ANESTHETIC MANIPULATIONS TO MINIMIZE BLEEDING AND IMPROVE OUTCOME OF FUNCTIONAL ENDOSCOPIC SINUS SURGERY

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Abstract

Objectives: The present study was designed as a trial to improve field visibility during functional endoscopic sinus surgery (FESS) by means of positional changes and the use of controlled hypotension achieved through maintenance of anesthesia using remifentanil and either of propofol infusion (Total Intravenous; TI) or isoflurane inhalation (Combined Intravenous/Inhalational; CII).

Patients & Methods: The study included 32 patients: 23 males and 9 females, with mean age of 39.2±8.4 years and assigned to undergo FESS. Patients were divided randomly into two equal groups according maintenance anesthetic regimen: Group TI and Group CII. Each group was subdivided according to patients’ position during surgery into supine and anti-Trendelenburg by 30°. Anesthesia was maintained in both groups by infusion of 0.5 µg/kg/min of remifentanil in addition to 10 µg/kg/min propofol infusion in Group TI or isoflurane 2% in Group CII. Patients were monitored non-invasively; before induction of anesthesia (T0) and 20 (T20), 40 (T40) and 60 min (T60) after induction of anesthesia, for mean arterial pressure (MAP) and heart rate (HR). The approach for FESS was conducted totally endonasal. The visibility of the operative field during FESS was evaluated using 6-points Fromme scale and total amount of bleeding as judged by the amount evacuated was also recorded.

Results: Both anesthetic modalities reduced blood pressure significantly and decreased heart rate throughout times of observation compared to preoperative levels with significantly lower MAP measures in anti-Trendelenburg compared to supine position. All surgeries were conducted completely without intraoperative complications and no extensive bleeding was recorded. There was a significant increase in the frequency
of good field visibility with TI compared to CII anesthesia with significantly improved field visibility in patients maintained in anti-Trendelenburg position compared to supine position. Estimated mean blood loss was significantly less and the recorded field visibility scores were significantly higher in TI group compared to CII group. There was a negative significant correlation between the field visibility score and mean MAP and mean amount of bleeding. Using regression analysis, the use of hypotensive anesthesia was found to be a significant independent factor for improving filed visibility, and the use of TI anesthesia was found to be significant determinant independent factor for induction of hypotensive anesthesia. The receiver operating characteristic (ROC) curve analysis judged by the area under the curve (AUC) defined the superiority of use of TI over CII anesthesia as independent determinant for field visibility.

**Conclusion:** It could be concluded that maintaining patients in anti-Trendelenburg position and anesthetic manipulation using total intravenous anesthesia could minimize bleeding and improve field visibility during FESS and thus this combination of manipulations could be appropriate strategy for such type of surgery.

**Introduction**

Functional endoscopic sinus surgery is a useful and widespread technique that allows the treatment of a large number of nasal pathologies aiming at maintaining physiological function and anatomical structure. The extent of the operation is adapted according to each case. It is focused on the osteomeatal complex in the middle meatus and the ethmoid cells. FESS enables re-establishing sinus drainage and mucosal recovery. (Eisenberg et al., 2008).

Chronic sinusitis not responding to medical treatment and nasal polyposis are two main classical indications for performing endoscopic sinus surgery. With FESS, the advantage of good illumination and clear vision with minimally invasive surgery, it is possible to achieve consistently good results, provided the surgery is done accurately and with care. (Bradley & Kountakis, 2005). Huang et al., (2006) reported that after endoscopic sinus surgery for chronic pediatric sinusitis, the antral mucosa recovered and muco-
Biliary clearance improved for both types of antral mucosa, with improved ventilation and drainage. Moretz & Kountakis, (2006) reported a significant decrease of the mean overall headache and sino-nasal outcomes test scores from 28.7 preoperatively to 6.7 postoperatively.

Intraoperative bleeding, which reduces visibility in the operative field, is one of the major problems of such interventions, (Eberhart et al., 2003). Complicated anatomic structure, its unique variations, vicinity of delicate cranial base, brain, eyes, blood vessels and nerves requires for the surgeon to know anatomy in detail and to precisely identify structures, thus abundant bleeding during surgeries undoubtedly is among the factors able to cause complications. Upon reduced visibility the time of intervention extends. Increased bleeding sometimes causes finishing surgeries before the due time, when targets raised at the beginning are given up in order to avoid possible complications, (Zeng et al., 2003). Improvement of intra-operative visibility while reducing bleeding is an important task for an anesthetist during a FESS. In the case of the expanded process, still more numerous interventions are performed with general anesthesia, (Cincikas & Ivaskevicius, 2003).

To improve the control of bleeding during FESS, induced hypotension was tried. The state of "hypotension" was achieved by reducing the peripheral blood vessel resistance, reducing the heart rate per minute and by inter-coordinating these two effects, (Jacobi et al., 2000). Most frequently peripheral vasodilators, beta-blockers, volatile anesthetics are used to cause induced hypotension, (Praveen et al., 2001).

The present study was designed as a trial to improve the control of bleeding during FESS by means of positional changes and the use of controlled hypotension achieved through maintenance of anesthesia using remifentanil and either of propofol infusion (Total Intravenous) or isoflurane inhalation (Combined Intravenous/Inhalational).
Patients and Methods

This prospective comparative study was conducted at Day-Surgery Unit, Al-Habib Medical Group, Riyadh, KSA and included 32 patients; aged 21-53 years and assigned to undergo FESS. After obtaining patients' fully informed written consents, they were divided randomly into two equal main groups (n=16) according maintenance anesthetic regimen used either total intravenous (Group T), or combined Intravenous/Inhalational (Group C). Each main group was further subdivided equally according to patient's position during surgery either supine or inclined by approximately 30° in anti-Trendelenburg. Patients with the cardiovascular pathology, heart failure, hypertension, as well as patients with bleeding diathesis and those administering aspirin or other medications affecting coagulation system and patients with kidney or liver dysfunctions, as well as anemia (Hb<10g/dl) were excluded off the study.

All patients were pre-medicated with midazolam (0.05 mg/kg), 2 min thereafter, anesthesia was introduced by a bolus of remifentanil (1 µg//kg), propofol (2 mg/kg) and rocuronium (0.5 mg/kg). Two minutes later, trachea was intubated and a posterior pharyngeal pack was placed to limit the risk of aspiration of blood and lungs were ventilated with 100% oxygen. Ventilatory parameters were adjusted so as to maintain end-tidal CO2 around 32 mmHg. Anesthesia was maintained in both groups by infusion of 0.5 µg/kg/min of remifentanil in addition to 10µg/kg/min propofol infusion in Group T group or isoflurane 2% in Group C. Propofol infusion rate and MAC of isoflurane were adapted according to hemodynamic responses, in order to maintain MAP values in the range of 60-70 mmHg.

Immediately after tracheal intubation, all patients underwent packing of the nasal cavity with adrenaline soaked pledgets (1:100,000) to obtain maximum vasoconstriction of the mucosa and thus better visualization of the main features of the cavity. Prior to insertion in the cavity, liquid is removed from the pledgets and then, under endoscopic guidance, carefully applied on the mu-
cosa. The middle meatus, hiatus semilunaris and the sphenethmoidal recess were packed as possible with cotton pads which were introduced using small auricular forceps, and after 5 minutes, the pledgets were removed. Xylocaine 1% with adrenaline (1:100,000), 1-1.5 ml, was injected under the mucosa of the uncinate process, at the level of the head of the middle turbinate and the inferior part of the bulla. Local anesthetic was given at the point of insertion of the middle turbinate, so as to block the vessels and the nerve fibers which come from the artery and the anterior ethmoidal nerve.

Patients were monitored non-invasively: before induction of anesthesia (T0) and 20 (T20), 40 (T40) and 60 min (T60) after induction of anesthesia, for systolic arterial pressure (SAP), diastolic arterial pressure (DAP) and MAP; HR, SPO2 and Et CO2.

The approach for FESS was conducted totally endonasal. The maxillary ostium was identified by locating the inferior posterior edge of the uncinate process. The unci-
Statistical analysis

Obtained data were presented as mean±SD, ranges, numbers and ratios. Data were analyzed using Wilcoxon Z-test for unrelated data and possible relationships were investigated using Pearson linear regression. Regression analysis (Enter Method) was used to define independent factors for providing proper field visibility and specificity of these factors were evaluated using the receiver operating characteristic (ROC) curve analysis judged by the area under the curve (AUC). Statistical analysis was conducted using the SPSS (Version 10, 2002) for Windows statistical package. P value <0.05 was considered statistically significant.

Results

The study included 32 patients; 23 males and 9 females with mean age of 39.2±8.4; range: 21-53 years. According to American Society of Anesthesiologists (ASA), there were 25 ASA grade I and 7 ASA grade II. Sixteen patients underwent anterior ethmoidectomy (resection of the uncinate process and opening of the bulla) and/or middle hiatal antrostomy; 9 patients underwent anterior and posterior ethmoidectomy with opening of the middle lamina of the turbinate and/or sphenoidotomy and 7 patients underwent anterior ethmoidectomy, opening of the middle lamina of the turbinate and/or opening of the frontal recess. There was a non-significant difference between patients enrolled in both groups as regards age, sex, ASA grade distribution or procedure performed. (Table 1).

Both anesthetic modalities reduced blood pressure significantly (p<0.05) at the three times of measurements compared to pressure levels determined preoperatively. Moreover, blood pressure parameters showed progressive significant (p<0.05) decrease at T40 and T60 compared to measurements determined at T20 in both groups with non-significantly lower pressure measures with propofol compared to isoflurane. (Fig. 1). Mean HR showed progressive significant (p<0.05) decrease in both groups compared to their preoperative rates with a non-significant difference between mean HR reported in both groups. (Table 2, Fig. 2). However, irrespective of
anesthetic modality used, anti-Trendelenburg position induced a significantly lower (Z=2.484, p=0.013) mean arterial pressure compared to those maintained in supine position, (Fig.3).

All surgeries were conducted completely without intraoperative complications. No extensive bleeding was recorded and no patient had visibility score of 0 and only 3 patients in group CII (20%) had visibility score of 1, 7 patients; 2 in TI (12.5%) and 5 in CII group (31.2%) had visibility score of 2. Fourteen patients; 8 in TI (50%) and 6 in CII group (37.5%) had visibility score of 3 and 8 patients; 6 in TI (37.5%) and 2 in CII (12.5%) had visibility score of 4. There was a significant increase ($\chi^2=5.544, p<0.05$) in the frequency of good field visibility with TI compared to CII anesthesia, (Fig. 4). Moreover, Patient's position during surgery significantly influenced surgical field visibility. Patient's positioning in anti-Trendelenburg position significantly ($\chi^2=9.164, p<0.01$) improved field visibility compared to supine position, (Table 3, Fig. 5).

Mean blood loss estimated in patients received TI anesthesia was 157.3±44.9; range 105-270 ml and was significantly (Z=3.184, p=0.001) less compared to those received CII anesthesia: 239±49.5; range: 135-355 ml, (Fig. 6). Moreover, recorded field visibility score was 3.33±0.6; range 2-4 in TI group and was significantly higher (Z=2.266, p=0.023) compared to score recorded in patients received CII group; 2.47±0.99; range 1-4, (Table 4, Fig. 7).

There was a negative significant correlation between the field visibility score and mean MAP, ($r=-0.486, p=0.006$) and mean amount of bleeding, ($r=-0.366, p=0.047$), (Fig. 8). Using regression analysis to determine the independent factor for improving the field visibility, the use of hypotensive anesthesia was found to be a significant independent factor for improving filed visibility ($\beta=0.370, t=2.222, p=0.035$), and the use of TI anesthesia was found to be significant determinant independent factor for induction of hypotensive anesthesia, ($\beta=0.242, t=2.500, p=0.015$). Using ROC curve to define the specific inde-
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dependent factor defined the superiority of use of total intravenous anesthesia over combined intravenous / inhalational anesthesia as independent determinant for field visibility, (AUC=0.778 vs 0.630, respectively). (Fig. 9).

Table (1): Patients' distribution in both studied groups according to patients' character and procedure performed

<table>
<thead>
<tr>
<th>Procedure performed</th>
<th>Group TI (n=16)</th>
<th>Group CII (n=16)</th>
<th>Total (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>38.3±8.8</td>
<td>40.2±8.8</td>
<td>39.2±8.4</td>
</tr>
<tr>
<td></td>
<td>(21-53)</td>
<td>(23-51)</td>
<td>(21-53)</td>
</tr>
<tr>
<td>Sex; M:F</td>
<td>12:4</td>
<td>11:5</td>
<td>23:9</td>
</tr>
<tr>
<td>ASA grade I:II</td>
<td>13:3</td>
<td>13:3</td>
<td>26:6</td>
</tr>
<tr>
<td>Anterior ethmoidectomy</td>
<td>7</td>
<td>9</td>
<td>16 (50%)</td>
</tr>
<tr>
<td>Ant &amp; Post ethmoidectomy</td>
<td>5</td>
<td>4</td>
<td>9 (28.1%)</td>
</tr>
<tr>
<td>Ant ethmoidectomy, opening of middle lamina of turbinates &amp; frontal recess</td>
<td>4</td>
<td>3</td>
<td>7 (21.9%)</td>
</tr>
</tbody>
</table>

Data are presented as mean±SD, numbers & ratios, ranges & percentages in parenthesis.

Table (2): Mean blood pressure and heart rate changes reported in both groups at T20, T40 and T60 after induction of anesthesia in comparison to preoperative measures

<table>
<thead>
<tr>
<th>Group TI (n=16)</th>
<th>Group CII (n=16)</th>
<th>Total (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>121.8±9.6</td>
<td>92.8±6.9</td>
</tr>
<tr>
<td>T20</td>
<td>83.2±6.2*</td>
<td>66.7±5.5*</td>
</tr>
<tr>
<td>T40</td>
<td>76.7±7.6†</td>
<td>64.3±4.3†</td>
</tr>
<tr>
<td>T60</td>
<td>79.4±7 i†</td>
<td>61.1±4.6†</td>
</tr>
</tbody>
</table>

Data are presented as mean±SD; *: significant versus T0; †: significant versus T20

Table (3): Patients' distribution according to the field visibility score reported in both groups categorized according to anesthetic modality and position during surgery

<table>
<thead>
<tr>
<th>Visibility score</th>
<th>Anesthetic Modality</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group TI (n=16)</td>
<td>Group CII (n=16)</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2 (12.5%)</td>
<td>5 (31.2%)</td>
</tr>
<tr>
<td>3</td>
<td>8 (50%)</td>
<td>6 (37.5%)</td>
</tr>
<tr>
<td>4</td>
<td>6 (37.5%)</td>
<td>2 (12.5%)</td>
</tr>
</tbody>
</table>

Table (4): Mean collective amount of bleeding and field visibility score reported at 60 minutes after induction of anesthesia in both groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Amount (ml)</th>
<th>Visibility score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group TI (n=16)</td>
<td>157.3±44.9 (105-270)</td>
<td>3.3±0.6 (2.4)</td>
</tr>
<tr>
<td>Group CII (n=16)</td>
<td>239±49.5 (135-355)</td>
<td>2.47±0.99 (1.4)</td>
</tr>
<tr>
<td>Z</td>
<td>3.184</td>
<td>2.266</td>
</tr>
<tr>
<td>P</td>
<td>=0.001</td>
<td>=0.023</td>
</tr>
</tbody>
</table>

Data are presented as mean±SD; ranges in parenthesis.
Fig. (1): Time-course changes of mean MAP reported in both groups

Fig. (2): Mean MAP measured throughout the operative time in patients categorized according to position during surgery

Fig. (3): Patients' distribution according to reported field visibility score

Fig. (4): Field visibility score in patients categorized according to position during surgery

Fig. (5): Mean (±SD) of amount of intraoperative bleeding
Fig. (8): Correlation between field visibility and mean MAP and mean amount of intraoperative bleeding reported in studied patients

Fig. (9): ROC curve analysis of mode of anesthetic maintenance as a specific independent predictor for improving field visibility
Discussion

FESS is most successful in patients who have recurrent acute or chronic infective sinusitis. Patients in whom the predominant symptoms are facial pain and nasal blockage usually respond well. The sense of smell often improves after this type of surgery. In patients with nasal polyps that is not controlled with topical corticosteroids, FESS permits the accurate removal of polyps, (Bugten et al., 2008).

A number of previous studies have tried to assess the effects of various hypotension-inducing drugs on the surgical field during FESS to minimize bleeding so as to improve the operative field visibility in FESS. (Nair et al., 2004). The present study was designed as a trial to improve the control of bleeding during FESS by means of positional changes and the use of controlled hypotension achieved through maintenance of anesthesia using remifentanil and either of propofol infusion or isoflurane inhalation.

Both anesthetic modalities significantly reduced blood pressure and heart rate measures throughout observation period compared to preoperative measures with progressive significant decrease at $T_{40}$ and $T_{60}$ compared to measures determined at $T_{20}$ in both groups, but with non-significant difference between both groups. These results agreed with Tirelli et al., (2004) who reported progressive reduction of blood pressure with both TIVA and inhalational anesthesia during endoscopic sinus nasal surgery and with Rathjen et al., (2006) who reported that TIVA allows the reduction of the mean arterial blood pressure to 60 mmHg and concluded that for general anesthesia in endonasal sinus surgery sodium nitroprusside is no longer recommended and instead a TIVA using propofol and remifentanil should be used.

The reported significant hypotension showed non-significant difference between both groups and this could be attributed to the maintenance of anesthesia using remifentanil infusion. In support of this explanation, Manola et al., (2005) compared three types of general anesthesia for FESS with controlled hypotension and report-
ed proper blood pressure adjustment using either TIVA or inhalational anesthesia with a significant difference in favor of remifentanil / propofol compared to either of sufentanil / sevoflurane or fentanyl / isoflurane.

Noseir et al., (2003) tried to explore the possible mechanisms of hypotension during the administration of remifentanil in young ASA I volunteers and reported direct effects of remifentanil on regional vascular tone that may play a role in promoting hypotension. Also, Jones, (2003) concluded that reductions in sympathetic outflow with remifentanil would implicate central effects of this anesthetic on sympathetic control.

Mean blood loss estimated in patients received TI anesthesia was significantly less with significantly higher field visibility score in TI group compared to CII group. These results agreed with Tirelli et al., (2004) and Sun et al., (2003); both studies reported that the mean estimated blood loss for patients received TIVA was significantly reduced compared to those received inhalational anesthesia with significantly improved quality of visibility of the surgical field and concluded that TIVA is effective in reducing bleeding during FESS.

The obtained results support that obtained by Sivaci et al., (2004) who found general anesthesia based on propofol infusion have the advantage of significantly decreased bleeding compared with conventional inhalation agents and therefore, making endoscopic surgery technically easier and safer by improving endoscopic visualization of the surgical field and with Manola et al., (2005) and Wormald et al., (2005) who reported significant reduction of bleeding and higher field visibility with propofol and remifentanil infusion as opposed to inhalation anesthesia using sevoflurane.

Statistical analysis to define if these effects could be attributed to induced decreased MAP or to the use of TI anesthesia showed that TI anesthesia was found to be a significant independent factor for determination of field visibility and showed wider area under ROC curve as specific determi-
nant. These findings could be attributed to the fact that in clinically relevant concentrations propofol did not influence the surface expression density of fibrinogen receptors, P-selectin molecules, and the percentage of leukocyte-platelet aggregates ex vivo; thus did not allow interruption of either of platelet or coagulation functions, (Scheinichen et al., 2002). Also, Dordoni et al., (2004) reported that propofol, in comparison to other anesthetics, had no effect on platelet function both ex vivo and in vitro and propofol might be considered hemostatically safer.

As an explanation for the effect of propofol on platelet function, Fourcade et al., (2004) experimentally reported that propofol does not significantly alter intracellular calcium increases caused by receptor activation and its inhibition of platelet aggregation appears to act distal to platelet receptors, inositol phosphate 3, and phospholipase C.

The obtained results and the previous experimental studied concerning effect of propofol on platelet function were contradicto-

ry to that reported by Beule et al., (2007) who compared the effect of propofol versus sevoflurane anesthesia on bleeding and field visibility during FESS and reported that total blood loss, blood loss per minute, and endoscopic vision showed no group difference and platelet function was significantly impaired 45 minutes after onset of surgery in both groups, but more pronounced after propofol anesthesia. On contrary to Beule et al., (2007) and in support of the results of the current study, Ahn et al., (2008) reported that in the high-Lund-Mackay score patients, propofol/remifentanil anesthesia results in less blood loss and a better surgical conditions for FESS than sevoflurane/remifentanil anesthesia.

Furthermore, patients' position during surgery showed additional impact on the reported beneficial effects of hypotensive anesthesia, irrespective of the type of anesthetic used manifested as significantly decreased MAP in patients maintained in anti-Trendelenburg position with significantly improved field visibility in comparison to those maintained in supine
position during surgery. These findings go in hand with Ko et al., (2008) who evaluated the factors related to the volume of intraoperative blood loss during endoscopic sinus surgery and reported that reverse Trendelenburg position may reduce intraoperative blood loss.

It could be concluded that maintaining patients in anti-Trendelenburg position and anesthetic manipulation using total intravenous anesthesia could minimize bleeding and improve field visibility during FESS and thus this combination of manipulations could be appropriate strategy for such type of surgery.

References


Dordoni P. L., Frassanito L., Bruno M. F., Proietti R., de Cris-


