

Does tranexamic acid, deliberate hypotension, and anti-Trendelenburg position improve the quality and outcome for functional endoscopic sinus surgery

Ahmed H. Khafagy and Sameh M. Osman

Departments of Otolaryngology – HNS & Anaesthesia,
Ain Shams University Hospital, Cairo, Egypt

Correspondence to Ahmed H. Khafagy, FRCS,
Department of Otolaryngology – HNS, Ain Shams
University Hospital, 11371 Cairo, Egypt
Tel: +01063882323;
e-mail: ahmedkhafagy@yahoo.com

Received 3 September 2012

Accepted 27 November 2012

The Egyptian Journal of Otolaryngology
2013, 29:71–75

Objectives

To improve the control of bleeding during functional endoscopic sinus surgery (FESS) by means of positional changes, controlled hypotensive anesthesia, and an intraoperative (IO) intravenous injection of tranexamic acid.

Patients and methods

The study included 45 patients assigned to undergo FESS. Patients were divided randomly into three equal groups: group A received an IO injection of tranexamic acid 10 mg/kg as a bolus injection after induction of anesthesia. Group B included patients placed on a table inclined by $\sim 30^\circ$ in the anti-Trendelenburg position and received an IO injection of tranexamic acid 10 mg/kg after induction of anesthesia. Group C included patients maintained supine who did not receive an IO injection of tranexamic acid. All patients received a maintenance anesthetic regimen that used combined intravenous/inhalational anesthesia. Operative field visibility was evaluated using the Fromme scale. The total amount of bleeding as judged by the amount evacuated was recorded.

Results

The anesthetic maneuver used reduced blood pressure and heart rate significantly at the end of surgery compared with the measures estimated at the time of induction of anesthesia. Groups A and C showed significantly higher blood pressure and heart rate estimated at the end of surgery compared with group B. All surgeries were conducted completely without IO complications. No extensive bleeding was recorded and no patient had a visibility score of 0 or 5. Four patients had a visibility score of 1, nine patients had a visibility score of 2, 15 patients had a visibility score of 3, and 17 patients had a visibility score of 4. The frequency of patients who had higher field visibility was significantly higher in group B compared with groups A and C, with a significantly higher frequency in group A compared with group C. Manipulations applied for group B significantly reduced the amount of IO bleeding, with a subsequent significant improvement in the mean field visibility score compared with groups A and C. Tranexamic acid significantly reduced the amount of bleeding and improved field visibility in group A compared with group C.

Conclusion

A combination of maintaining patients in the anti-Trendelenburg position, anesthetic manipulation using combined intravenous and inhalational anesthesia, and an IO intravenous injection of tranexamic acid could minimize bleeding and improve field visibility during FESS and this combination of manipulations could be recommended as strategy for this type of surgery.

Keywords:

bleeding, field visibility, functional endoscopic sinus surgery, hypotensive anesthesia, positioning, tranexamic acid

Egypt J Otolaryngol 29:71–75
© 2013 The Egyptian Oto - Rhino - Laryngological Society
1012-5574

Introduction

Functional endoscopic sinus surgery (FESS) 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 aeration, mucosal recovery, and sinus drainage [1].

Chronic sinusitis not responding to medical treatment and nasal polyposis are two classical indications for performing endoscopic sinus surgery. With FESS, which has the advantage of good illumination and clear vision

with a minimally invasive surgery, it is possible to achieve consistently good results, provided the surgery is performed accurately and with care [2]. Huang *et al.* [3] have reported that after endoscopic sinus surgery for chronic pediatric sinusitis, the antral mucosa recovered and mucociliary clearance improved, with improved ventilation and drainage.

Intraoperative bleeding, which reduces visibility in the operative field, is one of the major problems of such interventions. The complicated anatomy, its unique variations, and the proximity of the cranial base, brain, eyes, blood vessels, and nerves require the surgeon to know the anatomy in detail and to identify structures precisely; thus, excessive bleeding during surgery is undoubtedly one of the factors that can lead to complications. With reduced visibility, the time of intervention increases. Excessive bleeding might lead to abandoning surgery. Improvement of intraoperative visibility while reducing bleeding is an important task for an anesthetist during FESS [4-6].

The current study was designed as a trial to improve the control of bleeding during FESS by means of positional changes, the use of controlled hypotension achieved through maintenance of anesthesia using combined intravenous (i.v.)/inhalational, and an intraoperative i.v. injection of tranexamic acid.

Patients and methods

This prospective comparative study included 45 patients, aged 21–53 years, and assigned to undergo FESS, in the period between January 2002 and December 2003. After approval of the study protocol by the Local Ethical Committee and obtaining patients' fully informed written consents, patients were randomly divided, using sealed envelopes, into three equal groups ($n = 15$): group A received an intraoperative injection of tranexamic acid (Cyklocapron, 100 mg/ml, 5 ml ampule; Pfizer) 10 mg/kg as a bolus injection after induction of anesthesia. Group B included patients placed on a table inclined by $\sim 30^\circ$ in the anti-Trendelenburg position and received an intraoperative injection of tranexamic acid (Cyklocapron) 10 mg/kg as a bolus injection after induction of anesthesia. Group C included patients maintained supine and did not receive an intraoperative injection of tranexamic acid. All patients received a maintenance anesthetic regimen using combined i.v./inhalational anesthesia.

Patients with the cardiovascular pathology, heart failure, hypertension, as well as patients with bleeding diathesis and those taking aspirin or other medications affecting coagulation and patients with kidney or liver dysfunction, as well as anemia ($Hb < 10$ g/dl) were excluded from the study. The study patients were kept fasting as per the standard guidelines and were premedicated with oral midazolam 7.5 mg tablet 1 h before the induction of anesthesia. Upon arrival to the operating theater, an i.v. line was established and i.v. fluids were started using Ringer's solution. All patients were monitored with

noninvasive blood pressure for systolic, diastolic, and mean (MAP) arterial blood pressure, ECG for heart rate (HR), capnography for EtCO₂, and pulse oximetry for oxygen saturation (SpO₂), and a nerve stimulator for neuromuscular blockade monitoring. Anesthesia was induced using i.v. propofol (propofol – Lipro 1%; B. Braun Melsungen AG. D-34209, Melsungen, Germany), 2.5 mg/kg, remifentanyl (Ultiva; GlaxoSmithKline Manufacturing, S.P.A, Parma, Italy), 0.5 μ g/kg, as a bolus dose over 30 s, followed by an infusion of 0.05–2 μ g/kg/min using a syringe pump (JMS, SP 500; JMS Co., Ltd, Japan) and cisatracurium (Nimbex; GalaxoWellcome, S.P.A, Parma, Italy; 10 mg/5 ml ampule), 0.15 mg/kg. All patients were intubated with a cuffed endotracheal tube and oropharyngeal packing with wet gauze, which was removed at the end of surgery. The anesthesia was maintained with 40% O₂ and 60% N₂O, 2% sevoflurane, and cisatracurium 0.03 mg/kg. Patients were mechanically ventilated for an end-tidal CO₂ concentration of 32–35 mmHg and to insure SpO₂ 97%. MAP values less than 60 mmHg were easily corrected by reducing the sevoflurane concentration and/or increasing fluid administration or decreasing the remifentanyl infusion rate. Before the end of surgery by 15 min, all patients received intramuscular meperidine (Pethidine) 1 mg/kg. All anesthetics were stopped at the end of surgery and atropine 20 μ g/kg with neostigmine 40 μ g/kg were administered in one syringe to reverse the muscle relaxant, after which patients were awakened and transferred to the recovery room. Collectively, blood pressure measures and HR were determined at the end of surgery (T_E) and were compared versus these measures determined at the time of induction of anesthesia (T_I).

Immediately after tracheal intubation, all patients underwent packing of the 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. Before insertion into the cavity, the pledgets were gently squeezed and then, under endoscopic guidance, applied carefully on the mucosa. The middle meatus, hiatus semilunaris, and the sphenoethmoidal recess were packed with cotton pads that were introduced using small auricular forceps, and after 10 min, 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. A local anesthetic was administered at the point of insertion of the middle turbinate to block the vessels and the nerve fibers that come from the artery and the anterior ethmoidal nerve.

The approach for FESS was carried out after Kennedy [7]. Complete removal of the uncinate process yielded good exposure of the maxillary sinus ostium. Then, suction of any retained secretions was performed and the 0 and 30° endoscopes were used to remove thickened mucosa, polyps, and/or cysts.

The visibility of the operative field during FESS was evaluated using the Fromme *et al.* [8] scale adapted by

Boezaart *et al.* [9]: 5 = no bleeding, 4 = slight bleeding and blood evacuation not necessary, 3 = slight bleeding and sometimes blood has to be evacuated, 2 = low bleeding, blood has to be often evacuated and the operative field is visible for some seconds after evacuation, 1 = average bleeding, blood has to be evacuated often and the operative field is visible only right after evacuation, and 0 = high bleeding and constant blood evacuation is needed, but sometimes bleeding exceeds evacuation and surgery is hardly possible at all or impossible. The total amount of bleeding as judged by the amount evacuated was also recorded.

Statistical analysis

The data obtained were presented as mean \pm SD, ranges, numbers, and ratios. Data were analyzed using the Wilcoxon Z-test for unrelated data. Statistical analysis was carried out using the SPSS (Version 15, Chicago, USA) for Windows statistical package. A *P* value less than 0.05 was considered statistically significant.

Results

The study included 45 patients, 34 men and 11 women, mean age 39.2 ± 8.4 , range 21–53 years. According to the American Society of Anesthesiologists (ASA), there were 37 ASA grade I and eight ASA grade II. Twenty-nine patients underwent anterior ethmoidectomy (resection of the uncinate process and opening of the bulla) and/or middle meatal antrostomy; nine patients underwent anterior and posterior ethmoidectomy and/or sphenoidotomy and seven patients underwent posterior ethmoidectomy and/or opening of the frontal recess. There was a nonsignificant difference between patients enrolled in studied groups in terms of age, sex, ASA grade distribution, or procedure performed (Table 1).

The anesthetic maneuver applied significantly reduced blood pressure and HR at the end of surgery compared with measures estimated at the time of induction of anesthesia. Both groups A and C showed significantly ($P < 0.05$) higher blood pressure and HR estimated at the end of surgery compared with that recorded in group B, with a nonsignificant difference between groups A and C (Table 2).

All surgeries were performed completely without intraoperative complications. No extensive bleeding was recorded and no patient had a visibility score of 0 or 5. Only four patients (8.9%) had a visibility score of 1, nine patients (20%) had a visibility score of 2, 15 patients (33.3%) had a visibility score of 3, and 17 patients had a visibility score of 4. The frequency of patients who had higher field visibility was significantly higher in group B compared with group A ($\chi^2 = 3.174$, $P < 0.05$) and group C ($\chi^2 = 17.102$, $P < 0.01$), with a significantly higher frequency of higher field visibility scores in group A compared with group C ($\chi^2 = 5.635$, $P < 0.05$), (Table 3).

Manipulations applied for group B significantly reduced the amount of intraoperative bleeding, with a subsequent

significant improvement in the mean field visibility score compared with groups A and C. Moreover, the intraoperative administration of tranexamic acid for the patients in group A significantly reduced the amount of field bleeding and improved field visibility compared with that in group C (Table 4).

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 polyposis that is not controlled with topical corticosteroids, FESS allows the accurate removal of polyps [1,10].

For reduction of mucosal congestion, all patients underwent packing of the nose with adrenaline-soaked pledgets (1:100 000) to obtain maximum vasoconstriction of the mucosa and xylocaine 1% with adrenaline (1:100 000), 1–1.5 ml, was injected under the mucosa of the uncinate process. In support of this policy, Cohen-Kerem *et al.* [11] found that the injection of an epinephrine/lidocaine mixture during FESS did not produce higher blood levels of epinephrine compared with saline injection and did not induce any harmful side effects.

For all the patients studied, the anesthetic procedure using hypotensive anesthesia with combined i.v. and inhalational anesthesia led to a significant reduction in hemodynamic parameters compared with their baseline level. Induced hypotension reduced venous congestion, thereby reducing the amount of bleeding and thus improving field visibility. These data are in agreement with those of Sieškievicz *et al.* [12], who reported that during FESS, the best operative conditions were achieved in patients with the lowest MAP and HR, and there was a significant and strong correlation between the operative field conditions and MAP.

Dequate *et al.* [13] found that remifentanyl combined with propofol enabled controlled hypotension, reduced middle ear blood flow, and provided good surgical conditions for tympanoplasty with no need for additional use of a potent hypotensive agent. The current study reported a significant reduction in the amount of bleeding and improved field visibility when patients were maintained in the anti-Trendelenburg position and received an intraoperative i.v. injection of tranexamic acid compared with those who received tranexamic acid alone or did not receive any manipulations. These data indicated the beneficial effect of head-tilt position on the extent of bleeding and could be attributed to decreased venous congestion and minimized arterial supply of the head and neck region, an effect that is maximized using hypotensive anesthesia. In support of this explanation, patients in the head-up position had significantly lower blood pressure measures and HR

Table 1 Patients' distribution in both groups studied according to patients' characteristics and procedure performed

	Group A (n=15)	Group B (n=15)	Group C (n=15)
Age (years)	38.3 ± 8.8 (21–53)	40.2 ± 8 (23–51)	39.2 ± 8.4 (21–53)
Sex (male : female)	12 : 3	11 : 4	11 : 4
ASA grade I : II	12 : 3	12 : 3	13 : 2
Procedure performed [n (%)]			
Anterior ethmoidectomy	10 (66.7)	10 (66.7)	9 (60.1)
Anterior and posterior ethmoidectomy	3 (20)	2 (13.3)	4 (26.6)
Anterior ethmoidectomy, posterior ethmoidectomy and frontal recess	2 (13.3)	3 (20)	2 (13.3)

Data are presented as mean ± SD, numbers and ratios; ranges and percentages are in parentheses. ASA, American Society of Anesthesiologists.

Table 2 Mean blood pressure and heart rate changes reported in the groups studied at the end of surgery compared with measures determined at the time of induction of anesthesia

	SAP (mmHg)	DAP (mmHg)	MAP (mmHg)	HR (beat/min)
Group A (n=15)				
T _I	121.8 ± 9.6	78.3 ± 5.9	92.8 ± 7.1	81.8 ± 2.9
T _E	84.2 ± 5.2 ^{a,b}	66.7 ± 3.5 ^{a,b}	72.5 ± 4.7	73.3 ± 4.5 ^{a,b}
Group B (n=15)				
T _I	116.7 ± 5.2	76.5 ± 5	89.9 ± 5.1	82.8 ± 3
T _E	79.4 ± 3.6 ^a	63.1 ± 2.6 ^a	68.5 ± 2.9	67.5 ± 3.3 ^a
Group C (n=16)				
T _I	118.6 ± 5.6	77.7 ± 4.3	91.3 ± 4.7	78.6 ± 4.7
T _E	83.1 ± 4.1 ^{a,b}	65.1 ± 2.9 ^{a,b}	71.1 ± 3.3	70.6 ± 3.9 ^{a,b}

Data are presented as mean ± SD.

DAP, diastolic arterial blood pressure; HR, heart rate; MAP, mean arterial blood pressure; SAP, systolic arterial blood pressure.

^aSignificant vs. T_I.

^bSignificant vs. group B.

Table 3 Patients' distribution according to the field visibility score reported in the groups studied

	N (%)			
	Group A (n=15)	Group B (n=15)	Group C (n=15)	Total (n=45)
1	1 (6.7)	0 (0)	3 (20)	4 (8.9)
2	3 (20)	2 (13.3)	4 (26.7)	9 (20)
3	5 (33.3)	5 (33.3)	5 (33.3)	15 (33.3)
4	6 (40)	8 (53.4)	3 (20)	17 (37.8)

Data are presented as numbers and percentages, and are in parenthesis.

compared with other patients managed in the supine position. In agreement with these findings, Ko *et al.* [14] evaluated the factors related to the volume of intraoperative blood loss during endoscopic sinus surgery and reported that the reverse Trendelenburg position may reduce intraoperative blood loss. In agreement with the beneficial effects of patient positioning, Moumoulidis *et al.* [15] reported that the Trendelenburg position is considerably superior to the Valsalva maneuver in identifying bleeding vessels at hemostasis and it has become a common practice to place patients in the Trendelenburg tilt position routinely to check the adequacy of hemostasis without any intracranial complications using a tilt angle of 30°.

An intraoperative injection of tranexamic acid significantly reduced the amount of intraoperative bleeding and improved field visibility compared with that in patients who did not receive tranexamic acid. These beneficial

effects of tranexamic acid are in agreement with the results of multiple studies that have evaluated its effect for various forms of bleeding. Ipema and Tanzi [16] reviewed the literature on the intraoperative use of tranexamic acid that included a total of 16 publications in the setting of major surgical procedures and concluded that the use of tranexamic acid reduced postoperative blood loss, with a significant reduction in the number of packed red blood cell transfusions or units administered, ICU stay, or length of hospitalization. McConnell *et al.* [17] found that the use of tranexamic acid at induction or intraoperatively reduced blood loss compared with that of the control group undergoing hip arthroplasty. Greiff *et al.* [18] reported that tranexamic acid reduced the number of packed red cell transfusions administered to patients 70 years or older undergoing combined aortic valve replacement and CABG surgery.

In terms of otorhinolaryngological surgeries, George *et al.* [19] reported that tranexamic acid at a dose of 10 mg/kg administered i.v. preoperatively was effective in the control of tonsillectomy bleeding. Alimian and Mohseni [20] evaluated the effects of i.v. tranexamic acid on blood loss and surgical field quality during FESS and reported a significant reduction in blood loss, with a significantly lower bleeding score and significantly higher surgeon satisfaction with the surgical field in the tranexamic group than the placebo group, and concluded that i.v. tranexamic acid effectively reduces bleeding and improves the surgical field during FESS. Abrams [21] reported that the rate of secondary hemorrhage after oral and nasal interventions can be reduced considerably by tranexamic acid, which implies risk reduction and better compliance, especially in an increasingly aging patient population.

In agreement with the use of i.v. tranexamic acid as the effective route for administration, Choi *et al.* [22] reported that a preoperative i.v. bolus administration of tranexamic acid at 20 mg/kg reduces blood loss compared with placebo during bimaxillary osteotomy. Kaewpradub *et al.* [23] found that tranexamic acid in an irrigant fluid does not significantly decrease intraoperative blood loss compared with placebo during orthognathic surgery. Sankar *et al.* [24] have reported that preoperative and intraoperative administration of the antifibrinolytic agent, tranexamic acid, is effective in controlling blood loss and improving the quality of the surgical field for adolescent patients undergoing orthognathic surgery.

Table 4 Patients' distribution according to the field visibility score reported in the groups studied

	Group A (n=15)	Group B (n=15)	Group C (n=15)	Statistical analysis
Amount of bleeding (ml)	179 ± 25.5 (145–225)	139.7 ± 20.3 (105–180)	230.3 ± 41.3 (190–315)	Z=3.187, P ₁ =0.001 Z=2.986, P ₂ =0.003 Z=3.412, P ₃ =0.001
Visibility score	3.1 ± 1 (1–4)	3.4 ± 0.7 (2–4)	2.5 ± 1.1 (1–4)	Z=2.236, P ₁ =0.025 Z=2.828, P ₂ =0.005 Z=3.357, P ₃ =0.001

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

P₁: significance vs. group A.

P₂: significance vs. group B.

P₃: significance vs. group C.

It can be concluded that a combination of maintaining patients in the anti-Trendelenburg position, anesthetic manipulation using combined i.v. and inhalational anesthesia, and an intraoperative i.v. injection of tranexamic acid could minimize bleeding and improve field visibility during FESS, and this combination of manipulations could be a recommended strategy for this type of surgery.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

- Eisenberg G, Pérez C, Hernando M, Taha M, González R, Montojo J, et al. Nasosinusual endoscopic surgery as major out-patient surgery. *Acta Otorinolaringol Esp* 2008; 59:57–61.
- Bradley DT, Kountakis SE. Correlation between computed tomography scores and symptomatic improvement after endoscopic sinus surgery. *Laryngoscope* 2005; 115:466–469.
- Huang H-M, Cheng J-J, Liu C-M, Lin K-N. Mucosal healing and mucociliary transport change after endoscopic sinus surgery in children with chronic maxillary sinusitis. *Int J Pediatr Otorhinolaryngol* 2006; 70:1361–1367.
- Mohseni M, Ebneshahidi A. The effect of oral clonidine premedication on blood loss and the quality of the surgical field during endoscopic sinus surgery: a placebo-controlled clinical trial. *J Anesth* 2011; 25:614–617.
- Shen P-H, Weitzel EK, Lai J-T, Wormald P-J, Ho C-S. Intravenous esmolol infusion improves surgical fields during sevoflurane-anesthetized endoscopic sinus surgery: a double-blind, randomized, placebo-controlled trial. *Am J Rhinol Allergy* 2011; 25:e208–e211.
- Panda N, Verma RK, Panda NK. Efficacy and safety of high-concentration adrenaline wicks during functional endoscopic sinus surgery. *J Otolaryngol Head Neck Surg* 2012; 41:131–137.
- Kennedy DW. Prognostic factors, outcomes and staging in ethmoid sinus surgery. *Laryngoscope* 1992; 102 (12 II): 1–18.
- Fromme GA, MacKenzie RA, Gould AB Jr, Lund BA, Offord KP. Controlled hypotension for orthognathic surgery. *Anesth Analg* 1986; 65:683–686.
- Boezaart AP, Van Der Merwe J, Coetzee A. Comparison of sodium nitroprusside- and esmolol-induced controlled hypotension for functional endoscopic sinus surgery. *Can J Anaesth* 1995; 42 (5 I): 373–376.
- Lee JM, Chiu AG. Role of maximal endoscopic sinus surgery techniques in chronic rhinosinusitis. *Otolaryngol Clin N Amer* 2010; 43:579–589.
- Cohen-Kerem R, Brown S, Villaseñor LV, Witterick I. Epinephrine/lidocaine injection vs. saline during endoscopic sinus surgery. *Laryngoscope* 2008; 118:1275–1281.
- Sieškievicz A, Drozdowski A, Rogowski M. The assessment of correlation between mean arterial pressure and intraoperative bleeding during endoscopic sinus surgery in patients with low heart rate. *Otolaryngol Pol* 2010; 64:225–228.
- Degoute C-S, Ray M-J, Manchon M, Dubreuil C, Banssillon V. Remifentanyl and controlled hypotension; comparison with nitroprusside or esmolol during tympanoplasty. *Can J Anesth* 2001; 48:20–27.
- Ko M-T, Chuang K-C, Su C-Y. Multiple analyses of factors related to intraoperative blood loss and the role of reverse Trendelenburg position in endoscopic sinus surgery. *Laryngoscope* 2008; 118:1687–1691.
- Moumoulidis I, Del Pero MM, Brennan L, Jani P. Hemostasis in head and neck surgical procedures: Valsalva manoeuvre versus Trendelenburg tilt. *Ann R Coll Surg Engl* 2010; 92:292–294.
- Ipema HJ, Tanzi MG. Use of topical tranexamic acid or aminocaproic acid to prevent bleeding after major surgical procedures. *Ann Pharmacother* 2012; 46:97–107.
- McConnell JS, Shewale S, Munro NA, Shah K, Deakin AH, Kinninmonth AWG. Reduction of blood loss in primary hip arthroplasty with tranexamic acid or fibrin spray: a randomized controlled trial. *Acta Orthop* 2011; 82:660–663.
- Greiff G, Stenseth R, Wahba A, Videm V, Lydersen S, Irgens W, et al. Tranexamic acid reduces blood transfusions in elderly patients undergoing combined aortic valve and coronary artery bypass graft surgery: a randomized controlled trial. *J Cardiothorac Vasc Anesth* 2012; 26:232–238.
- George A, Kumar R, Kumar S, Shetty S. A randomized control trial to verify the efficacy of pre-operative intravenous tranexamic acid in the control of tonsillectomy bleeding. *Indian J Otolaryngol Head Neck Surg* 2011; 63: 20–26.
- Alimian M, Mohseni M. The effect of intravenous tranexamic acid on blood loss and surgical field quality during endoscopic sinus surgery: a placebo-controlled clinical trial. *J Clin Anesth* 2011; 23:611–615.
- Abrams J. Local use of tranexamic acid in ENT surgery. *HNO* 2012; 60:1014–1018.
- Choi WS, Irwin MG, Samman N. The effect of tranexamic acid on blood loss during orthognathic surgery: a randomized controlled trial. *J Oral Maxillofac Surg* 2009; 67:125–133.
- Kaewpradub P, Apipan B, Rummasak D. Does tranexamic acid in an irrigating fluid reduce intraoperative blood loss in orthognathic surgery? A double-blind, randomized clinical trial. *J Oral Maxillofac Surg* 2011; 69:e186–e189.
- Sankar D, Krishnan R, Veerabahu M, Vikraman B. Evaluation of the efficacy of tranexamic acid on blood loss in orthognathic surgery. A prospective, randomized clinical study. *Int J Oral Maxillofac Surg* 2012; 41:713–717.