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FACEMASK PRESSURE-CONTROLLED VENTILATION IN CHILDREN: WHAT IS THE PRESSURE LIMIT?

Anesth Analg 2010;110:1676-1679

Lagarde S, Semjen F, Nouette-Gaulain K, Masson F, Bordes M, Meymat Y, Cros A

Abstract

Purpose The purpose of this study was to determine the inspiratory pressure in pediatric patients during pressure-controlled mask ventilation and general anesthesia that maximized tidal volume without gastric insufflation. The variables examined were the tidal volume delivered at each inspiratory pressure, the occurrence of gastric insufflation, demographic data such as age and weight, and the occurrence of side effects such as laryngospasm, cough, regurgitation, movement, or bronchospasm.

Background During mask ventilation, the goal is to deliver appropriate alveolar ventilation without exceeding the pressure threshold of the esophagogastric sphincter to cause air to enter the stomach. The dangers of air expanding the stomach include risks of regurgitation and aspiration, hemodynamic compromise, and decreased alveolar ventilation due to increased abdominal pressures. The maximum inspiratory pressure recommended in adult patients is 20 cm H\(_2\)O to prevent gastric insufflation during mask ventilation. That same limit has been transferred to the pediatric population without evidence to support it. Alveolar ventilation may be a challenge with a limitation of the inspiratory pressure. However, pressure-controlled mask ventilation compared to manual mask ventilation decreases the inspiratory pressure required to generate a similar tidal volume as well as decrease gastric insufflation-related complications.

Methodology This prospective, observational study included 100 consecutive ASA I or II children, ranging in age from 1 day to 16 years, scheduled for general anesthesia. All participants were premedicated and induced according to a protocol including 0.4 mg/kg midazolam; mask induction with nitrous oxide, oxygen, and 6% sevoflurane; and sufentanil 0.5 µg/kg IV after IV insertion.

After induction, an anesthesia practitioner used a two hand technique to secure the mask during the pressure-controlled ventilation protocol. The inspiratory pressure started at 10 cm H\(_2\)O (P10) and was increased by increments of 5 cm H\(_2\)O for 5 breaths at each setting. A second anesthesia practitioner auscultated in a fixed location over the epigastric area continuously for gastric insufflation. If gastric insufflation was evident, the inspiratory pressure was reduced to the previous pressure to ensure the cessation of gastric insufflation. The protocol was stopped if gastric insufflation occurred at a pressure less than 25 cm H\(_2\)O or if no gastric insufflation occurred at 25 cm H\(_2\)O (P25).

The second phase of the protocol examined tidal volume delivered. The inspiratory pressure was set to achieve a tidal volume of 10 mL/kg. Depending on the presence or absence of gastric insufflation, the inspiratory pressure was adjusted lower or higher. The data collected included the tidal volume and the presence of gastric insufflation.

Result For analysis purposes, the children were separated into three groups: children one year and younger (age group 1), children 1 to 5 years (age group 2), and children older than 5 years (age group 3). Of the 100 participants, gastric insufflation occurred in 78. The incidences of gastric insufflation at the different pressures were 5 at P10, 16 at P15, 36 at P20, and 21 at P25. As inspiratory pressure was increased, the incidence of gastric insufflation increased. The rates of gastric insufflation at P15 and P20 were 21% and 58%, respectively.
Age was also a risk factor with an incidence of gastric insufflation in age group 1 of 95%, in age group 2 of 93%, and in age group 3 of 56%. The only gastric insufflation at P10 occurred in age group 1. The pressure threshold at which gastric insufflation ($P_{GI}$) occurred in the less than 1 year old group was $\leq 15$ cm H$_2$O in 50% of cases. The pressure threshold for gastric insufflation increased with age. The $P_{GI}$ for age group 2 was $\geq 20$ cm H$_2$O in 72% of cases and for age group 3 was $\geq 20$ cm H$_2$O in 90% of cases.

As inspiratory pressures increased from 10 and 15 cm H$_2$O, the tidal volume increased significantly, from 8.2 mL/kg to 12.1 mL/kg in children with gastric insufflation and from 6.1 mL/kg to 9.3 mL/kg in children without gastric insufflation ($P < 0.05$). At each of the four levels of inspiratory pressure, the tidal volume was lower in those without gastric insufflation, but not significantly. When a tidal volume between 8 and 12 mL/kg was delivered, gastric insufflation occurred in an age-related manner: 30% in age group 1, 10% in age group 2, and 4% in age group 3.

**Conclusion**

The $P_{GI}$ increased as the patient’s age increased with the lowest threshold for infants age one year and younger. Adequate tidal volume can be achieved with inspiratory pressure of 15 cm H$_2$O in most patients without the risk of gastric insufflation.

**Comment**

This study gives some insight into pressure limits and tidal volumes achieved that can be useful in limiting risks for pediatric patients during mask ventilation. With the pressure controlled ventilation protocol used in this study, as opposed to the more conventional manual mask ventilation with one hand, the generalizability of the recommended pressure limit of 15 cm H$_2$O is limited. However, the technique utilized in the study could possibly reduce the leak around the mask to direct more force into either the airway or the esophagus. This makes the $P_{GI}$ suggestion more conservative than with manual mask ventilation. Conversely, the tidal volumes generated with the two-hand pressure-controlled mask ventilation might overestimate those achieved by conventional one handed mask methods. An additional limitation is the exclusion of those with anticipated difficult airway, known or suspected respiratory disease such as former premature infants, and increased risk for pulmonary aspiration such as full stomach or emergency cases. The sample also included no obese patients. This narrow focus limits the generalizability of the findings.

The findings support the practice of using a precordial stethoscope for auscultation of breath sounds during pediatric anesthesia and the practice of beginning a mask induction with the Adjustable Pressure Limiting (APL) valve open then gradually closing it to deliver minimal pressure with optimal tidal volume and alveolar ventilation, especially with an unprotected airway.

The lower $P_{GI}$ for infants age one year and younger is congruent with the immaturity of the esophageal sphincter in the first year of life. The fact that some patients experienced gastric insufflation at pressures as low as 10 cm H$_2$O in this age group gets my attention. This signals that keen assessment of gastric insufflation must be ongoing during mask ventilation and inspiratory pressures adjusted to eliminate gastric insufflation if it is detected. One fact highlighted in this study was that no side effects, including regurgitation, occurred, even though gastric insufflation occurred in 78% of patients.

Terri M. Cahoon, DNP, CRNA
EFFECT OF SUXAMETHONIUM VS ROCURONIUM ON ONSET OF OXYGEN DESATURATION DURING APNOEA FOLLOWING RAPID SEQUENCE INDUCTION

Anaesthesia 2010;65:358-61

Taha SK, El-Khatib MF, Baraka AS, Haidar YA, Abdallah FW, Zbeidy RA, Siddik-Sayyid SM

Abstract

**Purpose** The purpose of this study was to compare the onset of oxygen desaturation during rapid sequence induction using succinylcholine or rocuronium.

**Background** It is known that succinylcholine administration causes muscle fasciculations, which can increase oxygen consumption. During induction of anesthesia, this increase in oxygen consumption may affect the time to oxygen desaturation following apnea. Studies have shown that non-depolarizing neuromuscular blocking drugs, such as rocuronium, do not increase oxygen consumption. Therefore, this study was to compare the time to onset of oxygen desaturation using these two drugs during a rapid sequence induction.

**Methodology** A power analysis determined that at least 17 patients were needed in each group. Sixty patients, 20 in each group, participated in this study. They were ASA I or II patients scheduled for elective surgery under general anesthesia. Three groups were created using a computer-generated table of random numbers. All patients received 5 mg oral diazepam one hour before induction and an infusion of Hartmann’s solution was started in the operating room. Standard equipment was used to monitor oxygen saturation, non-invasive blood pressure, heart rate, and end-expiratory capnography during the study. A tight fitting facemask delivered 8 l/min oxygen for three minutes prior to rapid sequence induction. The following was then administered to the patients based on their group assignment.

<table>
<thead>
<tr>
<th>Group</th>
<th>Lidocaine</th>
<th>Fentanyl</th>
<th>Propofol</th>
<th>Neuromuscular blocking drug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group R</td>
<td>1.5 mg/kg</td>
<td>2 µg/kg</td>
<td>2 mg/kg</td>
<td>rocuronium 1 mg/kg</td>
</tr>
<tr>
<td>Group S</td>
<td>1.5 mg/kg</td>
<td>2 µg/kg</td>
<td>2 mg/kg</td>
<td>Succinylcholine 1.5 mg/kg</td>
</tr>
<tr>
<td>Group SO</td>
<td>None</td>
<td>None</td>
<td>2 mg/kg</td>
<td>Succinylcholine 1.5 mg/kg</td>
</tr>
</tbody>
</table>

Muscle fasciculation intensity was counted as 0 for no fasciculations; 1 for mild, fine fasciculations of the eyes, neck, face, or fingers without limb movement; 2 for moderate fasciculations occurring on more than two sides or obvious limb movement; or 3 for vigorous or severe, sustained and widespread fasciculations.

The tracheal tube was inserted fifty seconds after the neuromuscular blocking drug was given. The tracheal tube was left open to air. Apnea duration was measured from the time the facemask was removed. The ventilator was connected once the oxygen saturation decreased to 95%. Anesthetists were blinded to what drugs were administered and a saline bolus was administered when there was no drug to give. Measurements recorded were end-expiratory oxygen, end-expiratory carbon dioxide after pre-oxygenation, end-expiratory carbon dioxide at initiation of ventilation, time for oxygen saturation to decrease to 95%, fasciculation score, duration of fasciculations, mean arterial pressure at intubation and two minutes post intubation, and heart rate at intubation and two minutes post intubation.
Result Baseline values along with patient characteristics were similar for all three groups. Oxygen desaturation occurred significantly faster in group SO (median 242 sec) than in Group R (median 378 sec) or Group S (median 358 sec) (P < 0.001). Similarly, oxygen desaturation occurred significantly faster in Group S than group R (P = 0.003).

Group SO had a significantly greater fasciculation score and duration of fasciculations than either Group S or Group R. Similarly, Group S fasciculation score and duration of fasciculations was significantly greater than Group R.

Mean arterial pressure and heart rate at intubation and 2 minutes post-intubation were about 20 mm Hg and 10 bpm higher respectively for Group SO when compared to Group S or Group R (P < 0.001). Mean arterial pressure and heart rate were not significantly different between Group R and Group S. After initiation of ventilation, end-expiratory carbon dioxide was about 4 mm Hg higher in Group SO than either Groups R or S. This difference, while clinically slight was statistically significant (P < 0.05).

Conclusion This study demonstrated that patients that received succinylcholine for rapid sequence induction desaturated faster than patient that received rocuronium. It also demonstrated that patients that did not receive lidocaine and fentanyl desaturated faster than patients that received these drugs regardless of neuromuscular blocking drug used. There was also a greater hemodynamic change in these patients, which demonstrated the benefit of these drugs to attenuate hemodynamic changes. The faster desaturation and the increase in end-expiratory carbon dioxide after initiation of ventilation may have been due to fasciculations which increased oxygen consumption.

Comment This well-conducted study looked at drugs we use everyday and gives us information that we can use for decision-making. It is an interesting study since patients that receive succinylcholine are patients, such as obese patients or patients with difficult airways, we want to intubate quickly to prevent desaturation. Succinylcholine is a great drug and has its uses. But this study demonstrates that in situations where you think desaturation may be an issue, rocuronium may be a better choice. Based on this study, there is no question that drugs like lidocaine and fentanyl are not just supplemental. They are necessary to attenuate the hemodynamic response to tracheal intubation and to slow the rate of desaturation in patients receiving succinylcholine or rocuronium. These results show that there are multiple factors that can impact the speed of desaturation and may effect our decisions about whether or not to use a drug.

Heather Fields, MSN, CRNA
LARYNGOSCOPY VIA MACINTOSH BLADE VERSUS GLIDESCOPE: SUCCESS RATE AND TIME FOR ENDOTRACHEAL INTUBATION IN UNTRAINED MEDICAL PERSONNEL

Anesthesiology 2009;110:32-7

Nouruzi-Sedeh P, Schumann M, Groeben H

Abstract

Purpose The purpose of this study was to compare success rate and time to intubation in untrained medical personnel using the Macintosh blade for direct laryngoscopy versus the GlideScope.

Background Tracheal intubation via direct laryngoscopy by medical personnel with limited training in advanced airway management has a high failure rate. Recent research suggests a higher success rate with video-assisted laryngoscopy with devices such as the GlideScope® (Verathon Medical, Ijsselstein, Netherlands) in cases of difficult intubation. However, further research is needed to determine if routine tracheal intubation by medical personnel with limited advanced airway management experience can be improved with the GlideScope technique.

Methodology This was a prospective study of 20 subjects with no intubating experience. Eight paramedic students, four 1st year residents, four nurses, and four medical students were recruited to compare the success rate (intubation within 120 s) and time to intubation using direct laryngoscopy with a Macintosh blade (size 3 or 4) versus the GlideScope technique. Each subject intubated 10 ASA I or II patients without suspected difficult airways; 5 with each technique; n = 200 patients. Patients were assigned in an alternating sequence by an anesthesiologist blinded to the professional status of the subject performing the intubation.

All subjects received manikin training with both techniques and were required to demonstrate three successful intubations in a row within 60 s for each technique before intubating a patient. Next, they observed each technique in an anesthetized patient. Subjects then intubated five patients (five attempts) with each technique for a total of 10 attempts. Human intubations were performed under close supervision of an attending anesthesiologist who did not provide advice or recommendations. The attending anesthesiologists took over the airway if the time exceeded 120 s, oxygen saturation dropped to < 95%, there was hemodynamic instability ( > 30% decrease in MAP from baseline), or airway trauma (i.e., blood stain on blade) was suspected. If the attending found a Cormack and Lehane Grade III or IV view, the patient was excluded from the analysis and the attempt was repeated with another patient.

Result A total of 202 intubation attempts were made. Two subjects with grade III views were excluded, leaving 200 subjects in the analysis (Macintosh blade n = 100; GlideScope n = 100). Demographic data (height, weight, age gender, and ASA Classification) and dose of induction agents (propofol, remifentanil, and mivacurium) administered were similar between the two techniques (P >0.05). There were significantly more patients with a Mallampati I in whom the Macintosh blade was used compared to the GlideScope® technique (68% vs. 52%; P = 0.02). With the Macintosh blade only 51% (95% CI: 41-61%) of subjects were successfully intubated within 120 s compared to 93% (95% CI: 86-97%) with the GlideScope technique (P < 0.01). Starting with the 2nd attempt with the GlideScope 100% of subjects could successfully intubate all patients (Figure 1).
The Cormack and Lehane grade view as evaluated by the subjects was significantly better in patients intubated with the GlideScope compared to direct laryngoscopy with the Macintosh blade (grade I + II: GlideScope: n = 92/100 vs. Macintosh blade: 50/100; P < 0.01). When subjects failed to intubate within two minutes, the attending anesthesiologist performed the intubation with a Macintosh blade. In each of these cases the anesthesiologist graded the laryngoscopic view as Cormack and Lehane I or II. The overall time (mean of all attempts) for successful intubation was significantly lower with the GlideScope technique compared to direct laryngoscopy with the Macintosh blade (63 ± 30 s vs. 89 ± 35 s; P < 0.01).

Conclusion  The success rate of intubation was significantly increased when subjects, who had never intubated a real patient before, used a video-assisted technique (GlideScope). Therefore the GlideScope technique might be a better choice for medical personnel who perform tracheal intubation infrequently.

Comment  I believe the GlideScope is changing the way many people approach a difficult airway. At my facility it has become the primary airway device for cases of suspected difficult intubation for many staff and trainees. The learning curve for the GlideScope is not nearly as steep as it is for direct laryngoscopy with a Macintosh or Miller blade, and the view of the glottis is many times better. The results of this study, I believe, support this latter statement as all of the “untrained” medical personnel where able to successfully
intubate patients (without a suspected difficult airway) with the GlideScope starting with the second attempt. Similarly, one of my new SRNAs who had only intubated a few patients with a Macintosh blade, and had never used the GlideScope before, successfully intubated a patient with a suspected difficult intubation on the first attempt with the GlideScope. I believe this attests to the benefits of this device.

I am a little concerned, however, that junior staff and students are using the GlideScope so much that they are not gaining valuable experience with traditional techniques such as direct laryngoscopy with a Macintosh or Miller blade, with an Eschmann stylet, and on when and how to perform an awake fiberoptic on a suspected difficult airway. Additionally, because the lifting motion of the GlideScope is so different from that of direct laryngoscopy, I have started to notice that when students who use the GlideScope frequently try to use a Macintosh blade, they tend to “crank back” a little more on the teeth.

My biggest concern, and one that is echoed in the literature\(^2\), is that because it is becoming a “first-line” instrument for many anesthesia providers in patients with a suspected difficult intubation, that we might be creating a false sense of security for these patients when they present for a future anesthetic. Unless we provide them with a note\(^2\) on what specific techniques and devices where used to secure their airway, we might in fact be increasing their risk or making it difficult for future anesthesia providers who do not have a GlideScope available. I work in several facilities in which no GlideScope is available, and in cases of a suspected difficult intubation I do an awake fiberoptic or if faced with an unanticipated difficult airway I attempt to use an Eschmann stylet or an intubating LMA. I think we are doing our students a disservice if we do not ensure that they learn when and how to expertly use an Eschmann stylet, intubating LMA, and perform an awake (or asleep) fiberoptic intubation. I know at least in the military that the GlideScope is not yet available on all deployable platforms and may not be available at small facilities, so it is imperative that we ensure the latter skills, and the judgment of when to use them, are passed on to future anesthetists.

As for this study, I felt overall it was a very good study that demonstrates the learning curve is not as steep with the GlideScope for untrained medical personnel who have never intubated before. There were some baseline differences in Mallampati scores, with more patients in whom the Macintosh blade was used who had a slightly better airway exam. This should have favored the Macintosh blade, but in fact it did not. In patients in whom the GlideScope\(^\circ\) was used there was a significantly higher success rate and better view of the glottis.

The major limitation of this study was that a true randomization sequence was not used; the investigators chose to alternate the techniques between patients for each subject. The study would have been strengthened if they had properly randomized the patients. This probably would have eliminated the baseline differences in the airway examination and made for a stronger study. Having said that, I think this study adds to our growing body of knowledge on the benefits of the GlideScope. But I still firmly believe we must ensure the judgment and skill to use other airway adjuncts and equipment is not lost by our future generation of anesthesia providers.

Dennis Spence, PhD, CRNA


2. Glynne SD. Is GlideScope\(^\circ\) the best way to intubate? Anesthesiology 2010;113:259.
Readers are encouraged to peruse the two bibliographic references which are correspondence submitted in response to the study reviewed in this abstract and comment. In the latter letter Dr. Glynne states, “that neither is there currently a standard for documenting the use of these devices nor is there a consistent means of informing the patient that such a device was used” in referring to the GlideScope. In his correspondence, he describes how he has developed a Microsoft Excel difficult airway template that can be given to patients to provide this very information. If contacted he will provide a copy free of charge. Readers are encouraged to contact him if they are interested.

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, Department of Defense or the United States Government.
PREDICTING DIFFICULT LARYNGOSCOPY IN ACROMEGALY: A COMPARISON OF UPPER LIP BITE TEST WITH MODIFIED MALLAMPA TI CLASSIFICATION

Neurosurg Anesthesiol 2010;22:138-143


Abstract

Purpose The upper lip bite test (ULBT) is a relatively new and simple test for predicting difficult intubation by classifying the ability to bite the upper lip with the lower incisors. This test has not been evaluated in patients with acromegaly. The primary purpose of this study was to compare the ULBT with the modified Mallampati classification (Mallampati) to predict difficult laryngoscopy in this group of patients.

Background Difficult airway management and an increased incidence of difficult laryngoscopy and intubation in acromegalic patients is widely recognized and may be attributed to the typical associated features which include: hypertrophy of the mandible, macroglossia, hypertrophy of the nasal turbinates, laryngeal and pharyngeal soft tissues, distortion of glottic structures and limited neck mobility. Since only oral intubation or tracheostomy is possible for transsphenoidal surgery, the importance of prediction of difficult intubation cannot be overstated.

The Mallampati is the gold standard for preoperative assessment of the airway. Mallampati scores of III and IV have been reported as valuable in predicting difficult laryngoscopy in both the general surgical population and in acromegalic patients.

The Mallampati view was graded as follows: class I – soft palate, fauces, uvula, and pillars visible; class II – soft palate, fauces, and uvula visible; class III – soft palate and base of the uvula visible; class IV – soft palate not visible at all. The ULBT was classified as: Grade I – lower incisors can fully cover the upper lip above the vermilion line; Grade II – lower incisors can bite the upper lip below the vermilion line; and Grade III – lower incisors are not able to bite the upper lip. Grade III has been associated with potentially difficult laryngoscopy and intubation in the general surgical population.

Methodology Over a 5-year period, 64 acromegalic (diagnosis confirmed by MRI) and 63 non-acromegalic patients (control group) scheduled for pituitary tumor resection were enrolled in this prospective, observational study. Preoperative airway assessment was done by two experienced anesthesiologists (> 5 years) and involved the Mallampati and ULBT according to the usual criteria. The airway management plan was left to the discretion of the attending anesthesiologist. After induction of anesthesia and when intubating conditions were obtained, laryngoscopy was performed by one of the two experienced anesthesiologists using a Macintosh blade of the appropriate size. The view was then classified according to the method of Cormack and Lehane. External laryngeal pressure was not applied until after the initial view was reported. Mallampati III and IV and ULBT III were considered predictors of difficult laryngoscopy as defined by Cormack-Lehane grades III or IV before external laryngeal manipulation. Intubation was defined as difficult if it required more than 2 attempts involving change of blade or the use of a bougie, or if either a fiberoptic bronchoscope or an intubating Laryngeal Mask Airway (LMA) was used. Statistical analysis was done to calculate the
sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the Mallampati and ULBT in predicting
difficult laryngoscopy.

Result

Acromegaly Group (n=62)

Laryngoscopy was predicted to be difficult in 61% (38) of patients based on the Mallampati and in 14% (9) of patients by the
ULBT. Of airways predicted to be difficult by either test, only 26% (10 of 38) predicted by Mallampati and 44% (4 of 9) predicted
by ULBT were actually difficult intubations. The ULBT failed to predict 73% (11 of 15) and the Mallampati failed to predict 33% (5
of 15) of the difficult laryngoscopies. Four were correctly predicted by both tests (27%), however neither test predicted difficulty in
33% (5 of 15) of the difficult laryngoscopies.

Control Group (n=63)

Only 9% (6 of 63) of laryngoscopies predicted to be difficult were actually difficult. However, the Mallampati failed to predict 17%
(1 of 6) and the ULBT failed to predict 33% (2 of 6) of difficult laryngoscopies. Both tests correctly predicted 67% (4 of 6) of
difficult laryngoscopies and all of the difficult laryngoscopies were predicted by the two tests together.

Conclusion  The incidence of difficult laryngoscopy and intubation was higher in the acromegalic patients with pituitary tumors
than in the control group. The ULBT was more specific and had higher accuracy but the Mallampati was more sensitive in
acromegalic patients. Both the Mallampati and ULBT had less sensitivity and accuracy in acromegalic patients compared to the
control group. The authors recommend using the ULBT in addition to Mallampati for preoperative airway assessment in patients
with acromegaly, with the caveat that a significant number of difficult laryngoscopies may be missed despite using both tests.

Comment

The recommendation to use both tests and therefore increasing sensitivity and specificity by combining Mallampati and ULBT is
suggested by the authors. The ULBT has a very low sensitivity (27%) due to high false negatives. Acromegalic patients have
prognathism, making mandibular protrusion relatively easy, and as the authors point out, the macroglossia and tissue hypertrophy,
which make intubations more difficult in this population, are picked up better by the Mallampati. The specificity of the Mallampati
was low (40%) due to fewer true negatives and more false positives. Neither of these tests predicted difficulty in 33% of
laryngoscopies that were defined as difficult. Having personally experienced the 33% of difficult laryngoscopies that are not
predicted by preoperative airway assessment, I always have a difficult airway cart that includes a rigid and flexible fiberoptic scope,
intubating LMA's, and jet ventilation in the room on standby for acromegalic patients undergoing pituitary tumor surgery. I think I will
continue to err on the side of false positives.

I was intrigued to find that in nonacromegalic patients the use of both tests together correctly predicted 100% of difficult
laryngoscopies. Based on this information, I have added the ULBT into my routine preoperative airway assessment.

Amy Pfeil Neimkin, DNP, MBA, CRNA
Statistical Terminology

Sensitivity - the percentage of correctly predicted difficult intubations as a proportion of all intubations that were truly difficult.

Specificity - the percentage of correctly predicted easy intubations as a proportion of all intubations that were truly easy.

Accuracy - the percentage of correctly predicted easy or difficult intubations as a proportion of intubations.
ADENOSINE-INDUCED FLOW ARREST TO FACILITATE INTRACRANIAL ANEURYSM CLIP LIGATION: DOSE-RESPONSE DATA AND SAFETY PROFILE

Anesth Analg 2010;110:1406-11

Bebawy JF, Gupta DK, Bendok BR, Hemmer LB, Zeeni C, Avram MJ, Bather HH, Koht A

Abstract

Purpose This case series reviewed the use of adenosine-induced cardiac arrest during intracranial aneurysm clip ligation to determine the dose-response relationship and perioperative safety profile.

Background To facilitate clipping of aneurysms that are large or with broad necks, surgeons often use proximal temporary arterial occlusion to decompress the aneurysm, thereby facilitating clip ligation. In cases where proximal temporary arterial occlusion is not feasible, perhaps due to a difficult surgical approach and exposure, other methods can be employed, such as extra-cranial cross-clamp of the carotid artery, endovascular balloon occlusion, or deep hypothermic circulatory arrest. These methods are not without their own inherent risks. Adenosine provides an alternative method of temporarily reducing circulation to facilitate decompression of the aneurysm. However, the starting dose most likely to produce an adequate period of hypotension is unclear and has to be established in each patient with the use of two to three escalating doses to determine the dose necessary to achieve 30 seconds of asystole.

Methodology The perioperative records of 24 patients who received adenosine to facilitate clip ligation were reviewed. About half the patients had hemodynamic data recorded by a dedicated observer to allow a dose-response relationship to be determined for the duration of a systolic blood pressure < 60 mm Hg. The patients were also monitored for post-adenosine arrhythmias, increases in peak airway pressure, increases in postoperative troponin I levels and the incidence of new, immediate postoperative neurologic deficits. All patients received an anesthetic that consisted of remifentanil (≥ 0.1 μg/kg/min), an inhaled anesthetic (≤ 0.5 minimum alveolar concentration) of desflurane or sevoflurane, and propofol (50-150 μg/kg/min). In addition, all patients received propofol to induce electroencephalographic burst suppression at the time of clip ligation and none were receiving antihypertensive drugs. Preliminary analysis of the raw data revealed a nonlinear dose-response relationship. The data was then examined using linear regression of the log-transformed dose of adenosine (normalized to the ideal body weight IBW in kilograms) and the speed of onset and duration of action.

Result There was a relationship between the log-transformed normalized to IBW adenosine dose and the duration of SBP < 60 mm Hg using a linear regression analysis of the initial doses of adenosine. However, the duration of SBP below the baseline SBP was not statistically related to the initial dose and the pooled analysis of all the doses did not reveal any statistically significant relationship. Of the 24 patients who received adenosine; 2 developed transient, but stable, atrial fibrillation; 2 developed mild postoperative increases in troponin levels; and three had a new neurologic deficit within 24 hours of surgery. None of the patients had any apparent pulmonary side effects perioperatively.

Conclusion The method of individualizing the dose-response relationship to adenosine by determining the response to escalating doses with complete recovery in between may not always be safe or practical. In instances of intraoperative aneurysmal rupture or the desire to avoid repeated cardiac and cerebral ischemia, the authors suggest the coordinated initial dose of 0.3-0.4...
mg/kg IBW to achieve approximately 45 seconds of controlled profound systemic hypotension with an anesthetic consisting of remifentanil, a low-dose inhalational agent and propofol for burst suppression. This initial report suggests low perioperative morbidity when doing so.

Comment

Adenosine is a potent systemic vasodilator achieving its action by binding to the A2 receptors on vascular smooth muscle and is used in cardiac stress testing to induce steal. The authors addressed this concern by not administering adenosine to patients with known left main coronary stenosis, severe multivessel coronary artery disease, AV conduction defects, or patients with severe reactive airway disease. They also advocated the placement of transdermal defibrillator/pacing pads on all patients who might receive adenosine and the routine monitoring of troponin I. In a series of 27 patients using adenosine to facilitate aneurysm clip ligation, one patient with coronary artery disease had prolonged hypotension requiring cardiopulmonary resuscitation, but with no postoperative elevation of cardiac enzymes. However, they did not routinely measure enzymes on the other patients.

Their retrospective data suggested a dose range of 0.24 to 0.42 mg/kg (not reported in IBW) of adenosine to provide about 30 to 60 seconds of hypotension and bradycardia. Anesthesia was maintained in these cases with a remifentanil infusion and low dose isoflurane or sevoflurane (doses not reported) and propofol was used for burst suppression only. Neither of these studies mentioned rebound tachycardia or hypertension after the recovery of cardiac rhythm. However, in a small series of 5 patients nitroprusside was used to attenuate rebound tachycardia and tachycardia. Remifentanil was not used for maintenance (isoflurane, propofol, and nitrous oxide-doses not reported) and he reported adenosine doses as high as 2.15 mg/kg to achieve 45 seconds of profound hypotension which was defined as a MAP of 25-30 mm Hg. Clearly, the contribution of the maintenance anesthetic on the dose-response curve of adenosine and on subsequent rebound tachycardia and hypertension needs to be investigated before generalizing these results to individual practice.

Controlled hypotension to facilitate microscopic dissection of the aneurysm or clip placement has been achieved by using drugs such as sodium nitroprusside or high dose isoflurane for years and is no longer routinely used due to poorer outcomes. It is important to remember that the anesthetic techniques and considerations are different for controlled-hypotension/flow arrest than for temporary arterial occlusion. If providing hypotension/flow arrest to facilitate dissection, blood pressure must be restored to normal before temporary clip placement to maximize collateral blood flow. In my opinion, using adenosine to induce flow arrest for intracranial aneurysm ligation should not be attempted without meticulous patient selection, advance planning for all potential complications, and only in instances where there is no other viable alternative, until further data is available.

Amy Pfeil Neimkin, DNP, MBA, CRNA


ANESTHETIC MANAGEMENT AND SURGICAL SITE INFECTIONS IN TOTAL HIP OR KNEE REPLACEMENT

Anesthesiology 2010;113:279-284

Chang C-C, Lin H-C, Lin H-W, Lin H-C

Abstract

Purpose The purpose of this study was to determine if subarachnoid block and epidural block were associated with lower rates of Surgical Site Infections than general anesthesia in patients who had total joint replacements.

Background Surgical site infections (SSIs) have been estimated to occur after about 5% of surgeries overall in the USA. Often resulting in additional hospital inpatient days or hospital readmission, SSIs reportedly add four days following breast surgery and 32 days following cardiothoracic surgery. With increased inpatient days comes increased cost, an average of $1,157 per surgical infection. The cost of care following discharge may be even greater.

Surgical site infections develop during the initial hours immediately postoperatively. Risk factors for the development of SSIs include: smoking, obesity, surgical duration, and hyperglycemia. Tissue oxygenation and leukocyte tissue perfusion are thought to be critical factors in whether or not an SSI develops postoperatively.

General anesthesia does not block the surgical stress response as completely as can regional anesthesia. Surgical pain also results in sympathetic activation. Sympathetic stimulation and increased circulating catecholamines result in vasoconstriction, reducing circulation to the wound. Reduced wound circulation results in reduced tissue oxygenation and locally reduced leukocyte activity. Furthermore, potent inhaled anesthetics and opioids have been shown to impair neutrophils and other cellular elements of the blood that defend against infection.

Subarachnoid and epidural anesthesia typically block sympathetic activation more completely than does general anesthesia, improving tissue perfusion, oxygenation, and leukocyte perfusion. In patients who had major upper abdominal surgery, combined general - epidural anesthesia has been shown to increase tissue oxygenation with an associated reduction in SSIs compared to general anesthesia alone.

Methodology This was a retrospective study of a systematically collected “Longitudinal Health Insurance Database,” available to Taiwanese researchers. A randomly selected subset of the database was used for this study. The investigators identified 3,081 patients who had either total hip (n=951) or total knee (n=2,130) replacements during a five year period. Of these surgical patients, 1,191 received general anesthesia and 1,890 either subarachnoid block (n=1,281) or epidural block (n=609). A postoperative SSI included infections, cellulitis, and abscesses either during hospitalization or after discharge but within 30 days of hospital admission.

Result The mean age of all patients was 62.6 years. On average, patients who received regional anesthesia were about 2 years older than general anesthesia patients. Regional anesthesia patients were also more likely to have hypertension, diabetes, hyperlipidemia, and coronary artery disease. Those who received general anesthesia were more likely to have had surgery at a teaching hospital.
Patients who had a general anesthetic for their total joint replacement were 2.21 times more likely (95% CI 1.25 – 3.90) to have an SSI compared to patients who had a subarachnoid block or epidural block. (Adjusted for comorbidities; the unadjusted risk for general anesthesia patients was 2.31.)

<table>
<thead>
<tr>
<th>Surgical Site Infection</th>
<th>All Patients</th>
<th>General Anesthesia</th>
<th>Regional Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>1.8 %</td>
<td>2.8 %</td>
<td>1.2 %*</td>
</tr>
<tr>
<td>NO</td>
<td>98.2 %</td>
<td>97.2 %</td>
<td>98.8 %</td>
</tr>
</tbody>
</table>

Data from Anesthesiology 2010;113:279 table 2. * P = 0.002 compared to general anesthesia.

**Comment**

This very simple study has a lot to teach us. While it does have limitations, from a common sense point of view, they were unlikely to have blurred the overall outcome and the study was reasonably adjusted for many of them. This is a big picture sort of study, not a bunch of minutia. And the big picture is that a spinal or epidural alone for your total hip or knee replacement cuts your risk of a surgical site infection in half.

There are lots of reasons we don’t do more total joints with regional anesthesia but, in my opinion, the reasons we don’t aren’t nearly as good as the reasons we should. I’m not going to address each one of them, but I am going to make my case for a patient care reason and a financial reason we should make regional anesthesia our first choice for total knee and total hip replacements. First, these patients have much better pain control and better surgical recovery when their total joint is done with a regional anesthetic. This is good patient care. Second, while regional anesthesia is often not used because “it takes too long” we must look at the total cost of care, not just the time to get the case started. In addition to the morbidity caused by postoperative infections, wound infections dramatically increase the cost of a total joint. If a regional anesthetic costs a little bit more for a few additional minutes of anesthesia time, it will, overall, be more than made up for by the lower cost of not having to treat twice as many infections. That is good financial management in a time of shrinking healthcare dollars (good patient care too).

While it would be easy to criticize this study for being retrospective, a prospective version would be hard to conduct for many reasons. One big reason is that most patients, and surgeons, have a strong idea of whether they want regional or general anesthesia and getting all to agree to have their anesthetic randomize might prove difficult.

This study is just one reason why all anesthesia providers need to be skilled in regional anesthesia and sedation techniques. And why anesthesia practice needs to be based upon evidence rather than simple surgeon’s preference, anesthesia provider convenience, an OR that is behind schedule, or the inability to coordinate care between services.

Michael Fiedler, PhD, CRNA