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Original Article

GlideScope® Cobalt AVL Video Baton for Intubation in Infants Weighing Less Than 10 Kilograms

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ABSTRACT

Background: The use of videolaryngoscopes (VL) within pediatric anesthesia has become more prominent in younger and smaller neonates and infants. This prospective study utilizes the GlideScope® Cobalt AVL Video Baton (GSC) as a tool for orotracheal intubation in pediatric patients weighing less than 10 kg scheduled for surgery. We hypothesized that the GSC would yield a high success rate, along with intubation times less than 30 seconds and a majority of optimal glottic views, regardless of user experience.

Methods: Two hundred pediatric subjects, less than 10 kg in weight, undergoing surgical procedures with general anesthesia underwent orotracheal intubation using the GSC. Time to best glottic view, time to intubation, total intubation time, Cormack and Lehane grade, and number of intubation attempts were documented.

Results: Our results showed a 90% (180/200) first-attempt success rate and an overall success rate of 99% (198/200) with the GlideScope® Cobalt blade. The mean (± SE) time to best view (TTBV) and time to intubation (TTI) were 6.2 ± 5.5 seconds and 14.0 ± 14.3 seconds, respectively. The mean (± SE) total intubation time (TIT) was 19.5 ± 16.3 seconds, with a Cormack and Lehane grade 1 view in almost 90% of patients.

Conclusions: This study demonstrates a high first-attempt intubation success rate in pediatric patients weighing less than 10 kg with the GlideScope® Cobalt videolaryngoscope, regardless of user experience. In addition to this, intubation times of less than 30 seconds, improved glottic views, and a low incidence of complications were demonstrated with this device.

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Over the last decade, the steady evolution of videolaryngoscopes (VL) has established them as adjuvant devices for orotracheal intubations in adult and pediatric patients. Because infants have a larynx which is more cephalad, a smaller mouth opening and a relatively large occiput and tongue, the ability of VL to align the oral, pharyngeal, and tracheal axes for an indirect view of the glottis with little manipulation of the head has seen its popularity soar within pediatric anesthesia. The advancements in technology that have made the transition of VL from adults to infants possible are the improved optics of the newer devices, better resolution, and smaller sizes for use in infants and neonates (1). While many studies have demonstrated the utility of VL in neonates and children, there still remains a need for large cohort studies in infants to validate those previous findings (2).

The GlideScope® Cobalt AVL Video Baton (GSC; Verathon Medical, Bothell, WA) represents an improvement from the original reusable GlideScope® (GS;

Verathon Medical, Bothell, WA). The system comes with two sizes of video batons (a high-resolution, full-color digital camera with an integrated LED light source and anti-fog feature), which connect directly to a full-color, digital video monitor for real-time viewing (Figures 1 and 2). Since the blades are sterile and for single use, this arrangement prevents direct camera contact with the patient and allows for quick turnover of the device between patients. Furthermore, the newer blade has a lower profile than the small-sized blade of the previous model, thus allowing for greater maneuverability. This second generation GlideScope®, with its important advances in optics and design (including a 10 mm laryngoscope blade), has the potential to improve intubation times, views, and number of attempts, making earlier studies (with the previous generation GlideScope®) difficult to interpret (2).

The role of VL in pediatric anesthesia continues to grow at an exponential rate. Numerous studies have demonstrated the ability of VL to provide improved glottic views and comparable intubation times in comparison to DL in the pediatric population (3-6). Unfortunately, some of these studies have been limited by small sample sizes and a lack of focus on neonates and infants (6). And while the first generation GS can provide a good glottic view with speed, the time required for intubation has been found to be too long (5, 7, 8). The time to intubation is especially important in neonates, where the National Resuscitation Program (NRP) recommends an intubation time of 30 seconds or less (9). We sought to investigate whether in a large cohort the GSC would demonstrate high rates of successful first-attempt intubations while meeting the NRP's guidelines.

The purpose of this study was to evaluate the second generation GSC in a large cohort of neonatal and infant patients in the hands of operators of various skill levels. We hypothesized that the use of the GSC by operators, with varying skill levels, in infants <10 kg, would provide good Cormack and Lehane views along with intubation times of 30 seconds or less. The primary outcome measurements were: time to intubation and Cormack and Lehane glottic view, secondary outcomes were number of attempts and intubation success rate.

METHODS

After Institutional Review Board (IRB) approval from the University of Texas Southwestern Medical Center, patients were recruited at a single-site, Children's Medical Center Dallas, for this prospective study. With the IRB Committee waiving written informed consent, since the GSC is a part of routine patient care at our institution and supervising faculty have extensive experience with the device, we enrolled a total of 200 neonates, infants and small children, all weighing 10 kg or less. All patients recruited were scheduled for surgical procedures under general anesthesia requiring orotracheal intubation with an American Society of Anesthesiology (ASA) physical status classification I-IV. Patients with a known difficult airway, risk of pulmonary aspiration, increased intracranial pressure, congenital cardiac disease or hemodynamic instability were excluded from the study. A difficult airway was suspected in patients with any syndrome known to be associated with a difficult airway, dysmorphic facial features, micrognathia, decreased submental compliance, short/immobile neck or decreased mouth opening. Any one of these findings resulted in exclusion from the study.

All video laryngoscopies were performed by staff pediatric anesthesiologists, pediatric anesthesia fellows or anesthesia residents. All providers were proficient in direct laryngoscopy and had previously used the GSC in pediatric patients. The degree of GSC exposure varied from an average of three intubations for residents to greater than 50 intubations for staff anesthesiologists.

Demographic information on each patient was recorded prior to induction: age (days), gender, weight (kg) and ASA physical status classification. For patients with an intravenous cannula (IV), anesthesia was induced with lidocaine (1 mg/kg), propofol (2-3 mg/kg), and fentanyl (1 mcg/kg). Patients without an existing IV access were first administered sevoflurane in N_2O/O_2 through a facemask. An IV was then placed, and if needed, propofol (1-2 mg/kg) administered. Muscle relaxant (rocuronium or vecuronium) ad-

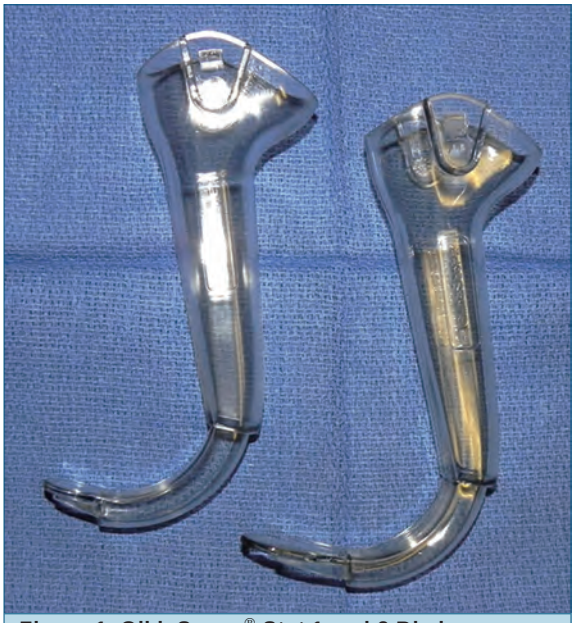

Figure 1. GlideScope® Stat 1 and 2 Blades.

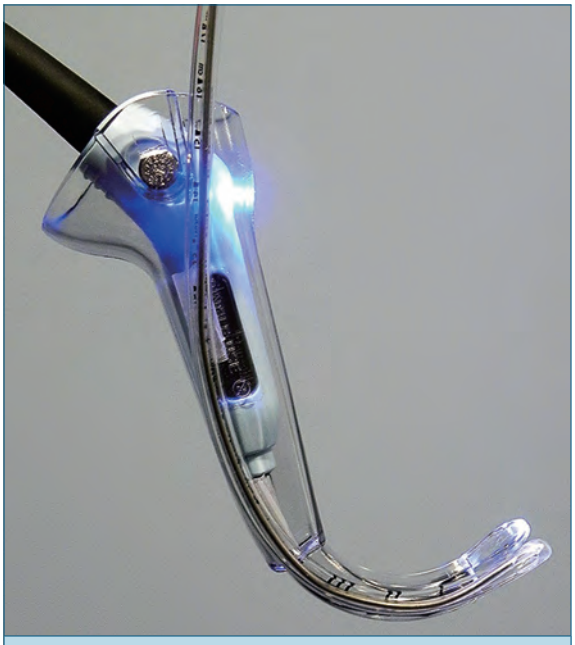

Figure 2. GlideScope® Stat 1 Blade with Video Baton and Styletted Endotracheal Tube Showing Proper Configuration.

ministration was left at the discretion of the anesthesiologist. In order to maintain oxygenation, a standard facemask was used to administer 100% oxygen. The time of preoxygenation (from when the nitrous oxide was discontinued to the beginning of intubation attempt) was usually 2-3 minutes. On the rare occasion where intravenous access was already present, preoxygenation was performed for at least 3 minutes prior to intubation. Preoxygenation was followed by laryngoscopy and endotracheal intubation with the GSC. The decision to use either a GVL® Stat 1 or GVL Stat 2 was based upon the manufacturer's weight-based recommendation, with modification for simplicity by the principal investigator. For patients less than 5 kg in weight the GVL® Stat 1 was used, for patients weighing 5 kg-10 kg the GVL® Stat 2 was used. A stylet was used for all intubations.

Time to best view (TTBV) was defined as the time the blade entered the patient's mouth until the best glottic view was acknowledged. Time to intubation (TTI) was defined as the time from when the best view was acknowledged until successful ETT placement, confirmed by end-tidal carbon dioxide detection on capnography. Total intubation time (TIT) was defined as the calculated summation of TTI and TTBV. The Cormack and Lehane grade (C&L) of the best glottic view and need for the BURP (backward, upward, and rightward pressure) maneuver were recorded for each patient. In summary, the data collected from each patient's intubation were 1) TTBV, 2) TTI, 3) TIT, 4) C&L grade, 5) number of attempts, and 6) need for BURP maneuver. Any airway complications such as oxygen desaturation, airway activation, bleeding, dental trauma, tissue injury or lacerations were documented. A maximum of three attempts were allowed with the GSC before GSC intubation was deemed unsuccessful and a standard direct laryngoscopy or other airway management technique was performed.

RESULTS

The demographic data of the patients studied are shown in Table 1. For the 200 patients that met inclusion criteria, GSC intubation was completed primarily by seven staff pediatric anesthesiologists (N=148), with the remainder by anesthesiology residents (N=42) or fellows (N=10). The GVL® Stat 1 was used in 34.5% (69/200) of patients and the GVL® Stat 2 was used in 65.5% (131/200) of patients. One hundred eighty patients (91%) in our study were intubated on the first attempt, 18 (9.0%) patients required a second attempt.

Two patients (1.0%) were unable to be intubated with the GSC, but were successfully intubated with direct laryngoscopy. In one case, intubation with the GSC was abandoned after only one attempt. The total intubation attempt time in this patient was 92 seconds despite a time to best view of 7.7 seconds. Intubation was accomplished by direct laryngoscopy. In the second case, a third GSC attempt was performed and oxygen saturation dropped to 68%. Oxygen was administered by face mask and the patient was successfully intubated by direct laryngoscopy. The rest of the vital signs were normal and stable

The mean (SD) range TTBV was 6.2 (± 5.5) 1.8-36.7 seconds, the mean (SD) range TTI was 14.0 (14.3) 1.8-100 seconds, and the mean (SD) range TIT was 19.5 (16.3) 5.2-123.8 seconds. A Cormack and Lehane grade 1 view was obtained in almost 90% of the cases. First-attempt success rate was 90% (180/200) with an overall success rate of 99% (198/200). The BURP maneuver was used in only one case. No mechanical complications related to intubation, such as bleeding, dental trauma, laceration, or tissue injury were noted. Recorded and calculated information is shown in Table 2.

Table 1. Patient Demographics.

Age (days)	239.04 (± 421.18)
Gender (F/M)	87/113
Mean weight in kg (standard deviation)	6.5 (± 2.3)
ASA	Class I – 40/200 (20.0%) Class II – 74/200 (37.0%) Class III – 77/200 (38.5%) Class IV – 9/200 (4.5%)

Table 2. Recorded and Calculated Values.

Time to best view (sec), mean (SD) range	6.2 (5.5) 1.8-36.7
Time to intubate (sec), mean (SD) range	14.0 (14.3) 1.8-100
Total intubation time (sec), mean (SD) range	19.5 (16.3) 5.2-123.8
Cormack and Lehane grade	Grade 1 – 175/200 (87.5%) Grade 2 – 24/200 (12.0%) Grade 3 – 1/200 (0.5%)
Muscle relaxant use	90/200 (45.0%)
GSC intubation rate	Successful – 198/200 (99%) Failed – 2/200 (1%)
Attempts (number) to successful GSC intubation	First – 180/198 (90.9%) Second – 18/198 (9.1%)

DISUSSION

With neonates and infants demonstrating low pulmonary reserve along with high oxygen consumption, it is pivotal that intubations are successful with the fewest attempts in the shortest possible time. The inherent difficulty of neonatal intubations has been demonstrated by Haubner et al, where 455 neonatal tracheal intubations had an overall success rate of only 44%, with attending physicians only reaching a success rate of 72.2% (10). This has also been echoed by O'Donnell et al, who found a success rate of 60% among the 122 orotracheal intubations reviewed (11). Others have found that even after 20 intubations, proficiency at intubating neonates by pediatric residents only reaches a success rate of 49%, with neonatology fellows reaching a success rate of 68% (12). This clearly demonstrates the inherent difficulty of the neonatal airway.

Our results show a 90% first-attempt success rate with an overall success rate of 99%. Numerous studies have already shown VL to be successful in adults and children, but what our study offers is a broadening of the GSC's utility to include neonates and infants (4, 13, 14). Much of the success seen with the GSC can be attributed to the improved view offered, which is a result of the improved optics and the decreased profile of the blade (1). The BURP maneuver was only required once to improve the view of the glottis, a reflection of how easily the GSC obtains the best possible view. The fact that all intubations were performed by staff anesthesiologists, fellows, or residents, demonstrates the utility of the GSC in operators of varying skill levels. Prior studies have shown success with VL but have been limited by the number of operators and their high skill-level. Our study shows success in residents with less than 3 GSC intubations and success in attendings with greater than 50 GSC intubations.

In this study, only two patients failed intubation with the GSC and had to be intubated with DL. Both patients were ASA 3, and managed by staff anesthesiologists. The prolonged intubation time in one case and the significant hypoxemia in the other may represent the need for a learning curve in the manipulation of the styletted endotracheal tube under video guidance as well as the need to avoid multiple intubation attempts. The aim of VL is not to supplant DL, but work

alongside it; it may even have a role in teaching DL for neonatal and infant intubation.

The time to intubation is critical for neonates and infants since it can minimize the physiologic stress, secure the airway quickly, and prevent hypoxia (9). The ideal total intubation time set by the NRP is less than 30 seconds (9). Unfortunately, few neonatal or infant studies with either VL or DL have been able to consistently meet this standard. The TTI and TIT results of our study were 14 and 19.5 seconds, respectively; both well below the 30 second standard of the NRP guidelines. Furthermore, these results were obtained in a large sample size with sixteen different operators of different skill- levels. The GSC's potential to provide expedient intubations may have enormous implications in the delivery room and neonatal intensive care unit, where repeated and protracted intubations have serious consequences.

The limitations of our study include the lack of a DL control, which was an omission based upon our desire to obtain a large sample size. The objective of the study was to assess the performance of the GSC in a large cohort, and not to directly compare it to DL for superiority or non-inferiority. All orotracheal intubations were performed in the operating room, and not in delivery rooms or neonatal intensive care units. This might limit the applicability of the study for those settings, but staying in the operating room made recruitment of patients and operators more feasible. There was no standardization of training or experience with the GSC prior for the operators. We felt that the efficacy of the GSC would be more genuinely represented by a group of operators with varied training and experience, as seen in a realistic clinical setting.

This study demonstrates a high successful first-attempt intubation rate in pediatric patients weighing less than 10 kg with the GSC, regardless of user experience. In addition to this, mean total intubation time was less than 30 seconds with a low incidence of complications. This makes the GSC a viable and safe alternative to standard DL in healthy neonatal and infant patients. Further studies with the GSC in this pediatric population should be conducted with a focus on patients with difficult airways.

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One of the authors (PO) serves as a Consultant for Teleflex Medical, Inc., maker of the laryngeal mask airway. None of the additional authors of this study have any disclosures.

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