PERIODICUM BIOLOGORUM
VOL. 113, No 2, 217–221, 2011

UDC 57:61
CODEN PDBIAD
ISSN 0031-5362

Original scientific paper/new guidelines

The effect of injection speed on haemodynamic changes immediate after lidocaine/adrenaline infiltration of nasal submucosa under general anaesthesia

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Key words: infiltration anesthesia; general anesthesia; local anesthetic; epinephrine; blood pressure; heart rate

Received March 16, 2011.

Abstract

Background and Purpose: *Substantial systemic absorption after adrenaline-containing local anaesthetic infiltration can cause transitional changes in heart rate and arterial blood pressure in humans even during general anaesthesia. The aim of this study was to determine the effect of injection speed of local infiltration of adrenaline- containing lidocaine solution on transitional haemodynamic changes during local infiltration of nasal submucosa under general anaesthesia.*

Patients and Methods: *A retrospective, comparative, non-randomised, open study on 1–2 ASA physical status 83 patients, aged 18 to 81 years, scheduled for septoplasty, septorhinoplasty, classical or functional endoscopic sinus surgery was performed. All patients received the submucosal infiltration of 2% lidocaine containing adrenaline solution (2ml) plus adrenaline (0.025 mg) plus plain 2% lidocaine solution (5ml) before surgical incision. Two different infiltration techniques were identified: fast infiltration (Group F, n=40) and slower, incremental infiltation (Group S, n=43). Heart rate (HR), systolic arterial pressure (SAP), diastolic arterial pressure (DAP) and mean arterial pressure (MAP) were recorded before, five minutes after and ten minutes after infiltration.*

Results*: There was no significant difference in HR, SAP, DAP nor MAP between the F group and the S group. There was significant decrease of HR (p=0.006), SAP (p=0.018), DAP (p=0.029), and MAP (p=0.010) at 10 minutes point within the S group compared to baseline. There was significant decrease of HR (p=0.04) at the 10 minutes point within the F group compared to baseline.*

Conclusions*: This study did not confimed that the speed of injection of lidocaine with adrenaline made any effect on haemodynamic changes during local infiltration of nasal submucosa.However it confirmed that lidocaine with adrenaline induced a decrease of blood pressure.*

INTRODUCTION

Local infiltration of local anaesthetics is widely used in clinics to provide good analgesia as a single method for simple superficial surgical procedures *(1, 2)*. In addition, due to the efficient blockade of noci-

ceptive pathways on its' origin, local infiltration of local anaesthetics is often used in combination with general anaesthesia in order to decrease the need for systematic opioid analgesics *(3)*. However, general anaesthesia itself and some local anaesthetics exhibit vasodilatating effect that makes hyperaemic local mucosa (e.g. nasal) and a bloody surgical field, which distracts the surgeons during a surgical procedure *(4)*. Hence the need for a topical application of different drug agents to decongest the nasal mucosa (e.g. cotton pledgets soaked with ephedrine) or use of vasoconstrictors (e.g. adrenaline) in addition to local anaesthetics to reduce the nasal blood flow and optimize the surgical field *(5)*.

Various studies showed that adding adrenaline to solutions containing lidocaine in the surgical procedure on nasal field provides good haemostasis, improves visibility of a surgical field, decreases blood loss and prolongs effectiveness of local anaesthesia *(6, 7, 8)*. However, in addition to these beneficial affects of adrenaline, substantial systemic absorption of adrenaline is shown to appear, which can cause temporary significant changes in heart rate and blood arterial pressure *(7, 9, 10)*. These haemodynamic changes after local infiltration of adrenaline were associated with physical status of the patient *(11, 12),* adrenaline dose *(13)* and the vascularity of infiltration site *(14)*. However, the haemodynamic effect of speed of injection in nasal field has not specifically explored so far.

In our Institution otorhinolaryngologists often use local infiltration of adrenaline containing lidocaine solution during nasal surgery under general anaesthesia. The dose of lidocaine and adrenaline is standardised according to the local protocol. However, the speed of injection is not defined by the protocol, but it varies and depends on the surgeon's techniques. The aim of this study was to evaluate our current practice and to determine the effect of the speed of local infiltration of adrenaline- containing lidocaine solution on systemic haemodynamics.

PATIENTS AND METHODS

Pre-study

In a pre-study period we performed a pilot study on evaluating the time and speed of injection used by our surgeons. We did not apply for an ethical approval of Institutional Ethic Committee for this part of the study because of two reasons: 1. this study did not influenced in any way the procedure and the safety of the patients; 2. we wanted to keep the surgeons blinded for the measurements. An anaesthesiologist on duty measured time each surgeon used to apply the standardised dose of lidocaine and adrenaline for the infiltration of nasal submucosa by using a stopwatch. Surgeons were not aware of the study. Each of six surgeons were identified as A, B, C, D, E, F and followed for 10 procedures. According to the average time results the two groups of surgeons/techniques were identified: the group F (fast infiltration)-surgeons who infiltrated less that 60 seconds, and the group S (slow infiltration)-surgeons who infiltrated more than 60 seconds. This group stratification was further used in the main study.

Patients

We reviewed data on patients scheduled for different types of nasal surgery under general anaesthesia at the Department of Otorhinolaryngology at General Hospital »Sveti Duh« in Zagreb, between January 2008 and February 2011. For the review we used our database that we fill in on a regular basis with data on anaesthetized patients together with selected vital parameters following each ear-nose-throat operation.

From the database pool of the patients, we reviewed only the patients who had undergone septoplasty/septorhinoplasty, classic or functional endoscopic sinus surgery (n=336). From the selected population, we enrolled in the study further only the patients above 18 years, who were scheduled by surgeons identified as A, B, C; D; E; F in a pre-study, and in whom local infiltration with adrenaline containing lidocaine solution was used. We excluded patients in whom cotton pledgets soaked with ephedrine were used either alone or with infiltration of lidocaine with adrenaline. In addition, we excluded patients with the evidence of severe cardiovascular, renal, haematological, hepatic or respiratory disease, and cerebrovascular insufficiency. The final study sample consisted of 83 adults, 52 men and 31 women, with normal cardiovascular and pulmonary status, haematological parameters in the normal range, and American Society of Anaesthesiologists (ASA) score I/II. The patients were aged between 18 and 81 years. The body weight ranged from 50 kg to 110 kg.

Anaesthesia

On arrival to an operation theatre, an 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 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 paralyzed 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 was 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 0.05–0.1 mg or vecuronium 0.01 mg/kg as required. Patients were mechanically ventilated to keep end-tidal carbon-dioxide tension ($P_{ET}CO_2$) 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 whole surgery, patients were monitored using a standard three--lead electrocardiography, pulse oxymetry, capnometry and non-invasive arterial pressure oscillometry.

After intubation and prior to the surgical incision, patients received 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) applied with a 28 gauge-sized needle by a surgeon.

Recordings

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

To assess cardiovascular responses to local infiltration, we found the note on each anaesthetic chart identifying the exact time when local infiltration was applied. The values of heart rate (HR) systolic (SBP), diastolic (DBP) and mean blood pressure (MAP) prior to the local infiltration (baseline values), and 5 and 10 minutes after the local infiltration were extracted from the printed recorded data and used for further analysis. Haemodynamic changes >20 % were considered as clinically not acceptable.

The occurrence of intraoperative adverse events during the studied period hypotension (decrease in SBP from 30% of baseline), hypertension (increase in SBP from 30% of baseline), tachycardia (HR of >100 beat per minute, $bmin^{-1}$) and bradycardia (HR of <50 $bmin^{-1}$) were also recorded.

TABLE 1

Demographic data.

	Group F (n=40)	Group S (n=43)
Age (years)	29 (23–36.5)	30 (25–38)
Weight (kg)	76.33±15.94	77±14.02
Height (cm)	174.43±8.42	177.05±9.05
BMI (m^2/kg)	24.97±4.35	24.44±3.28
Gender (male/female)	24/16	28/15
ASA (I/II)	28/12	27/16

Data are presented as means (±SD) (normal data distribution) or medians with ± (25%/75% interquartile range) (not normal data distribution) or numbers (categorical data). There was no significant difference between the groups.
BMI = body mass index
ASA = American Society of Anaesthesiologists score
F = fast infiltration
S = slow infiltration

Statistical analysis

Statistical analysis was performed with SPSS software for Windows, version 9.0 (SPSS Inc., Chicago, IL, USA). Categorical data were expressed as frequencies, and presented as numbers. Distribution of numerical data was determined with the Kolmogorov-Smirnov test 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). Patients' characteristics (gender, ASA, age, weight, height and BMI) were compared by χ^2 test. Intergroup comparisons of SBP, DBP, MAP and HR were made using one-way analysis of covariance (ANCOVA) (dependant variable: haemodynamic value; fixed variable: group; covariate: the baseline of haemodynamic value). Paired *t* test was used for intragroup differences in SBP, DBP, MAP and HR. $P<0.05$ was considered statistically significant.

TABLE 2

Mean (±SD) changes in systolic arterial pressure (SAP) mmHg, diastolic arterial pressure (DAP) mmHg, mean arterial pressure (MAP) mmHg and heart rate (HR) $bmin^{-1}$ in group F (n=40) and group S (n=43); observations: baseline; 5 min after application; 10 min after local infiltration.

	Group	Baseline	5 min	10 min
SAP mmHg	F	113.98±15.78	113.2±17.08	113.8±15.68
	S	115.84±12.62	111.81±20.89	107.12±25.68*
DAP mmHg	F	64.35±12.56	63.5±13.59	61.0±12.57
	S	68.56±11.32	65.05±14.19	65.23±11.23*
MAP mmHg	F	80.89±12.23	80.1±13.73	78.6±12.40
	S	84.32±9.91	80.64±13.10	79.19±13.43*
HR $bmin^{-1}$	F	69.1±14.02	69.7±20.11	66.1±13.12*
	S	72.98±16.88	71.56±14.67	67.26±10.81*†

*significant difference 10 min vs 0 min <0.05 within the same group; †significant difference 10 min *vs.* 5min <0.05 within the same group
There were no significant differences between the groups.
F = fast infiltration
S = slow infiltration

RESULTS

There was no difference between the groups regarding age (p=0.597), weight (p=0.507), height (p=0.066), body mass index (p=0.435), gender (p=0.630) and ASA status (p=0.656) (Table1).

Table 2 shows mean (±SD) changes in heart rate (HR) $bmin^{-1}$, systolic arterial pressure (SAP), diastolic arterial pressures (DAP) and mean arterial pressure (MAP) mmHg as measured at three time points. There were no significant differences between the groups in haemodynamic values at any time point. Similar there was no difference found when baseline haemodynamic values were compared to values measured at 5 minutes within both groups. However, there was significant decrease in HR at 10 minutes compared to HR at 5 minutes in the group S (p=0.001). In addition, we found significant decrease of SAP (p=0.018), DAP (p=0.029), MAP (p=0.010) and HR (p=0.006) at 10 minutes versus baseline values within the group S. Within the group F we found the only decrease of HR at 10 minutes compared to baseline HR (p=0.04).

The occurrence of intraoperative adverse events was noted in 13 cases. We noted one case of hypotension in the group S at 10 minutes. There was no recorded case of hypertension. Tachycardia (HR of >100 $bmin^{-1}$) was noted in eight measured values (six in the group F, two in the group S). Two cases of recorded tachycardia were at baseline, and the rest six were at 5 minutes. Bradycardia (HR of <50 $bmin^{-1}$) was noted in four measured values (all four in the group F, two times at 5 minutes and two times at 10 minutes).

DISCUSSION

In this study we compared two different speed of local anaesthetic infiltration of nasal mucosa used by our otorhynolaryngologists during nasal surgery under general anaesthesia: fast infiltration (in less than 60 seconds) and slower infiltration (in more than 60 seconds). Contrary to our expectations our results showed no significant difference in measured haemodynamic values between the groups. This result could lead us to possible conclusion that the speed of injection in nasal field does not play role in determing haemodynamic changes. This was quite surprising because there is general belief, though not always followed in practice, that injection should be slow and incremental in order to avoid side effects.

Older studies reported hypertension and arrhythmias as side effects of adrenaline absorption that could be attributed to alpha effect of adrenaline *(9)*. Newer studied have been focused more on changes that could be attributed to beta-2 (decreased MAP and SVRI) or beta-1 adrenaline effect (increased HR, CI and ACI) *(10)*. In addition several recent studies also reported marked hypotension after infiltraiton of lidocaine with adrenaline *(15, 16, 17)*. The results of our study correlate more with the studies that report hypotension after adrenaline absorption but with one distinction which does not allow us to make firm conclusions. The most published studies report their changes at 1.5 minutes *(17)* or maximum within 6 minutes *(10)* after infiltration. Despite the careful printed notes we collected and used for the analysis in our study, we lack the data on haemodynamic values in shorter time frame than 5 minutes, because this was the shortest period our automated non invasive blood pressure measurement was activated and the values recorded. However, Murthy et al. showed a biphasic diastolic and mean arterial hypotension in 2 minutes and 9–15 minutes *(18)*. This could be partial explantation why we did not noticed any change at 5 minuts point but noticed the decrease of MAP at 10 minutes, that correlates well with the second phase of hypotension reported by Murthy et al. at point 9–15 minutes.

In addition we noted decreased HR at 10 minutes time point in both groups, that is quite opposite to all previously mentioned published studies, in which there was reported increased HR as compensatory mechanisam to hypotension to keep cardiac output. The only possible explanation for our opposite result could be pure speculative, because we did not collected supportive data, but realistic to every anaesthestiolgist. Immediate before the surgical incision, our anaesthetic practice is to deepen level of general anaesthesia or to give extra bolus of intravenous opioids to mitigate sympathic response to surgical incision resulting in decreased HR, and this was done within these first 10 minutes.

There are few limitations of this study that should be included in this discussion. As retrospective one, it carries few methodological faults. First of all, data were collected based on routine haemodynamic measurements (heart rate, non invasive blood pressure) measured every five minutes. As already discussed we obviusly lack for the data in shorter time points during first five minutes after infiltration, which is haemodynamically most sensitive period. Secondly, we divided groups by extrapoliting the results of the time, that surgeons needed for infiltration collected on ten recently performed procedures, on the procedures they perfomed in the past time. This can also be source of bias since the techniques of infiltration can be changed by the same surgeon through the certain period of time, so even the same surgeon can use both techniques. For the given reasons, we recommend to accept the results of this study with due respect of these described methodological faults. Any further study that would like to explore these phenomena should include shorter study time frames and measurements of lidocaine and adrenaline plasma concentrations to determine their specific influence and exclude the influence of other determinats such as general anaesthetics.

According to this study, we could not confirm that the different speed of injection of lidocaine with adrenaline, slower (in more than 60 minutes) versus faster (less than 60 minutes), made any effect on haemodynamic changes during local infiltration of nasal submucosa. However, this study confirmed that lidocaine with adrenaline induced a decrease of blood pressure.

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