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The Connell airway: A feasibility study

Management of the patient's airway during sedation preferably includes not only a dependable passageway for gas exchange, but also a reliable way to deliver oxygen and measure expired carbon dioxide. The Connell airway is a newly described modification of the nasopharyngeal airway that provides a conduit for gas exchange and 2 additional channels: 1 for the administration of oxygen and the second for monitoring of expired gases. We studied 10 sedated patients who had a Connell airway placed orally to support their airway during their procedure. Although minor difficulties were noted with early use of the device, subsequent experience demonstrated good performance of the device for airway support and oxygen delivery, easy observation of the end-tidal carbon dioxide waveform, and few minor complications. We believe that the Connell airway is a feasible airway design that could have use in the management of a patient's airway during sedation and that it warrants further investigation.

***Key words*: Airway, general anesthesia, sedation.**

The management of a patient's airway during sedation or light general anesthesia presents several challenges to the anesthetist. First, it would be optimal to establish a dependable conduit for gas exchange without stimulating the patient's airway to cough or gag, or even worse, to cause laryngospasm and obstruction. Second, it is imperative that such an airway enables the anesthetist to provide supplemental oxygen easily. Third, it would be an advantage for such a device to enable the anesthetist to monitor the extent of gas exchange, that is, to monitor inhaled and exhaled gas concentration. Several types of airways are in common use today, including the Guedel oral airway and the Berman airway. Likewise, nasopharyngeal airways are commonly used, but all generally fall short because they have no means to provide supplemental oxygen directly or monitor exchanged gases.[1]

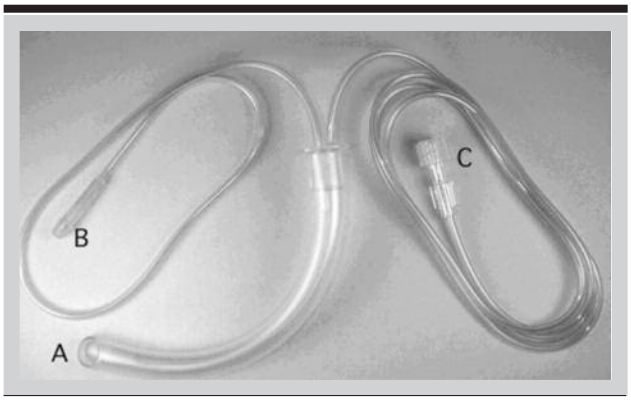
The Connell airway is a new airway that resembles a common nasopharyngeal airway but has 3 channels: a conduit for spontaneous gas exchange, a channel to provide supplemental oxygen, and a channel to monitor airway gases (eg, end-tidal carbon dioxide [$ETCO_2$])[2] (Figure). The purpose of the present study was to assess the feasibility of using the Connell airway orally as a means to support the airway and monitor ventilation in 10 patients scheduled to undergo deep sedation/light general anesthesia for brief surgical procedures.

Methods

After institutional review board approval, 10 healthy adult patients with normal airways and no sore throat were invited to participate in the study. The group included men and nonpregnant women aged 18 years or older who were scheduled to undergo regional or local anesthesia with sedation for relatively short procedures (less than 2 hours). The patients consented to the protocol by signing the patient consent form. After routine preoperative care, patients were brought to the operating room and sedated using small doses of fentanyl, midazolam, and propofol, and then intravenous propofol infusion was begun.

A Connell airway was inserted orally along the right side of the patient's mouth. Oxygen (2 L/m) was insufflated via the oxygen port of the airway, and $ETCO_2$ waveform was monitored via the sampling channel. Assessment of intraoperative performance of the device was based on several factors: ease of insertion, patient response to insertion, patency of airway, presence of $ETCO_2$ waveform, ease of removal, presence of

Figure. The Connell airway (15 cm long)



A. Distal tip B. Oxygen source connector C. End-tidal monitor connector

blood on the device, and patient response to removal of the device. Any adverse events associated with use of the device were noted. At the conclusion of the required anesthetic, the airway was removed, and the patient recovered from anesthesia in the usual fashion. Several parameters (heart rate, blood pressure, oxygen saturation, respiratory rate, and $ETCO_2$ [intraoperative only]) were monitored and recorded at the following times during the procedure: before sedation, after sedation/induction, after insertion of Connell airway, at incision/start of procedure, after removal of Connell airway, and upon arrival at the recovery room. Each patient was asked immediately following surgery whether he or she had a sore throat and was asked the same question again in a phone call 1 day after the procedure.

Results

Ten subjects were included in the present initial feasibility study, and all tolerated the device well. Results of demographic and management parameters are noted in Table 1. Heart rate, blood pressure, oxygen saturation, respiratory rate, and $ETCO_2$ (intraoperative only) demonstrated changes consistent with the effects of sedation and are presented in Table 2. No effects noted were attributed to the presence of the Connell airway.

After the nurse anesthetist became accustomed to the length of the tube and appropriate depth of oral insertion, the Connell airway performed well. Oral insertion of the device was easy in all patients and tolerated well (1 patient gagged) with this sedation. Head tilt, to establish an effective airway with adequate gas exchange and evidence of $ETCO_2$ tracing, was used for 3 patients, and $ETCO_2$ tracing was consistently evident in 7 subjects, with intermittent waveform present in 3 subjects. In 1 patient (patient #1), oxygen saturation briefly dropped to 78% when the airway was being repositioned to establish a consistent $ETCO_2$ waveform. The distal tip of the device apparently touched the epiglottis on repositioning, which caused the patient to cough and clench her teeth. The device was easily removed, with a small amount of blood evident on the device, and repositioned without incident. This patient had a sore throat that resolved by the next day.

In another patient, $ETCO_2$ waveform was lost as the patient was being repositioned from the lithotomy position at the end of the procedure. This was attributed to the shift in the patient's weight as she was returned to the supine position. With minor manipulations of the tube in a few of the other patients, the $ETCO_2$ could be monitored easily and oxygen delivered without complication.

Table 1. Demographics and drugs administered (mean ± standard error of the mean)

Age (y)	58 ± 3
Sex (N)	8 women
	2 men
Weight (kg)	73 ± 6
ASA physical status (N)	I (4)
	II (4)
	III (2)
Mallampati (N)	I (4)
	II (6)
Midazolam (mg)	1.4 ± 0.2
Fentanyl total (μg)	68 ± 7
Propofol bolus total (mg)	40 ± 0
Propofol infusion start rate (μg/kg per min)	215 ± 17

Table 2. Physiologic parameters monitored at specific points in the procedure (mean ± standard error of the mean)

	Baseline	Insertion	Incision	Removal	Recovery	ANOVA *P* value
Respiratory rate	17 ± 1	14 ± 1	15 ± 2	14 ± 1	16 ± 1	.24
Heart rate	77 ± 4	76 ± 4	74 ± 4	75 ± 4	72 ± 4	.74
Systolic blood pressure	136 ± 7	126 ± 7	112 ± 7	112 ± 7	126 ± 7	< .01
Diastolic blood pressure	76 ± 5	71 ± 5	60 ± 5	62 ± 5	70 ± 5	.02
Oxygen saturation	98 ± 1	96 ± 1	97 ± 1	98 ± 1	97 ± 1	.50
End-tidal co_2		40 ± 2	44 ± 2	41 ± 2		.04

One subject noted a mild sore throat immediately following the procedure, which resolved by the following day.

The Connell airway was used in lieu of a natural airway in 4 subjects, a simple oxygen mask in 2 subjects, and the cuffed oropharyngeal airway in 4 subjects.

Discussion

Recent changes in anesthetic practice have placed more emphasis on simple, less-invasive techniques that allow easy management while maintaining effective support and monitoring. This has become apparent with the advent of the laryngeal mask airway, and more recently, the cuffed oropharyngeal airway.[3] Increased use of local or regional anesthetic techniques has given the anesthetist the opportunity to reduce the need for invasive airway maneuvers in favor of less-stimulating, traumatic, and complicated techniques. This may, however, require a heightened appreciation for the anatomy and methods to support the airway.[4] While the Connell airway seems to be a feasible design to support a patient's airway while providing supplemental oxygen and monitoring $ETCO_2$, it became evident early in our experience that some practice with the device is necessary to become familiar with the design. Minor changes in the prototype design (as provided by Mallinckrodt, Inc, St. Louis, Mo) may improve the ease and consistency of use, such as providing depth/length markings. Further study is required to characterize the benefits of using this device during deep sedation/light general anesthesia, especially as compared with alternative devices/techniques, such as a simple oxygen mask, nasopharyngeal airway, or cuffed oropharyngeal airway.

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