Reports of Investigation

Anesthesia of the airway by aspiration of lidocaine

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Purpose: Lidocaine instilled onto the back of the tongue of a supine subject and aspirated has been reported to provide effective topical anesthesia of the airway. The purpose of this study was to observe endoscopically the fate of lidocaine so instilled and document the efficacy of anesthesia for awake fiberoptic intubation.

Methods: In Part 1 of the study, a fiberoptic bronchoscope was positioned in the pharynx of three volunteers lying supine and the route followed by tinted lidocaine solution instilled onto the back of the protruded tongue during mouth breathing was observed. In Part 2, the airway of 39 patients requiring awake fiberoptic intubation was anesthetized by having them gargle twice with 5 ml lidocaine 2%, followed by instillation of 0.2 ml·kg⁻¹ or 20 ml lidocaine 1.5% (whichever was less) onto the dorsum of their tongues as described above. The efficacy of anesthesia was scored by the patient reaction (coughing or gagging) to instrumentation in the pharynx, at the glottis, and in the trachea; to passage of the tracheal tube into the trachea; and to the presence of the tube in the trachea.

Results: Lidocaine instilled on to the back of the tongue was swallowed initially but ultimately pooled in the pharynx and was aspirated. In all patients the trachea was intubated without requiring supplemental lidocaine, and all but one patient tolerated the tracheal tube *in situ*.

Conclusion: A combination of lidocaine gargles and lidocaine instilled on to the back of the tongue and aspirated provides effective anesthesia of the pharynx, larynx, and trachea for awake fiberoptic intubation.

Objectif : On a démontré que la lidocaïne instillée sur le dos de la langue d'un sujet en décubitus dorsal et aspirée produit une anesthésie topique efficace des voies aériennes. L'objectif de la présente étude était d'observer sous endoscopie l'action de la lidocaïne instillée et d'en documenter l'efficacité anesthésique pour une fibroscopie vigile.

Méthode : Dans la Partie 1 de l'étude, un fibroscope bronchique a été placé dans le pharynx de trois volontaires en décubitus dorsal et la voie empruntée par la lidocaïne colorée instillée sur le dos de la langue en protrusion pendant la respiration buccale a été observée. Dans la Partie 2, dans le but de provoquer l'anesthésie des voies aériennes, 39 patients admis pour une fibroscopie vigile se sont gargarisés deux fois avec 5 ml de lidocaïne 2 %, puis ils ont reçu par instillation 0,2 ml·kg⁻¹ ou 20 ml de lidocaïne 1,5 % (peu importe la plus faible) sur le dos de la langue. L'efficacité de l'anesthésie a été cotée selon la réaction du patient (toux ou haut-le-cœur) à l'intubation du pharynx, à la glotte et dans la trachée; au passage du tube endotrachéal dans la trachée et à la présence du tube dans la trachée.

Résultats : La lidocaïne instillée a été avalée initialement, mais plus tard, réunie dans le pharynx et aspirée. Chez tous les patients, l'intubation endotrachéale n'a pas nécessité de lidocaïne supplémentaire, et tous les patients, sauf un, ont toléré le tube endotrachéal *in situ*.

Conclusion : Une combinaison de lidocaïne administrée par gargarisme et de lidocaïne instillée sur le dos de la langue et aspirée produit une anesthésie efficace du pharynx, du larynx et de la trachée lors de la fibroscopie vigile.

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THE technique of anesthetizing the airway by aspiration of lidocaine¹ was first reported in 1990. It involves the operator applying gentle traction on the protruded tongue of a supine subject and trickling lidocaine solution slowly onto the dorsum of the tongue, allowing it to be aspirated into the trachea. This aspiration technique differs from the instillation technique described by Fry.² In the latter, the patient is placed in the sitting position and instructed to hold his tongue forward with the help of gauze. The operator performs indirect laryngoscopy and instills local anesthetic solution on to the base of the tongue, the valleculae, the epiglottis, the vocal cords, and the trachea in turn with the help of a malleable cannula. In the aspiration technique, the patient lies supine and the anesthetic solution is simply dripped on to the tongue without any attempt to direct it at specific anatomical landmarks. Yet anesthesia provided in both the upper and lower airway appears to be complete.¹

Although the aspiration technique has been adopted for awake fiberoptic intubation in other centres^{ab} and our own,^{3,4} its efficacy has not been systematically investigated. The aims of this study were to understand how lidocaine instilled onto the dorsum of the tongue finds its way to the trachea and to document the efficacy of the technique in clinical practice.

Materials and methods

The protocol was approved by the Ethics Committee of the institution. All subjects gave informed consent.

The subjects in Part 1 of the study were the authors of this article, all of ASA class 1 physical status and weighing 55 to 70 kg. These three authors took turns in being the subject, the laryngoscopist, and the operator. A consultant anesthetist not involved with the project was medical supervisor and could stop the procedure on any subject as he judged necessary.

All three subjects fasted from midnight, and NIBP and pulse oximetry were monitored during the procedure. The subject lay supine with 10° head-up tilt. After 1 ml cocaine 5% was applied topically to the nasal passages with cotton-tip applicators, the laryngoscopist introduced a 5 mm fiberoptic bronchoscope through the nose of the subject and positioned it in

the posterior pharynx so that the glottis was clearly in view. The operator, standing at the subject's side, used gauze to grasp the subject's tongue and pull it gently forward. While the subject was reminded to breathe through the mouth and not to swallow, 10 – 12 ml lidocaine 2% tinted with 0.5 ml methylene blue were trickled slowly and steadily onto the posterior third of the subject's tongue. The subject's reaction to the instillation of lidocaine was noted and the route followed by the coloured solution was recorded with a video camera attached to the bronchoscope. The recording was viewed later by an otorhinolaryngologist who gave an independent view on the fate of the lidocaine after instillation.

In Part 2 of the study, 40 patients who required awake fiberoptic intubation were recruited. They were premedicated before coming to the OR according to the choice of their attending anesthesiologist and all received an intravenous infusion of normal saline in the OR. Some also received intravenous sedation on admission to the OR at the discretion of their anesthesiologist to alleviate anxiety. All were monitored by NIBP, ECG, and pulse oximetry and observed for signs of toxicity during and after the topical anesthesia procedure. One of us (DCC) anesthetized the airway topically in all patients. All of them lay supine with a 10° head-up tilt during the anesthetic procedure. For orotracheal intubation, anesthesia consisted of a two-stage approach: (1) gargling with two consecutive 5 ml aliquots of lidocaine 2% for approximately one minute each; excess lidocaine at the end of each gargle being removed by suction and (2) slow and steady trickling of 0.2 ml·kg⁻¹ or 20 ml (whichever was less) of lidocaine 1.5% onto the dorsum of the tongue as described in Part 1 immediately following gargling. For nasotracheal intubation, additional topical anesthesia to both nostrils of the patient was applied using gauze packing soaked in 1.5 ml of cocaine 5%. In 35 subjects the blood pressure and heart rate immediately before and after the instillation and aspiration of lidocaine were recorded. The blood pressure and heart rate data from before and after the instillation/aspiration of lidocaine were analyzed using paired two-tail Student's *t* test.

Laryngoscopy and intubation was allowed to proceed immediately after the topical anesthetic procedure. It was performed with a 3.8 mm fiberoptic bronchoscope by the patient's anesthesiologist who was not a member of the investigation team. A modified Williams airway⁵ was used to facilitate oral intubation. Lidocaine 1.5%, in aliquots of 2 ml via the injection port of the bronchoscope, was used to supplement inadequate anesthesia at the discretion of the

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patient's anesthesiologist. This anesthesiologist also scored the patient's reaction to instrumentation in the pharynx, at the glottis, and in the trachea and to the passage of the tube into the trachea as follows: no reaction (0), mild coughing or gagging without affecting performance of the procedure (1), and persistent coughing or gagging requiring supplemental lidocaine to complete the procedure (2). The adequacy of anesthesia in the trachea was judged also by whether the patient tolerated the tracheal tube when breathing spontaneously during inhalation induction with isoflurane.

Results

In the first part of the study, lidocaine dripped onto the tongue was observed to flow into the valleculae and around the base of the epiglottis to reach the pharynx and the piriform recesses. At the beginning, the flow of lidocaine initiated attempts by the subjects to swallow, during which the operator could feel the tongue being pulled back but failed because of the applied traction. At the same time the pharyngeal constrictors could be seen contracting around the bronchoscope. During this initial "swallowing phase", the lidocaine solution did not pool in the pharynx. Some of it could be seen spilling over into the vestibule of the larynx but not beyond the cords. The volume of lidocaine swallowed during this phase varied among the three subjects: swallowing stopped after 3 and 5 ml instilled lidocaine in two subjects and persisted for almost 10 ml lidocaine solution in the third. After swallowing had subsided, the subjects breathed with an open glottis; and lidocaine solution could be seen pooling in the pharynx and flowing over the interarytenoid notch and beyond the cords into the trachea during both inspiration and expiration. In all three subjects, lidocaine solution flowing past the vocal cords into the trachea produced only muted coughs that were short-lived. The coughs gave way to a gurgling noise during both inspiration and expiration as lidocaine solution was aspirated continuously into the trachea. This fate of the lidocaine solution after instillation was confirmed by the independent otolaryngologist. All three

TABLE I Indications for awake fiberoptic intubation.

Limited mouth opening	n = 19
Limited head & neck mobility	
cervical spine pathology	n = 6
giant goitre	n = 4
clivus chordoma	n = 1
Intraoral tumour	n = 5
Previous difficult intubation	n = 5
Total	n = 40

TABLE II Patient characteristics

	Male	Female
ASA 1	n = 7	n = 3
ASA 2	n = 14	n = 9
ASA 3	n = 4	n = 3
Total	n = 25	n = 15
Age - yr*	49.1 ± 14.7	57.6 ± 17.1
Weight - kg*	59.8 ± 13.2	52.8 ± 8.0

* Mean ± SD

TABLE III Premedication and sedation.

Premedication	
antisialagogue (atropine 0.4-0.6 mg)	n = 4
sedative (temazepine 5-10 mg)	n = 2
Total number of patients	n = 40
Sedation on admission into OR	
nil	n = 7
alfentanil (1 mg)	n = 1
fentanyl (20-150 µg)	n = 22
fentanyl (25-100 µg) & midazolam (0.4-4 mg)	n = 10
Total number of patients	n = 40

TABLE IV Patient reaction to instrumentation within the airway

	0	1	2
Airway/scope in pharynx	n = 32	n = 7	n = 0
Scope through glottis	n = 29	n = 10	n = 0
Scope in trachea	n = 29	n = 10	n = 0
Tube into trachea	n = 18	n = 21	n = 0

0 = no reaction to instrumentation

1 = mild coughing or gagging without affecting procedure

2 = persistent coughing or gagging requiring supplemental lidocaine

subjects tolerated the procedure well with no symptoms or signs of lidocaine toxicity.

In the second part of the study, 25 male and 15 female patients agreed to participate. The indications for awake fiberoptic intubation are listed in Table I. The characteristics of these patients are presented in Table II. Premedication and sedation in the OR are summarized in Table III. One patient, a drug addict with a large pharyngeal abscess and limited mouth opening, refused to cooperate after gargling with lidocaine 2% and the trachea was intubated fiberoptically after induction of general anesthesia breathing sevoflurane. Of the remaining 39 patients, intubation was performed via the oral route in 17 and via the nasal route in 20 patients. In two others the route of intubation was changed from oral to nasal in one, and from nasal to oral in another because of technical difficulties. The

median time required for fiberoptic intubation was 3.25 min (range 1 - 10 min).

The reaction of patients to instrumentation in the airway is summarized in Table IV. All 39 patients tolerated instrumentation in the pharynx, at the glottis, in the trachea, and passage of the tracheal tube into the trachea without requiring supplemental lidocaine. All but one patient breathed spontaneously through the tracheal tube after it was positioned *in situ*. The patient who did not, had a giant goitre with retrosternal involvement and tracheal compression. He reacted to the presence of the tube with persistent coughs and received intravenous induction. One patient who tolerated the tracheal tube was induced intravenously as well for clinical reasons: inhalation induction was contraindicated because he had raised intracranial pressure. All other patients received inhalational induction. No patient developed symptoms or signs of lidocaine toxicity during or after the topical anesthesia procedure. The systolic and diastolic blood pressures and heart rate were recorded in 35 patients. These measurements were (mean $\pm$ SD) 150 $\pm$ 27 mmHg, 80 $\pm$ 11 mmHg, and 88 $\pm$ 16 bpm respectively before the topical anesthesia procedure and 151 $\pm$ 26 mmHg, 81 $\pm$ 12 mmHg, and 89 $\pm$ 16 bpm respectively afterwards. Any difference between these values before and after the instillation/aspiration of lidocaine was not statistically significant (P = NS).

Discussion

In the first part of this study, we observed that lidocaine solution instilled onto the back of the tongue of a supine subject flowed passively to reach the pharynx. When it came into contact with the pharyngeal mucosa, the lidocaine solution invoked a strong reflex to swallow in all three subjects, during which they pulled their tongue back against the operator's grasp and their pharyngeal constrictors contracted around the bronchoscope. During this phase, all the lidocaine disappeared down the esophagus. It was only later that these attempts at swallowing stopped and lidocaine then pooled in the pharynx and overflowed into the trachea.

Our observations are consistent with the description of swallowing in the literature. During the normal act of swallowing, the tongue acts as a piston to propel the bolus of food or liquid from the back of the mouth through the pharynx into the esophagus, the larynx rises cephalad to create a negative postcricoid pressure to suck the bolus towards the esophagus, and the pharyngeal constrictors contract to ease the bolus into the esophagus.⁶⁻⁸ At the same time a combination of closure of the true and false cords and downfolding and retroversion of the epiglottis over the laryngeal aditus prevents aspiration.⁹⁻¹¹

In our technique, traction on the tongue prevents it from participating in the normal act of swallowing and prevents epiglottic downfolding and retroversion over the glottis. This encourages aspiration. However, despite traction on the tongue, pharyngeal peristalsis can still function normally to propel the bolus down the esophagus. The stimulus of this swallowing reflex is fluid in contact with the pharyngeal mucosa.^{12,13} We observed this was so, even when the fluid is lidocaine. Only with time, when the pharyngeal mucosa becomes anesthetized, does the reflex to swallow subside. It is then that the instilled lidocaine begins to pool in the pharynx, ready to be aspirated. We noticed the swallowing phase can be prolonged and a large volume of solution swallowed before anesthesia of the pharynx occurs, such as in one of us. We therefore modified our technique in Part 2 of this study by instructing our patients to gargle with lidocaine solution first, so as to decrease the intensity of the swallowing reflex and encourage earlier pharyngeal pooling of lidocaine. At the same time we limited the dose of the lidocaine aspirate to no more than 3 mg·kg⁻¹.

In the second part of the study, this technique was used successfully to anesthetize the airway for awake fiberoptic intubation in patients with a variety of airway difficulties, including those with intraoral pathology (Table I). Of the 40 patients recruited, one was excluded because he did not cooperate. All local anesthetic techniques require patient cooperation and this is no exception. Of the remaining 39 patients, 32 (82%) did not react to insertion of the airway conduit or fiberoptic bronchoscope in the pharynx and 29 (74%) did not react to manipulation of the fiberoptic bronchoscope through the glottis and in the trachea. The rest reacted only mildly to instrumentation and did not require supplemental lidocaine. While nearly half of the patients (46%) did not react to passage of the tracheal tube into the trachea, the rest did with muted coughs that did not interfere with the procedure. This was not unexpected because advancement of the tracheal tube through the glottis over the bronchoscope was not always straightforward and sometimes required rotation of the tube and repeated attempts. Advancement of the tube through the glottis is obviously a more potent stimulus than passage of the finer bronchoscope. Once the tracheal tube was *in situ*, all but one patient (97%) tolerated it, breathed spontaneously, and accepted inhalation induction. The only patient who coughed persistently on the tracheal tube had a giant goitre with retrosternal extension and tracheal compression. The distorted anatomy of this patient's trachea may be the reason for poor tracheal anesthesia.

Only four patients were premedicated with atropine, but salivation in the other patients was not noticeable during the instillation and aspiration of lidocaine or during fiberoptic intubation. As expected, the lidocaine gargles attenuated attempts by the patients to swallow. During the instillation and aspiration of lidocaine, the patients reacted at most with muted coughs and showed little signs of distress. The absence of any change in blood pressure and heart rate after the instillation/aspiration of lidocaine supported the observation that the procedure caused little discomfort. The dose of lidocaine instilled into the airway was limited to $0.2 \text{ ml}\cdot\text{kg}^{-1}$ or 20 ml, whichever was less, of a 1.5% solution. There were no signs of systemic toxicity in any patient.

We have demonstrated that lidocaine gargles together with lidocaine instilled on to the back of the tongue in a supine subject and allowed to be aspirated is a simple non-invasive method of anesthetizing the pharynx, larynx, and trachea topically for awake fiberoptic intubation. Traction on the tongue is a most important manoeuvre in this technique: it modifies the act of swallowing and prevents the epiglottis from protecting the airway from aspiration. When lidocaine contacts the pharyngeal mucosa, it provokes a strong reflex to swallow so that the first few millilitres of the solution are swallowed, not aspirated. We, therefore, modified the original technique by having our patients gargle with lidocaine first to attenuate the swallowing reflex so that lidocaine pooled in the pharynx was aspirated as it was instilled. Despite manipulation of and instrumentation in the airway, premedication with an antisialagogue does not seem to be necessary for this technique.

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