversible even with an adequate middle meatal antrostomy**
- **This study evaluated the effect of complete removal of maxillary sinus mucosa through a combined endoscopic and canine fossa approach (endoscopic radical antrectomy), and compared this approach with classical endoscopic middle meatal antrostomy**
- **Subjective and objective outcome measures were significantly better in the endoscopic radical antrectomy group**
- **In those patients fulfilling the selection criteria, endoscopic radical antrectomy seemed to be an appropriate surgical option, with no additional post-operative morbidity**

As regards the timing of radical intervention, several authors initially performed classical endoscopic middle meatal antrostomy for all cases. They considered radical intervention, either through the Caldwell–Luc procedure, Denker’s procedure or the use of high-pressure water jet irrigation, for those patients with persistent subjective and objective findings suggestive of irreversible mucosal pathology despite a well performed endoscopic middle meatal antrostomy.<sup>4,37,38</sup> However, careful combined evaluation of patients’ clinical data, intra-operative endoscopic appearances and histopathological findings is helpful in selecting those patients who will benefit from primary radical mucosal removal. According to the literature, asthma, aspirin sensitivity and severe sinonasal polyposis are associated with poor prognostic outcome, with a significantly higher need for revision surgery.<sup>39,40</sup> Furthermore, the macroscopic and histopathological evidence of chronic, hyperplastic, eosinophilic sinusitis which can be determined by either pre-operative or intra-operative biopsy is another important hallmark of disease severity. While awaiting spontaneous recovery can be justified in those patients with non-polypoid chronic sinusitis, primary radical surgery seems to be more time- and cost-effective in those fulfilling the previously mentioned criteria, especially those patients having a poor follow-up perspective, without additional morbidity.

Although success was greater after endoscopic radical antrectomy, in comparison with endoscopic middle meatal antrostomy, certain limitations should be recognised in this study. Our assessment did not include the difference in post-operative medication usage between the two groups, which might have influenced the surgical outcome. To limit this effect, systemic steroids were not allowed throughout the study period. Furthermore, the difference in local steroid usage during the healing period would have a minimal effect on the outcome, as steroid was delivered as a nasal spray. This delivery mechanism was previously reported to result in minimal post-operative deposition of medication on maxillary sinus mucosa.<sup>41</sup> It is therefore most likely that the difference in outcome between the two groups is the result of the difference in surgical procedures.

The other limitation of this study was the sample size. One hundred and nineteen patients meeting the diagnostic criteria of chronic, hyperplastic, eosinophilic, maxillary sinusitis were recruited over a four-year period. To include eligible participants, exclusion of subjects was considered at various stages of the study. This resulted in a relatively small sample size and a relatively low power. Perhaps in the future, a multicentre, randomised, controlled trial with enrolment of a sufficient number of patients within a reasonable time frame will firmly establish the efficacy of our proposed technique.

### Conclusions

We conclude that patients fulfilling the clinical, radiological and histopathological criteria of extensive sinonasal pathology require initial treatment with a procedure that permits complete removal of the irreversibly damaged mucosa. The presented technique of endoscopic radical antrectomy constitutes a surgical option offering full visualisation within the maxillary sinus. This technique has significantly better results than the classical endoscopic middle meatal antrostomy, in terms of symptom improvement and the post-operative endoscopic appearance of the maxillary sinus mucosa.

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