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Clinical experience

Haemodynamic effects and the visibility of the surgical field after lidocaine infiltration during septoplasty under general anaesthesia

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Abstract

Background and Purpose: *The aim of this study was to determine the effect of local infiltration of adrenaline- containing lidocaine solution during septoplasty under general anaesthesia on systemic haemodynamics and the visibility of the operative field, and to compare it to the topical application of ephedrine.*

Patients and Methods: *A retrospective, comparative, non-randomised, open study on 72 ASA physical status I and II patients, aged 20 to 73 years, scheduled for septoplasty was performed. Lidocaine/adrenaline-ephedrine group (group LA-E; n=18) received four cotton pledgets soaked with 1 % ephedrine, and then the submucosal infiltration of 2% lidocaine containing adrenaline solution (2ml) plus plain 2% lidocaine solution (5ml). Lidocaine/adrenaline group (LA group; n=25) received the submucosal infiltration of 2% lidocaine containing adrenaline solution (2ml) plus plain 2% lidocaine solution (5ml). Ephedrine group (E group; n=29) received four cotton pledgets soaked with 1% ephedrine. Heart rate (HR) and mean arterial pressure (MAP) were recorded at predetermined time intervals. Bleeding in the surgical field was rated according to a 6-point scale.*

Results*: LA and LA-E groups showed significant lower HR and MAP compared to E-group. LA group showed only slight oscillations in HR. Average bleeding score was 2.28±0.83 in LA-E, 2.08±0.81 in LA and 3.14±0.74 in E group (p<0.001).*

Conclusions: *We demonstrated that infiltration of lidocaine with adrenaline has statistically and clinically better impact on systemic haemodynamics and visibility of the surgical field than that achieved by topical application of ephedrine alone.*

Abbreviations:
LA – E lidocaine/adrenaline with ephedrine
LA – lidocaine/adrenaline
E – ephedrine

Key words: Anesthesia, general, Anesthesia, local, Lidocaine, Adrenaline, Nasal septum, Surgical procedures, Ephedrine

INTRODUCTION

A bloodless and clear surgical field is an everyday challenge during nasal surgery.

Published studies support the combination of lidocaine, a short acting local anaesthetic, with adrenaline to be effective in decreasing blood loss and improving visualisation of the surgical field during nasal surgery *(1, 2)*. In addition, this combination of local anaesthetic infiltration, directly in the surgical field, with general anaesthesia provides beneficial analgesic effect by blocking nociceptive pathways, and thereby it reduces the need for systemic analgesics *(3)*.

Ephedrine has a long history of use in otorhinolaryngology as a topical decongestant during nasal examinations *(4)*. Although it is used by some otorhinolaryngologists as topical pre-treatment for relieving swelling and bleeding of nasal mucosa during nasal surgery, there is no clear evidence for its efficacy in nasal surgery under general anaesthesia.

The aim of this study was to review and evaluate the current practice of the specific measures used for improving haemostasis during septoplasty under general anaesthesia in our Institution. We wanted to determine the effect of local infiltration of adrenaline- containing lidocaine solution compared to the topical application of ephedrine on systemic haemodynamics and the visibility of the operative field.

PATIENTS AND METHODS

Patients

We reviewed data on patients scheduled for different types of nasal surgery under general anaesthesia in the Department of Otorhinolaryngology at the General Hospital »Sveti Duh« in Zagreb, between June 2006 and February 2009. For the review we used our database that we fill in on a regular basis with selected vital parameters following each ear-nose-throat operation.

From the reviewed pool of patients (n=281), we enrolled only the patients undergoing septoplasty (n=176). In addition, we excluded patients with evidence of severe cardiovascular, renal, haematological, hepatic or respiratory disease, and cerebrovascular insufficiency. The final study sample consisted of 72 adults, 44 men and 28 women, with normal cardiovascular and pulmonary status, haematological parameters within the normal range, and American Society of Anaesthesiologists (ASA) score I/II. The patients were aged between 20 and 73 years. The body weight ranged from 53 kg to 110 kg.

Anaesthesia and the applied measures for the intraoperative control of bleeding

On arrival to the operating theatre, intravenous access was established by the insertion of an intravenous canulla. Anaesthesia was induced with midazolam 2.5–5 mg (Dormicum®, F. Hoffman-La Roche Ltd., Basel, Switzerland), fentanyl 0.10 mg (Fentanyl®, Janssen Pharmaceutica, Beerse, Belgium), propofol 1–2 mg/kg (Disoprivan®, AstraZeneca, UK Ltd, Macclesfield, Chesire, United Kingdom). After the use of a facemask for ventilation had been checked, the patient was paralysed with vecuronium 0.1 mg/kg (Norcuron®, N. V. Organon, Oss, the Netherlands). Two minutes later, another fentanyl bolus of 0.10 mg was given and trachea was intubated with a reinforced endotracheal tube of proper size. After the position of the endotracheal tube had been checked and secured, a gauze throat pack was inserted. Anaesthesia was maintained with nitrous oxide 60% in oxygen, and supplemented with additional bolus of midazolam of 2.5 mg, fentanyl of 0.05 mg or vecuronium 0.001mg/kg as required. Patients were mechanically ventilated to keep end-tidal carbon-dioxide tension (PETCO2) to maintain normocapnia (4.5–5.0 kPa). After induction, dexamethason 12 mg (Dexamethason Krka®, Krka d.d., Novo Mesto, Slovenia) and metoclopramide 10 mg (Reglan®, Alkaloid AD – Skopje, Skopje, Macedonia) were applied intravenously. Doses and time intervals of applied drugs and the total volume of intravenous fluids were recorded on the anaesthetic chart. No halogenic inhalation anaesthetics were used.

During the induction of anaesthesia and the surgery, patients were monitored using a standard three-lead electrocardiography, pulse oxymetry, capnometry and non-invasive arterial pressure monitoring.

After intubation and prior to the surgical incision, patients received one of three measures for the control of bleeding in the nasal surgical field. In the first group the surgeon decongested the nose with four cotton pledgets soaked with 1% ephedrine (magistral solution made in the hospital pharmacy), and then applied the submucosal infiltration of 2% lidocaine containing adrenaline solution (2ml; i.e. 40 mg of lidocaine plus 0.025 mg adrenaline) (Lidokain-Adrenalin®, Belupo, Croatia) plus plain 2% lidocaine solution (5mL; i.e. 100 mg of lidocaine) (Lidokain®, Belupo, Croatia) with 28 gauge-sized needle (group LA-E; n= 18). In the second group, the surgeon applied the submucosal infiltration of 2% lidocaine containing adrenaline solution (2ml; i.e. 40 mg of lidocaine plus 0.025 mg adrenaline) plus plain 2% lidocaine solution (5mL; i.e. 100 mg of lidocaine) with 28 gauge- sized needle (group LA; n= 25). In the third group, the surgeon decongested the nose with four cotton pledgets soaked with 1% ephedrine (group E; n=29). The surgeon decided on the patient allocation to one of these three groups. There were several surgeons and each one preferred a different solution. Ten minutes after the method of choice had been applied, the surgical incision was performed and the surgical procedure commenced.

Recordings

Preoperative, intraoperative, and postoperative data on oxygen saturation, heart rate (ECG, lead II) and non-invasive arterial pressure (oscillometry) were recorded automatically every 5 minutes or less if required by an anaesthetic monitor machine.

TABLE 1

Demographic and intraoperative data.

	Group LA-E (n=18)	Group LA (n=25)	Group E (n=29)
Age (years)	41 (27.75–48.50)	39 (30–47.50)	36 (26.50)
BMI (m^2/kg)	24.8 (23.88–29.75)	24.22 (22.75–28.15)	25.25 (24.19–28.89)
Gender (male/female)	10/8	13/12	21/8
ASA (I/II)	10/8	12/13	14/15
Duration of surgery (min)	40 (30–50)	30 (40–45)	30 (25–40)
Duration of general anaesthesia (min)	60 (55–77)	50 (40–60)	60 (47.5–60)
Fentanyl consumption (mg)	0.25 (0.20–0.26)	0.20 (0.20–0.25)	0.25 (0.20–0.25)

Data are presented as medians with ±(25%/75% interquartile range) (not normal data distribution) or numbers (categorica data). There was no significant difference between the groups.

BMI = body mass index
ASA = American Society of Anaesthesiologists score
LA-E = lidocaine/adrenaline infiltration plus ephedrine pledgets
LA = lidocaine/adrenaline infiltration
E = ephedrine pledgets

To assess cardiovascular responses to the applied specific measures for the control of bleeding, heart rate (HR) and non-invasive arterial pressure measurements (systolic (SBP), diastolic (DBP) and mean blood pressure (MAP)) were recorded prior to the applied measure (baseline values), immediately after the applied measure (values at 0 minutes), and 5 and 10 minutes after the applied measure. Haemodynamic changes >20% were considered as clinically not acceptable. All recorded data were printed at the end of surgery.

To assess visibility of the surgical field a 6-point scale was used *(5),* where 0= no bleeding; 1= slight bleeding, blood evacuation not necessary; 2= slight bleeding, some blood must be evacuated; 3= low bleeding, blood must be evacuated frequently as the operative field is visible only briefly after evacuation; 4= average bleeding, blood must be evacuated often as the operative field is visible only immediately after evacuation, and 5=high bleeding, constant blood evacuation needed, as often bleeding exceeds evacuation, rendering surgery nearly impossible. An anaesthesiologist rated the score.

To assess the intraoperative need for systemic analgesics, intraoperative fentanyl consumption was recorded in mg on the anaesthetic chart by an anaesthesiologist. Intraoperative midazolam and vecuronium consumption was also recorded.

The occurrence of intraoperative adverse events during the applied measures, including hypotension (decrease in SBP from 30% of baseline), hypertension (increase in SBP from 30% of baseline), tachycardia (HR of >100 beat per minute) and bradycardia (HR of <50 beat per minute) were also recorded.

Statistical analysis

Categorical data were expressed as frequencies, and presented as numbers or percentage. Distribution of numerical data was determined with the Kolmogorov-Smirnov test and Shapiro Wilk tests of normality. Normally distributed data were expressed as mean±standard deviation (SD), whereas not normally distributed data were presented as median with interquartile range (IQR). Data on gender and complications were compared by χ^2 test. Age, weight, height, ASA, duration of surgery and anaesthesia, intraoperative drug consumption, and fluid administration were compared by Kruskal-Wallis test. One-way ANOVA test followed by Scheffe's post-hoc test was used for differences in SBP, DBP, MAP and HR between groups. Paired *t* test was used for intragroup differences in SBP, DBP, MAP and HR. Bleeding scores were assessed by Kruskal Wallis and Wilcoxon signed ranks test. $P < 0.05$ was considered statistically significant. Statistical analysis was performed with SPSS software for Windows, version 11.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

There was no difference between the groups regarding age (p=0.570), body mass index (p=0.425), gender (p=0.264), ASA (p=0.862), duration of surgery (p=0.134), duration of anaesthesia (p=0.108), intraoperative consumption of fentanyl (p=0.460) (Table 1). Intraoperative midazolam (p= 0.336) and vecuronium (p=0.300) consumption, and intraoperative fluid administration (p= 0.095) were the same in all three groups.

TABLE 2

Mean (±SD) changes in heart rate (HR) bmin-1 and mean arterial pressure (MAP) mmHg in group LA-E (n=18), group LA (n=25) and group E (n=29), observations: baseline; immediate after application (0 min); 5 min after application; 10 min after application.

	Group	Baseline	0 min	5 min	10 min
HR bmin-1	LA-E	80.94 ± 15.17	79.94 ± 16.13	79.17 ± 17.64	78.44 ± 18.30
	LA	76.16 ± 14.18	70.80 ± 10.65[a]	67.6 ± 11.66[†,‡,b, d]	67.80 ± 11.34[†, c]
	E	81.62 ± 12.56	79.48 ± 14.50	79.59 ± 14.15	82.69 ± 17.09[f]
MAP mmHg	LA-E	94.17 ± 9.76	85.44 ± 17.44[a]	92.39 ± 16.64[d]	97.22 ± 19.44*[,c]
	LA	86.60 ± 12.04	90.56 ± 19.69	84.92 ± 16.21[†]	86.60 ± 19.84[†]
	E	94.86 ± 13.64	93.83 ± 12.94	100.83 ± 13.47[b,d]	112.17 ± 15.05[c,e,f]

*significant difference LA-E vs E <0.05; †significant difference LA vs E <0.05, ‡significant difference LA vs LA-E <0.05

a – significant difference 0 min vs baseline <0.05 within the same group; b – significant difference 5 min vs baseline <0.05 within the same group; c – significant difference 10 min vs baseline <0.05 within the same group; d – significant difference 5 min vs 0 min <0.05 within the same group; e – significant difference 10 min vs 0 min <0.05 within the same group; f – significant difference 10 min vs 5min <0.05 within the same group

LA-E = lidocaine/adrenaline infiltration plus ephedrine pledgets
LE = lidocaine/adrenaline infiltration
E = ephedrine pledgets

Table 2 shows mean (±SD) changes in heart rate (HR) bmin-1, and mean arterial pressure (MAP) mmHg as measured at four time points.

There was no difference in baseline HR and MAP between the groups nor at 0 minutes.

HR at 5 minutes was significantly lower in LA group compared to E-group (by 15%, mean difference –15.91, SE 4.169, p=0.012) and compared to LA-E group (by 15%, mean difference –11.57, SE 4.427, p=0.039). HR at 10 minutes was 18% lower in LA group (mean difference –14.89, SE 4.279, p=0.004) compared to E group (Table 2).

MAP at 5 minutes was significantly by 16 % lower in LA group (mean difference –15.91, SE 4.169, p<0.001) compared to E group. MAP at 10 minutes was by 12% lower in LA-E group (mean difference –14.95, SE 5.383, p=0.026) and by 23% LA group (mean difference –25.57, SE 4.896, p<0.001) compared to E group.

When compared within LA-E group, MAP showed a statistical significant decrease immediate after infiltration compared to baseline (by 9% p=0.044). There was a statistical significant increase in MAP at 5 minutes compared to values at 0 minutes (by 8%, p=0.037). At 10 minutes MAP were statistically higher only when compared to the values at 0 minutes (by 12%, p=0.037), but not to baseline or immediate previous measurement at 5 minutes (Table 2).

Within LA group, there was a significant decrease in HR at 0 minutes, 5 minutes and 10 minutes when compared to baseline (by 7 %, p=0.005; by 11%, p<0.001; by 11%, p=0.001, respectively). HR at 5 minutes was by 5 % lower compared to HR at 0 minutes (p=0.029) (Table 2).

Within E group, HR was similar in all measured points, except that the value at 10 minutes was slightly higher compared to 5 minutes (by 4 %, p=0.052). MAP within E group was higher at 5 minutes and 10 minutes compared to baseline (by 6 %, p=0.025; by 15%, p<0.001, respectively). MAP at 5 minutes and 10 minutes was higher than the value at 0 minutes (by 7%, p=0.007; by 16% p<0.001, respectively). MAP at 10 minutes was by 11% higher than that at 5 minutes (p<0.001) (Table 2).

The most frequent grading scores for the bleeding in the surgical filed were Score 2 (n=26, 36.1%) and Score 3 (n=25, 34.7%). There was a significant difference in the bleeding rating score between the groups (p<0.001). Average bleeding score was 2.28±0.83 (median 2.00 IQR 2-3) in LA-E, 2.08±0.81 (median 2.00 IQR 1.5-3) in LA and 3.14±0.74 (median 3.00 IQR 3-4) in E group.

Majority of patients (n=47, 65.3 %) had no complications. Hypertension was registered as the most often complication (40%). There was no difference between the groups (p= 0.133).

DISCUSSION

In this study we compared three different pre-treatments of nasal mucosa used by our otorhynolaryngologists during nasal surgery under general anaesthesia: local infiltration of 2% lidocaine with adrenaline; cotton pledgets soaked with 1% ephedrine, or the combination of ephedrine topical application and lidocaine infiltration on nasal mucosa.

Our results showed greatest haemodynamic stability in the group with local infiltration of lidocaine with adrenaline compared to groups with ephedrine alone or

the combination of lidocaine infiltration with the topical ephedrine application. In the group with infiltration of lidocaine with adrenaline, there was only difference in HR during the study period, which was less than 10%, and that is clinically insignificant and acceptable. On the contrary, the ephedrine did not influence HR but caused an increase in blood pressure with maximum of 17%. This increase falls within a clinically acceptable range of less than 20%; however, when compared to LA- group this difference was 23%, which is clinically not acceptable. LA-E group demonstrated in a certain way the characteristics of both groups. In comparison to LA group, it had more oscillations in blood pressures, but compared to ephedrine group these were clinically acceptable. This lead us to conclude that infiltration of lidocaine with adrenaline has a beneficial and counteracting effect to ephedrine on systemic haemodynamics when used in combination.

The incidence of haemodynamic complications was a secondary end point of this study. Unfortunately, because of the size number, we did not determine any statistically significant difference. However, we found important, from the clinical point of view, more hypertensive cases in the ephedrine group, and two hypotensive cases associated with the infiltration of lidocaine with adrenaline. Ephedrine reaction is easily explained by its pharmacological effect on α1- and α2-adrenergic receptors *(6)*. However, there is a certain lack of clarity regarding the mechanism of the hypotensive reaction of lidocaine with adrenaline. Enlund *et al.* showed lidocaine-induced dose--depended arterial hypotension when combined with a defined level of general anaesthesia during orthognathic surgery *(7)*. On the contrary, Yang *et al.,* in their later performed study, related the registered hypotensive reaction to adrenaline only *(8)*. Enlund reanalysed both studies and found significant differences in the extent of the hypotensive reaction in Yang's and his study, and found also difference in the doses of lidocaine and adrenaline used *(9)*. As an integrative conclusion, it was stated that a combination of relatively small doses of lidocaine (approximately 40 mg) and adrenaline results in profound hypotension, mainly as a result of the adrenergic β2 effect. In addition, a combination of relatively large doses of lidocaine and adrenaline results in less severe hypotension, as a result of predominately affected β1 receptors *(9)*. This explanation also seems appropriate for understanding of haemodynamic manifestations related to lidocaine with adrenaline in our study. Our doses of lidocaine and adrenaline, and the extent of haemodynamic oscillations were more similar to the study of Enlund *et al.* We did not demonstrate profound hypertension, except in the noted cases, although we also demonstrated the tendency of lidocaine to lower the values of blood pressure.

In addition, it helps to explain the best average bleeding score demonstrated in lidocaine with adrenaline group compared to ephedrine. Obviously, to achieve the best surgical conditions, it is necessary to control systemic and local haemodynamics simultaneously. Ephedrine may be a good decongestant, but in our study showed undesirable increases in blood pressure. Therefore, it is not surprising that the addition of ephedrine or topical application of ephedrine alone resulted in worse bleeding scores in our study.

When compared to other techniques for decreasing bleeding in the nasal operative field with the same bleeding score scale, our results were satisfying. Boezaart *et al.* achieved 2.94±0.34 by using a hypotensive technique with esmolol *(5)*. Our best score achieved with infiltration of lidocaine with adrenaline was 2.08±0.81. In a recent study, Ayoglu *et al.* achieved, however, 1.7±1.2 by using dexmedetomidine in septoplasty under general anaesthesia *(10)*.

Our study has a few limitations that should be addressed before the final conclusion. The main limitation of our study is its open design without randomisation and masking. The surgeon decided on patient allocation according to his preference. However, to avoid their bias, an anaesthesiologist did the scoring. Masking in our study could not have been in any case achievable because the application of ephedrine and lidocaine are two different techniques that could not be blinded. The possible advantage of the study was that we had a good pool of patients with systematically collected data, so we were able to carry out a strict selection and finally obtain comparable groups of patients. Therefore, although the study design was made retrospectively, we believe we obtained useful results. The study period was focused and limited on a relatively short period, so haemodynamic values were related to the studied measures exclusively, excluding any other potential influence of applied treatments such as deepening/lightening anaesthesia, fluid overloading, drug application etc.

In conclusion, we demonstrated that the local infiltration of lidocaine with adrenaline showed statistically and clinically significantly more desirable haemodynamic properties and achieved better visibility of the surgical field when compared to topical ephedrine application in patients undergoing septoplasty under general anaesthesia.

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