

## ANAESTHETIC CONCERNS IN FUNCTIONAL ENDOSCOPIC SINUS SURGERY

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### ABSTRACT

#### BACKGROUND

Functional endoscopic sinus surgery provides a challenge and an opportunity for the anaesthesiologists to provide surgeons with a surgical field, which can make this delicate surgery more safe, fast and precise. The article discusses causes of bleeding in functional sinus surgery.

#### MATERIALS AND METHODS

It focuses on various techniques and drugs, which can be used by anaesthesiologists to control bleeding. It also discusses the pros and cons of controlled hypotension during this surgery. Various techniques of local instillation of various drugs are discussed.

#### RESULTS

Various drugs and techniques are compared and advantages and disadvantages of each are discussed.

#### CONCLUSION

Premedication with various drugs, techniques of positioning and controlled hypotension are useful for control of bleeding in functional endoscopic sinus surgery.

#### KEYWORDS

Endoscopic Sinus Surgery, Controlled Hypotension.

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#### BACKGROUND

Chronic rhinosinusitis has a significant impact on health related and generic quality of life. It can cause high cost burden to both society and patients and may be associated highlights with absenteeism, loss of productivity and poor respiratory function.<sup>1</sup>

Most vital aspect of endoscopic sinus surgery is an optimal visibility in the surgical field. This invariably requires controlled hypotension and provision of good quality surgical field. This article reviews various modalities of provision of controlled hypotension and the method to assess the quality of surgical field.

It is a highly-sophisticated surgery, which has revolutionised the surgical management of chronic sinus diseases. It is a minimally invasive procedure done to restore the natural mucociliary clearance mechanism, drainage and aeration of the sinuses while maintaining the normal anatomy as much as possible. Bleeding is difficult to control due to extensive vascular supply in the sinus region.<sup>1</sup>

Major complications like optic nerve damage, damage to dura mater, CSF rhinorrhoea, meningitis and even death have been reported for FESS under general as well as local anaesthesia.<sup>1</sup> This results from impaired visibility due to excessive bleeding during surgery.<sup>2</sup>

The treatment of serious complications from the poor visibility due to excessive bleeding in the surgical field and the possibility of neurological damage makes it important for anaesthesiologists to produce optimal surgical conditions.

Bleeding occurs from intrabony vessels which are unsupported and capillaries which cannot be ligated.<sup>3</sup> Antifibrinolysis and haemostasis are the two mechanisms, which can be used for optimal surgical field without endangering life or well-being of the patient. The need for blood transfusion is also reduced.

Many techniques have been proposed to improve the field of functional endoscopic sinus surgery.<sup>1</sup> Many pharmacological as well as non-pharmacological techniques have been tried.<sup>1</sup> SNP, NTG, ganglion blocking agents, volatile agents and MgSO<sub>4</sub> have been tried for decreasing blood loss in nasal surgery.<sup>4,5,6</sup>

Here, we will try to review various measures followed for better surgical field.<sup>1</sup> Bipolar diathermy, packing, local vasoconstrictor and induced hypotension are the most commonly used techniques.<sup>4,5,6</sup>

Diathermy can lead to local mucosal damage and delayed bleeding.<sup>4</sup> Use of local vasoconstrictors can lead to endoscopic surgery is a minimally invasive technique that has found a definite place in all surgical techniques. It can range from endoscopic septoplasty, turbinoplasty and functional endoscopic sinus surgery to advanced surgery like endoscopic orbital and optic nerve decompression, endoscopic dacryocystorhinostomy and endoscopic skull base approaches.<sup>1</sup>

The advantages are absence of external scars, minimal damage to normal tissue and bone and short recovery time and length of hospital stay. But intraoperative bleeding presents a larger obstacle to endoscopic visualisation.<sup>1</sup>

The risk of complications increases with intraoperative bleeding. The most common indications are: chronic sinusitis

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refractory to medical treatment, recurrent sinusitis, nasal polyposis, antrochoanal polyps and sinus mucoceles.

Mucosa of nasal cavity, paranasal sinuses, palate and nasopharynx is innervated by post-sympathetic fibres from superior cervical ganglion through maxillary nerve. Stimulation of nasal mucosa causes severe cardiovascular response through this pathway.<sup>7</sup> Oral clonidine and atenolol effectively attenuate tachycardia as well as hypertension without causing postoperative sedation.

Careful consideration of all factors regarding the control of bleeding throughout the entire perioperative period is required.

Preoperative preparations and intraoperative techniques and novel surgical material and technique will help to improve the quality of surgical field.<sup>1</sup>

### Preoperative Evaluation

Coagulation comprises 3 major components: Vascular compartment, platelets and coagulation factors. Problem with any of the components can lead to bleeding. History of unexplained bleeding associated with surgical procedures, trauma, unexplained bruises or haematomas, family history suggesting bleeding tendency and use of prescribed and over-the-counter medications and supplements needs to be evaluated. Preoperatively, investigate the presence of petechiae, ecchymotic lesions, telangiectasias, hepatosplenomegaly and haemarthrosis of the joints. Preoperative coagulation profile will help to confirm a suspected diagnosis and for preoperative planning.

Discontinuation of warfarin for 5 days and aspirin and clopidogrel for 7 days is advisable. Surgery can be done if INR is less than 1.5. Patients who pose moderate-to-high risk for thromboembolic phenomena should receive LMWH 3 days before surgery. Preoperative embolisation is rarely needed only in cases of vascular tumours, which can be done 24 to 72 hours before surgery. Preoperative administration of steroid is beneficial due to their anti-inflammatory and anti-oedematous effects. This can improve visibility of field.

### Anaesthesia Considerations

**Controlled Hypotension:** It includes various modalities associated with different potency and adverse effects. The safety is dependent on thorough knowledge about mechanism of action for each modality, adequate monitoring of the patient's haemodynamic instability especially in patients with a history of hypertension or ischaemic heart disease.

Induced hypotension exposes the patients to more anaesthetic drugs and hence higher risk of potential side effects. Neither of these methods guarantees a desirable surgical field with no bleeding. Therefore, investigators are working on more effective and safer methods to reduce bleeding and hence to improve the field of endoscopic sinus surgery.<sup>7</sup>

Preoperative steroids can be given in cases of severe nasal polyposis for its anti-inflammatory effect and decrease in mucosal oedema. An ideal hypotensive agent should be easy to administer with short time to onset, effects should disappear quickly when discontinued with rapid elimination of toxic metabolites with negligible effects on vital organs and with predictable and dose dependent effects.<sup>5</sup>

Proper precautions need to be taken during hypotensive anaesthesia like protection of pressure points by padding, monitoring of ECG especially V5 lead with ST segment analysis to detect cardiac ischaemia, maintaining normocapnia, avoidance of hypothermia as it decreases the effectiveness of vasodilators, maintaining adequate perfusion to all vital organs.<sup>6</sup>

Capillaries consist of just one layer of epithelial (lining) cells held in place by a 'Skeleton' of cross-linked collagen fibres embedded in a matrix of laminin which 'glues' the lining cells to the collagen net. The gel/laminin structure supporting basement membranes and is a component of all blood vessels.

Vitamin C works its bleeding by the synthesis and deposition of both collagen and laminin.

As vitamin C is used up and excreted quickly, we have to administer 3 or 4 doses of 500 mg of vitamin in a day. For collagen production, scientists have used vitamin C,<sup>6</sup> other dietary antioxidants, minerals, proline and lysine.

Ethamsylate is thought to stabilise capillaries, reinforcing capillary membranes by polymerising hyaluronic acid.<sup>8</sup>

Ethamsylate limits capillary bleeding through its action on hyaluronic acid and initial studies showed a reduction in intraventricular haemorrhage.

Ethamsylate may also have an effect on the microcirculation, encouraging platelet aggregation and vasoconstriction and hence haemostasis. It also inhibits the effects of the prostaglandin-mediated vasodilatation and increased capillary permeability, hence reducing oedema through capillary leakage.<sup>8,9</sup>

The other oral drugs which can be used for bloodless field are alpha agonists and B blockers, NTG, sodium nitroprusside and magnesium sulphate, opioids like remifentanyl. Some disadvantages have been reported of these techniques including delayed recovery from inhaled anaesthetics, resistance to vasodilators and cyanide toxicity for nitroprusside.

### Role Oral and Intravenous of Beta Blocker

Atenolol is a selective B1 blocker vasoconstriction of the mucous membrane arterioles and pre-capillary sphincters results from unopposed alpha-adrenergic effects of the endogenous catecholamines and the increased sympathetic tone.<sup>7</sup>

Oral bisoprolol has been used.<sup>10,11</sup>

Esmolol can be given as intravenously 500 mg/kg/min as a bolus over 10 minutes after induction followed by infusion at the rate of 100 - 300 mg/kg/min.<sup>12</sup>

Esmolol is found to be superior as compared to other hypotensive agents.

### Role of Local, Oral and Intravenous Alpha-2 Agonists

The role of oral clonidine is desirable to enhance the hypotensive action of inhalational agents without disadvantages of intravenous vasodilators.<sup>13</sup>

Clonidine is centrally acting selective partial alpha-2 adrenergic agonist. Clonidine stimulates alpha-2 adrenergic inhibitory neurons in medullary vasomotor centre resulting in decrease in sympathetic outflow from CNS to peripheral tissue resulting in decreased blood pressure, heart rate, cardiac output and results in peripheral vasodilation.

Dexmedetomidine<sup>14,15,16</sup> is being used in the loading dose 1 mg/kg 20 minutes before induction of anaesthesia. The alpha-2 receptors are involved in regulating the autonomic and cardiovascular systems. Alpha-2 receptors are located on blood vessels where they mediate vasoconstriction on stimulation and in the brain act on sympathetic terminals where they inhibit norepinephrine release.

Use of dexmedetomidine in providing better surgical field and less blood loss during controlled hypotension was reported during tympanoplasty, septoplasty and maxillofacial surgeries.<sup>16</sup>

Advantage of dexmedetomidine is that it has inherent analgesic, sedative and anaesthetic sparing properties, which avoid administration of multiple drugs and their side effects.

The effect of total intravenous anaesthesia using propofol has been compared with inhalational anaesthesia using sevoflurane.<sup>17</sup>

### Role of Magnesium

It can be given as 10% Solution, 40 gm/kg bolus over a period of 10 minutes before the induction of anaesthesia followed by 15 - 30 mg/kg/hr as infusion to achieve MAP of 55 - 65 mmHg.<sup>14</sup>

Magnesium limits the outflow of calcium from sarcoplasmic reticulum and produces a vasodilating effect by increasing the synthesis of prostacyclin and inhibiting angiotensin-converting enzyme activity. It also reduces the need for analgesic and sedative drugs, as it is an NMDA receptor antagonist.<sup>18</sup>

### Role of Vasodilators

Glyceryl trinitrate 2-10 mg/kg/hr. biotransformation pathway produces nitric oxide and contributes directly to its vasodilating effect with H<sub>2</sub> of 0.1 sec.<sup>12,20</sup>

Activation of fibrinolysis during and after surgery is a well-known phenomenon. Many mechanisms associated with coagulation disorders such as surgical trauma, blood loss and consumption of coagulation factors and platelets; systemic infusion of anti-fibrinolytic drugs have been used to reduce bleeding in various forms of surgery such as major orthopaedic surgery, adeno-tonsillectomy and endoscopic sinus surgery.<sup>16</sup>

### Antifibrinolytics

Intravenous tranexamic acid has been shown to be very useful in reducing blood loss in coronary artery bypass, spinal surgery, scoliosis, maxillofacial surgery, orthotopic liver transplant and total hip or knee arthroplasty.<sup>21,22</sup>

Tranexamic acid has been used in tonsillectomy surgery in dose of 15 mg/kg. It has also been used for control of blood loss for FESS in children.<sup>19,20</sup> Tranexamic acid also has been used topically for control of bleeding in FESS.<sup>23</sup>

Ethamsylate is haemostatic drug used for control of dysfunctional uterine bleeding<sup>8,9</sup> and periventricular haemorrhage in children.<sup>24</sup> Oral route has been used to control bleeding in dacryocystorhinostomy surgery and for control of epistaxis.<sup>25</sup>

Assessment of surgical field for bleeding will be according to category scale adapted from Fromme et al.<sup>10</sup> According to this scale, category scale values of 2 and 3 for the surgical field are considered as ideal.

### Grade

- 0- No bleeding, cadaveric condition.
- I- Slight bleeding, no suctioning of blood required.
- II- Slight bleeding, occasional suctioning required, surgical field not threatened.
- III- Slight bleeding; frequent suctioning required. Bleeding threatened surgical field a few seconds after suction removed.
- IV- Moderate bleeding, frequent suctioning required. Bleeding threatened surgical field.

The target Mean Arterial Pressure (MAP) between 55 and 65 mmHg can be decided after revising previous studies, in which metabolic and hormonal responses were investigated in patients who were subjected to induced hypotension in an attempt to provide bloodless surgical field without hazard of tissue ischaemia.<sup>24</sup>

Patient positioning: Reverse Trendelenburg is a common surgical position. Head elevation reduces mean arterial pressure in the elevated part by about 2 mmHg for each 2.5 cm above the cardiac level. This position reduces venous return from lower extremities, thereby reducing total blood loss.

Use of endotracheal intubation with mechanical ventilation has added advantage over the use of supraglottic airway devices. Ventilation with normocapnia has been advocated to minimise bleeding and optimising the surgical field.

Recent studies have demonstrated that high frequency jet ventilation reduces bleeding, but is not practical.<sup>1</sup>

### Medications for Controlled Hypotension

Inhalation anaesthetics VIMA: It decreases arterial blood pressure through peripheral vasodilatation due to blockage of alpha-adrenoceptors.

Total intravenous anaesthesia TIVA: Propofol and opioids.

Propofol poses risk of propofol infusion syndrome characterised by metabolic acidosis and circulatory collapse. Opioids are often used as adjunct of TIVA or VIMA. Antihypertensive agents to maintain MAP at 65 - 70 mmHg to avoid organ hypoperfusion.

### Surgical Considerations

Topical vasoconstrictors: Aim is to decongest the nasal cavity. E.g. Cocaine, epinephrine, phenylephrine, oxymetazoline. These drugs are not free from side effects. Haemostatic biomaterial application can be done topically.

Topical anti-fibrinolytics: Mechanism of action is to bind with the lysine site of plasminogen, which prevents fibrinolysis and stabilises the blood clot thus decreasing further bleeding.<sup>23,25</sup>

Gelatin thrombin matrix: It stops bleeding on an average of 2 minutes.<sup>26</sup> Some studies reported its adverse effect,<sup>27,28,29</sup> but one study evaluated its efficiency without complications.<sup>30</sup>

Others: Microporous polysaccharide hemispheres,<sup>31,32</sup> oxidised methylcellulose,<sup>33</sup> fibrin glue,<sup>34</sup> microfibrillar collagen<sup>35</sup> and gelatin sponges<sup>36</sup> can be used to control intraoperative bleeding. There is lack of scientific evidence comparing the efficacy of these agents.

### Surgical Techniques

Hot water irrigation with 40 - 42 degrees saline reduces diffuse oozing from sinonasal mucosa. Mechanism may include formation of oedema and narrowing of intranasal lumen which contributes to the compression of the leaking vessel, decreasing the flow, cleaning of blood coagulates from the nose.

Direct control of feeding vessels is another surgical technique.<sup>37,38</sup> It can be done with endoscopic bipolar electrocautery or radiofrequency coagulator.<sup>39,40</sup>

### Injected and Topical Local Anaesthetics and Vasoconstrictors

These can help to relieve postoperative pain, decrease blood loss, mucosal congestion. Commonly used vasoconstrictors are cocaine and phenylephrine.

Systemic absorption of these agents may cause hypertension tachycardia and other arrhythmias, hence should be continuously used in patients with CAD, CHF, malignant arrhythmias and those with MAOI.

The dose of phenylephrine should not exceed 0.5 mg in adults (4 drops of 0.25% solution) or 20 mg/kg in children up to 25 kg.

The topical application of epinephrine 1:100000 may effect same as injected epinephrine during FESS.

Body temperature: Maintenance of normothermia is vital for function of platelets and coagulation factors are essential for haemostasis.

Maintenance of anaesthesia depth: Manoeuvres like absence of PEEP will help preventing high intrathoracic pressure and will not impair venous drainage and hence will not increase surgical bleeding.<sup>1</sup>

Choice of anaesthetic agent: VIMA or TIVA can reduce arterial blood flow and glow through ethmoidal and supraorbital artery which supply ethmoid, sphenoid and ethmoid sinus.<sup>40</sup>

### CONCLUSION

Various strategies have been tried to minimise intraoperative bleeding and improve the endoscopic surgical field. Various surgical techniques and anaesthetic techniques enhance the ability of each other to control bleeding. Cooperation between surgeon and anaesthesiologist and proper utilisation of one or two techniques will help provide better surgical field in endoscopic sinus surgery.

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