REVIEW

Rhinology, 42, 114-120, 2004

Postoperative care following endoscopic sinus surgery*

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SUMMARY

Postoperative care is very important in the global management of the patient undergoing ESS. Postoperative tamponnade, packing, splinting or stenting is advocated by many surgeons, but its clinical beneficial effects have not clearly been demonstrated. Postoperative rinsing/washing of the surgical cavity offers advantages in healing: high volume, low pressure is to be preferred. Suction cleaning is advocated on a weekly basis starting one week after ESS and continues until secretions, blood, crusts have disappeared. Topical medications have not been the subject of randomized clinical trials. Of the various classes of systemic (oral) medications, only steroids resulted in better short term outcome when using higher doses compared to lower doses. Antibiotics have not shown clinical effects and should not routinely be given.

Key words: sinus surgery, postoperative treatment

INTRODUCTION

The use of endoscopes in paranasal sinuses underwent an impressive (r)evolution during the last 25 years from a purely scientific, diagnostic technique (Messerklinger, 1978) into a worldwide accepted, clinical and predominantly therapeutic tool. Endoscopic sinus surgery (ESS) has become a standard surgical procedure for inflammatory disorders of the paranasal sinuses, even the actual gold standard. Investigations and developments focused mostly on surgical techniques, extended indications and new instruments and to a lesser degree also on outcomes. Postoperative care attracted much less attention, despite the recognition of its importance (Stammberger, 1991; Gross and Gross, 1994; Min and Yung, 1996; Kuhn and Citardi, 1997; Tom et al., 1997; Nayak et al., 1998; Bolger et al., 1999). Based on the literature, only prevention of adhesions by placing stents, splints, sheaths … seemed interesting and worthwile investigating and reporting (McDonogh, 1990; Shikani, 1994; Brennan, 1996; Kuhn and Citardi, 1997; Tom et al., 1997; Nayak et al., 1998; Bolger et al., 1999). Here, an attempt is made to consider all aspects of postoperative care (Table 1) based on the literature and personal studies.

The optimal treatment is the one that gives best results/outcome, is easy to follow and well tolerated. It may depend on the indication. The postoperative period and healing process can be divided in an early one (first weeks) and a later one (up to 6 months) (Hosemann et al., 1991). The early period is most likely to be influenced by the surgery itself and the early postoperative treatment. The underlying disease determines predominantly the later healing phase.

The goal of the postoperative treatment is optimal woundhealing with least morbidity. Many parameters can be evaluated in this process, including subjective symptoms (secretions, post nasal drip, headache and pressure feeling, stuffiness, smell problems, cough, …) and objective signs. In addition to endoscopic evaluation of secretions, mucosal swelling and scar formation, nasal function tests such as rhinomanometry, acoustic rhinometry, mucociliary clearance, and biochemical and microbiological parameters can be included in the list of outcome parameters. Postoperative (infectious) complications should also be included, as well as recurrences.

Table 1. Commonly used postoperative measures, procedures and medications.

- *materials at the end of ESS*
  - packing, spacers, stents, splints, tamponnade
  - pharmacological active agents
- *cleaning of the surgical space/cavities*
  - by the patient themself
  - by the ENT surgeon
- *medications*
  - antihistamines
  - steroids
  - antibiotics
  - antifungal agents
  - mucolytics
  - anticholinergics

*Received for publication: March 11, 2004; accepted: May 19, 2004

1) PROCEDURES AT THE END OF THE SURGERY

a) Stents/splints/sheaths/tamponnade/packing

Opinions concerning placing "foreign" material in the nasal cavity and/or middle meatus – paranasal sinuses vary from avoidance (never or occasionally) (Gross and Gross, 1994; Min and Yung, 1996) to imperative (standard procedure, virtually always) (McDonogh, 1990; Shikani, 1994; Brennan, 1996; Kuhn and Citardi, 1997). The material can be positioned 1) to control bleeding, 2) to prevent formation of adhesions and scars and 3) to maintain patency of the paranasal sinuses.

The most frequently used is polyvinyl acetal (Merocel®, Ivalon®, . . .), but a wide variety of other materials have been described (Table 2). Polyvinyl acetal is currently treated or covered with a non-adherent film to facilitate removal and reduce trauma upon removal.

Table 2. Materials for tamponnades, packings, stents, spacers, splints, etc..

polyvinyl acetal (Merocel®)
gelatin film (Gelfilm®)
autologous fibrine
microfibrillar collagen (Avitene®)
oxidized, regenerated cellulose (Surgicel®)
silicone
hyaluronic acid (Merogel®)
dental wax
cottonoid
latex or vinyl surgical glove finger
…

Considering the average duration of postoperative bleeding and the infection risk because of the "foreign body", there is no reason to leave a packing/stenting for more than 3 days.

Blood surrounding the packing may (re)organize and the fibrin deposits around the packing could lead to scar tissue and adhesions. Packing moreover may obstruct evacuation of blood and secretions from the paranasal sinuses.

When a packing is left for more than 24h, antibiotics should be given, to reduce the risk of toxic shock syndrome (TSS) (Abram et al., 1994).

A number of studies showed fewer adhesions between the middle turbinate and the lateral nasal wall after packing (McDonogh, 1990; Shikani, 1994; Kuhn and Citardi, 1997; Nayak et al.; 1998), but no long term effect on sinus health has been demonstrated. Ideally the material should keep mucosal surfaces apart until re-epithelialisation is achieved, whilst preserving the openings and thus drainage of the paranasal sinuses. The latter is the most difficult one to achieve.

During the last 15 years in the UZLeuven, a tamponnade is only placed when there is severe, immediate postoperative bleeding. This was never necessary when surgery was performed under local anaesthesia and is frequently linked to highly inflamed and/of infected mucosal linings. The polyvinyl acetal tamponnade is usually removed the day after surgery.

b) Pharmacologically active agents

Twenty years ago, paranasal sinus application of ointments containing steroids and/or antibiotics was a routine procedure. Since these lipids may cause lipogranuloma and myospherulosis (Wheeler et al., 1980; Godbersen et al., 1995; Min and Yung, 1996; Biedlingmaier et al., 1997; Weidman et al., 1999; Culviner et al., 2000), fatty ointments no longer should be used after ESS. Even today evidence for a beneficial effect of any medications applied locally is lacking. Recently, hyaluronic acid has been promoted to prevent adhesions but convincing data are lacking. It may even be harmful to the healing process and its application interferes with daily "douching" of the surgical cavity and with suction cleaning by the surgeon (Jacob et al., 2002; Miller et al., 2003).

In specific cases mitomycin C can be used to prevent scar and adhesion formation (Ingram et al., 2000; Rahal et al., 2001; Chung et al., 2002).

2) POSTOPERATIVE CLEANING OF THE SURGICAL CAVITY

a) Suction cleaning under endoscopic control by the surgeon

Cleaning the surgical cavity has always been considered a cornerstone in postoperative care. Up to some 10 years ago one could have had the impression from the literature that it was more important than the surgery itself. Removal of blood, secretions, fibrin clots, oedematous mucosa, adhesions was propagated even on a daily basis.

Since then our understanding of mucosal healing has changed and improved, and with that the instructions and advice for suction cleaning has also changed (Gross and Gross, 1994; Kuhn and Citardi, 1997; Moloney and Ah-See, 1998; Kennedy et al., 2000): recommended frequency is now at most weekly starting one week after surgery, and gentle, and atraumatic. However, hard proof is lacking and guidelines are based on personal experience and philosophy rather than on randomized, double blind, placebo controlled studies.

In our institution suction cleaning is done in all patients at day 8, but only seems necessary in two thirds at day 15 and in less than 1/4 after 3 weeks. Straight and curved (maxillary) suction cannula are routinely used, forceps only rarely and placement of a stent or spacer is exceptional.

b) Nasal and paranasal sinus rinsing/washing/douching by the patient

During the last years the relevance of daily rinsing/douching/washing has been stressed (Gross and Gross, 1994; Kuhn and Citardi, 1997; Moloney and Ah-See, 1998; Kennedy et al., 2000; Bachmann et al., 2000). The effect depends on a number of parameters including: volume, pressure and composition (Table 3).

Table 3. Humidification - rinsing - douching of the nose and paranasal sinuses using physiological saline solution.

Nasal cavity		
nihil	0 ml	
sprays	1 ml	e.g.: Sterimar®, Physiomer®, …
aerosol	3-5 ml	e.g.: Rinoflow®
unidose vials	<10 ml	e.g.: Naaprep®, Physiologica®, …
Paranasal sinuses		
nose can	>100 ml	
Grossan Water Pik®		

Using small volumes (up to 1ml) only humidifies the nasal mucosa, and the paranasal sinuses cannot be reached. The high pressure of delivery in some of the commercially available saline solutions may damage the mucosa.
When somewhat higher volumes are delivered to the nasal cavity some rinsing effect is possible, but it has never been shown that the solution may reach e.g. the maxillary sinus, even after a large middle antrostomy. The pressure of delivery does not seem to be a problem, although eustachian tube problems are listed as contraindications for the Rinoflow® apparatus.

Only with large volumes (300 ml for a nose can) can the paranasal sinuses be reached, rinsed and washed. This has been shown endoscopically and radiographically for the maxillary and ethmoidal sinuses in surgical patients and for the middle meatus in control patients. In addition to the pure mechanical rinsing, the saline will mix with secretions and decrease viscosity, propagating evacuation by mucociliary transport.

Considering the composition, there are no clear guidelines regarding tonicity of the solution, though acidity is to be avoided (Bachmann et al., 2000). Medications (steroids and/or antibiotics) may be added, certainly when using the Rinoflow® or a nose can, but clinical superiority over classical use of drops or sprays has never been demonstrated.
In our department a number of rinsing systems have been tested in prospective, randomized single blind, comparative studies: Sterimar® versus nose can and Rinoflow® versus nose can.
The results of these two studies are summarized in Table 4. Because of the better results both endoscopically (secretions, oedema and polypoid mucosa) and in symptom scores, the excellent tolerance and compliance and the low cost the nose can is to be preferred above Sterimar®. The single advantage of the Rinoflow® system over the nose can was a trend towards a better subjective symptom score. Based on the superior endoscopic results for the nose can and the mentioned afore elements, the nose can was preferred above the Rinoflow® system.
In conclusion, high volume – low pressure rinsing of the nose and paranasal sinuses is the preferred technique for cleaning the surgical cavity and improving woundhealing.

3) MEDICATIONS

a) Antihistamines

Although evidence is lacking that antihistamines are effective in non-allergic paranasal sinus disease, they were traditionally frequently used after ESS. In a prospective, double blind, placebo controlled, randomized study we investigated the effect of an old, sedating antihistamine (dexchloorfeniramine-maleate, Polaramine®) in 100 consecutive patients. Patients received the same treatment as in the nose can versus the Sterimar® study. No statistically significant differences were

Tabel 4. Nasal washing after FESS: nose can versus Sterimar®.

	Nose can	**vs**	**Sterimar®**	**Nose can**	**vs**	**Rinoflow®**
Number of patients	50		50	50		50
Frequency	3x/d		10x/d	3x/d		3x/d
Volume per day	900ml		+ 5ml	900ml		15ml
Other treatments						
	Polaramine® 1/d					
	Celestone® 1/d			Celestone® 1/d		
	Antibiotics			Antibiotics		
	Suction cleaning d3, d8, d15, d29			Suction cleaning d3, d8, d15, d29		
Statistically significant advantages ($p<0.05$)						
Symptoms	nasal obstruction		/	/		/
Endoscopy	secretions		/	secretions		/
	oedema			crusting		
	polypoid mucosa					
Advantageous trends						
Symptoms	global score			/		global score
	secretions		sneezing			
	headache					
Endoscopy	global score		/	global score		/
	crusting					
	blood					

found either in the symptom scores, nor in the endoscopic evaluations and allergic patients did not benefit from the antihistamine.
Since then, antihistamines have no longer been included in our postoperative treatment protocol.

b) Steroids
Based on the anti-inflammatory effect of steroids, one might expect less oedema and polypoid mucosa, less scarring and less smell problems. However, in addition to the classical systemic side effects, there might also be an increased risk for bacterial infection of the surgical cavity with associated inflammation.
Recommendations regarding the use of oral steroids vary widely from none (Gross and Gross, 1994; Fernandez, 1999) to high doses (Min and Yung, 1996; Kuhn and Citardi, 1997) eventually depending on the indication for surgery. These recommendations must be classified as "expert opinion" and are not based on scientific studies.
The effect of oral steroids was investigated in the UZLeuven in a prospective, randomized, double blind, comparative study: 1 tablet Celestone® (betamethasone 0.25 mg) during 20 days versus a reducing regimen (5d 4/d, 5d 3/d, 5d 2/d and finally 5d 1/d), see Table 5.
Systemic side effects were as expected, more often reported in the higher oral steroid group.
Locally, there were a number of differences in favour of the higher dosage: smell, oedema, (Table 5 and Figure 1). These differences were also related to the indication (Tables 6 and 7): with less adhesions occurring in recurrent acute rhinosinusitis and less oedema in chronic rhinosinusitis and nasal polyposis.
For all groups of patients beneficial effects of a higher dose of steroids during the first 3 weeks after ESS were found and the systemic and local side effects of the higher dose oral regimen were minor. For these reasons we now give the higher dose regimen of oral steroids to all our ESS patients.
Whether topical steroids during the first weeks after surgery have a similar effect is not known. It has been recommended

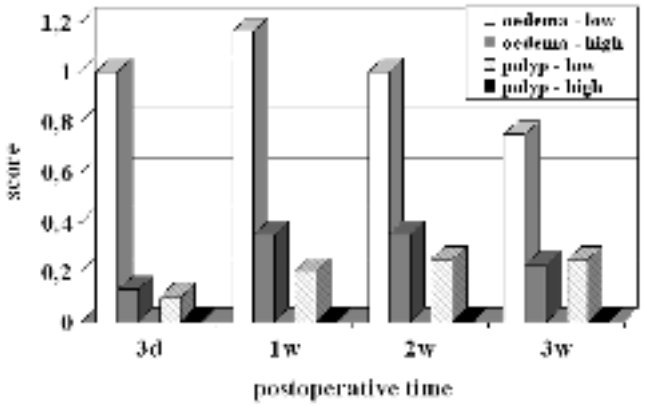

Figure 1. Steroids after ESS for chronic rhinosinusitis: oedema and polypoid mucosa. low: lower dose steroids, high: higher dose steroids. Asterisk: $p<0.05$.

Table 6. Oral steroids after FESS: symptoms versus indications.

	Smell	disorder	Illness	PND	secretions
POL	↓	↑	=	=
CRS	↓	↑	=	=
RAS	=	↑↑ ($p<0.05$)	↑	($p<0.05$)

POL: nasal polyps; CRS: chronic rhinosinusitis; RAS: recurrent acute rhinosinusitis; PND: post nasal drip; ↓: decrease with higher dose oral steroids; ↑: increase with higher dose oral steroids

Table 7. Oral steroids after FESS; nasal endoscopy versus indications.

	oedema	polyps	pus	Adhesions
POL	↓↓ ($p<0.05$)	=	↑	=
CRS	↓↓ ($p<0.05$)	↓	=	=
RAS	=		↑↑ ($p<0.05$)	↓

POL: nasal polyps; CRS: chronic rhinosinusitis; RAS: recurrent acute rhinosinusitis; ↓: decrease with higher dose oral steroids; ↑: increase with higher dose oral steroids

Table 5. Oral steroïds after FESS: study design and results.

	Celestone co low dose	**Celestone co higher dose**
Number of patients	75	75
Steroids	***1co/d 20 dagen***	***4co/d d1 - d5***
		3co/d d5 - d10
		2co/d d11 - d15
		1co/d d16 - d20
Other treatments	rinsing, nose can, 3x/d	
	Antibiotics (cefuroxime axetil, 2x250mg/d)	
	Suction cleaning: d3, d8, d15, d22	
Statistically significant advantages ($p<0.05$)		
Symptoms	general malaise	/
Endoscopy	/	oedema
		polypoid mucosa
Advantageous trends		
Symptoms	post nasal drip	smell
	secretions	
Endoscopy	pus	adhesions

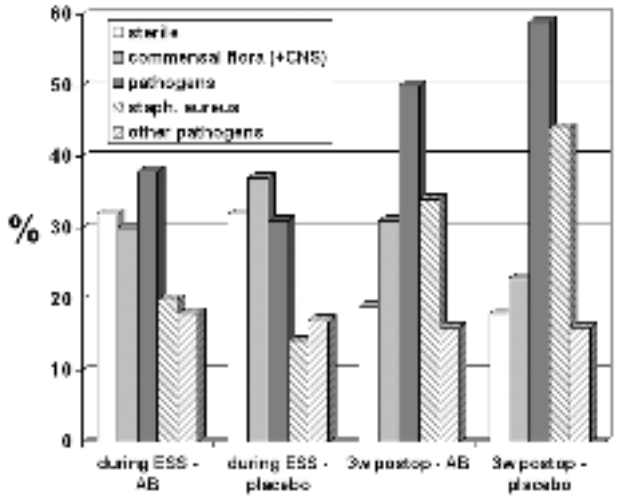

Figure 2. Bacteriology per- and 3w postoperative, antibiotics versus placebo. AB: antibiotic treatment (Zinnat®). CNS: coagulase negative *staphylococci.* The increase in pathogens and in *Staphylococcus aureus* in particular is statistically significant higher in the placebo group compared to the increase found in the Zinnat® group ($p<0.01$).

for frontal recess oedema, refractory to other treatment modalities (Citardi and Kuhn, 1998). Weber et al. (1996) reported better wound healing using local steroids in a very limited number of patients, but these findings have not been confirmed.

c) Antibiotics

Antibiotics have been advocated after ESS for many reasons (Moriyama et al., 1995). It was traditionally thought that the damaged sinuses are prone to bacterial infection and when placing a packing after the surgery, the risk for TSS had to be prevented. However, antibiotics also have side effects and resistent bacteria may be selected in the long term.

In the context of a number of clinical studies looking at various elements in the postoperative care after ESS, a prospective, randomized, double blind, placebo controlled study was started. In it, 202 patients were included (Jorissen and Annys, 1998; Jorissen et al., 1998; Annys et al., 2000) using cefuroxime axetil as the active drug (2 x 250mg/d). Other elements of postoperative care included nasal rinsing using the nose can, weekly suction cleaning and the above mentioned higher dose oral steroids. Nasal packing was not used. The symptoms scores, endoscopic findings, post-op infections and microbiology were evaluated.

There were no differences in symptom scores, endoscopic findings and postoperative infectious episodes and complications (preseptal cellulitis) between the antibiotic and the placebo treated group. Based on these finding antibiotics care no longer be advocated as part of our standard, routine postoperative care after ESS.

The microbiological investigations (Figure 2), showed an increase in the prevalence of pathogenic bacteria after ESS. This can be attributed almost entirely to a doubling in the prevalence of *Staphylococcus aureus*. Treatment with antibiotics can partially prevent this increase in *S. aureus* (Figure 2) and postoperative infectious problems are almost invariably associated with *S. aureus*. However, the presence or absence of *S. aureus* during the surgery has no predictive value neither for its presence or absence after ESS, or for the risk of infectious episodes postoperatively. Whether specific anti-*S. Aureus* treatment may influence the postoperative healing process is unknown, but based on these observations, is at least worth investigating.

d) Antifungal agents

Based on the biodisponibility, pharmacokinetics and potential side effects, systemic use of antimycotic agents is only indicated in life threatening, aggressive, invasive fungal rhinosinusitis. For non-invasive fungus balls, neither systemic nor topical antifungal agents are indicated. The maximal surgical removal of the fungal material and concrements is the keystone of the therapy.

Furthermore at present there are insufficient data to support the topical use of antifungal agents after ESS, not even in so-called eosinophilic fungal rhinosinusitis (EFRS) (Ponikau et al., 1999; Ponikau et al., 2002; Ricchetti et al., 2002).

e) Mucolytics

There are no controlled studies available (Pigret and Jankowski, 1996) and theoretically there are few arguments to add mucolytic agents to the postoperative care regimen.

f) Anticholinergics

There are no data concerning the effect of anticholinergic agents after ESS. Theoretically, the drying effect may even be deleterious.

SPECIFIC CONDITIONS

Children

The major difference between children and adults regarding postoperative care is the great difficulty for ambulatory suction cleaning by the surgeon. It is frequently recommended that suction cleaning is performed under general anaesthesia 2 to 3 weeks postop, but the efficacy of this procedure has not been demonstrated (Tom et al., 1997; Walner et al., 1998).

Cystic fibrosis

Postoperative washing using antibiotics (e.g. tobramycin) is indicated (Moss and King, 1995) and systemic antibiotics should also be administered. It is the author's opinion that daily nasal lavages and suction cleanings should be advocated.

Immunodeficiencies

Although not proven it seems logical and medicolegally wise to administer antibiotics after ESS in these patients.

POSTOPERATIVE CARE REGIMEN

1) At the end of the surgery no packing is placed except when bleeding is a major problem. The packing, tamponnades or the like, should be removed as soon as possible (after 1 day).
2) Placement of a stent, splint, spacer in the middle meatus can be indicated when the mucosa between the head of the middle turbinate and the lateral nasal wall has been extensively damaged in combination with a narrow middle meatus. This splint may be left in place for a number of days.
3) "Immediately" after the surgery nasal and paranasal douching/washing is started. High volume (>100 ml), low pressure rinsing is preferable.
4) Gentle, "atraumatic" suction cleanings are done weekly, starting one week after ESS until crusting, secretions and blood have almost completely disappeared.
5) The only medication that positively influences the immediate postoperative period is oral steroid treatment, using a higher dose regimen. There is no need for routine antibiotic administration.
6) When there are clinical signs of infection postoperatively, antibiotics are indicated, and may empirically be directed against *S. aureus*.
7) Medication later than 3 weeks postoperatively depends on the macroscopic appearance of the mucosa and the underlying pathology.
8) Fungus balls do not need medical treatment after the surgery.

CONCLUSION

Postoperative care after ESS is very important, but not very complicated.

Nasal and paranasal sinus washing/rinsing, a limited number of suction cleanings and orally given steroids should be sufficient. Further investigations are needed to optimize the postoperative care protocol.

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