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Original Research

Comparison of Hyperangulated and Standard Geometry Video Laryngoscopy Tracheal Intubation for Prehospital Care in a Manikin: A Randomized Controlled Crossover Trial

Nicholas Lepa, MD [1,*], Andrew Cathers, MD [1], Kevin Emmerich, MD [2], Richard Galgon, MD [3], Brian Jennett, MD [4], Kristopher M. Schroeder, MD [5], Michael Steuerwald, MD [1]

[1] *BerbeeWalsh Department of Emergency Medicine, University of Wisconsin–Madison, Madison, WI*
[2] *Vituity Emergency Medicine, Methodist Hospitals, Gary, IN*
[3] *Department of Surgical Services, SSM Health Dean Medical Group, Saint Mary's Hospital, Janesville, WI*
[4] *Iowa Methodist Emergency Medicine, Iowa Methodist Medical Center, Des Moines, IA*
[5] *Department of Anesthesiology, University of Wisconsin–Madison, Madison, WI*

ABSTRACT

Objective: The purpose of this study was to investigate the efficacy of hyperangulated video laryngoscopy (HAVL) versus standard geometry video laryngoscopy (SGVL) in the simulated prehospital environment using a manikin. There is consensus that video laryngoscopy (VL) can be very useful in the emergency department when difficult intubations are predicted. Emergency medical service (EMS) providers are also often faced with difficult, rapidly deteriorating airway management situations that not only involve patient and operator factors but also include challenging unique environmental factors, such as nonoptimized positions in transport vehicles (eg, helicopters and ambulances) or at ground level or entrapped positions. To our knowledge, there has never been a study purposefully investigating the efficacy of hyperangulated geometry versus standard geometry VL techniques in the prehospital environment.

Methods: A single-center, randomized controlled crossover trial was performed using attending physician helicopter EMS providers. Physicians were randomized to perform 5 HAVL or SGVL intubations followed by the subsequent technique. Intubations were performed on ground level and then repeated in the helicopter with the first location also randomized. A manikin airway management trainer was used to simulate intubation in each environment. The time to intubation (primary outcome) as well as first-pass success and the Cormack-Lehane view were recorded for each attempt. Qualitative data were also obtained for physician preference and perceived difficulty.

Results: There was no statistically significant difference in the time to intubation with HAVL versus SGVL (ground: 15.02 vs. 14.88 seconds, $P = .86$; helicopter: 16.11 vs. 16.14 seconds, $P = .93$). First-pass success was 100% for both techniques in both scenarios. More Grade 1 views were obtained with HAVL (147/150 vs. 134/150). Moreover, most physicians preferred HAVL overall and felt that HAVL required less force (9/15 grounded manikin and 10/15 helicopter manikin) and led to the best chance for first-pass success (11/15 grounded manikin and 10/15 helicopter manikin).

Conclusion: The results of this study are limited because of the static and highly favorable anatomy of a manikin versus the variability and often difficult anatomy of individual patients. Our results suggest that both techniques are efficacious when the patient is both on the ground or in the helicopter, although provider preference does seem to vary.

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Emergency medical service (EMS) providers are often faced with difficult, rapidly deteriorating airways in the prehospital setting. These patients can have severe facial deformation, oropharyngeal hemorrhage and edema, and cervical spine pathology, making intubation both difficult and critical to patient outcomes. Video laryngoscopy (VL) seems to have a promising role and could be a good choice for safe and effective

*Address for correspondence: Nicholas Lepa, MD, BerbeeWalsh Department of Emergency Medicine, University Bay Office Building, 800 University Bay Drive, Suite 310, Madison WI 53705.

E-mail address: njlepa@medicine.wisc.edu (N. Lepa).

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airway control in the prehospital setting.[1] This has been explored in prior studies,[2-9] but the efficacy of different VL techniques has not yet been well established. Specifically, the use of standard geometry video laryngoscopy (SGVL) versus hyperangulated geometry video laryngoscopy (HAVL) has not been directly compared in the prehospital setting (nor elsewhere) to our knowledge.

We define SGVL as the use of a blade that maintains the traditional geometry of a Macintosh laryngoscope to apply force vectors that align the native curvatures of the airway into a straight line. This is followed by the passage of a tube under direct sight line or indirect video visualization using that straight line. We define HAVL as the use of a blade that does not maintain the traditional geometry of a Macintosh laryngoscope but rather has a curvature that is much more acute. Instead of applying force to align airway axes in this case, the acute curvature of the blade facilitates "a look around" the native hypopharyngeal curvature to the glottis. Tube delivery to and passage through the glottis are then accomplished under indirect video visualization, generally using a curved stylet that brings the tube to the glottis in a curvilinear fashion.[10,11] The specific aim of our study was to evaluate the favorability of 1 specific VL technique (not one device vs. another) in simulated prehospital situations.

Methods

A single-center, randomized controlled, crossover trial was performed using attending physician helicopter EMS providers in 2 simulated environments. The primary outcome was the time to intubation with secondary outcomes of the Cormack-Lehane grade view and first-pass success.

The Health Sciences Institutional Review Board at the University of Wisconsin, Madison, WI, approved this study as part of a simulation technology assessment activity. After obtaining informed consent, study participants were randomized to perform intubations in a hangared EC-135 helicopter with the manikin in the standard patient position on the stretcher versus on a ground-level manikin on the floor of the hangar. After randomization to environment, each participant was again randomized to perform HAVL (CMAC D-Blade; Karl Storz, Tuttlingen, Germany) or SGVL (CMAC MAC 4, Karl Storz) intubations first. Each participant then performed 5 intubations on the manikin with each technique (Fig. 1).

Before starting, they were given a box of items including a bag valve mask, endotracheal tube, flexible and rigid stylet, 10-mL syringe, and the laryngoscope to which they had been randomized. They were allowed to familiarize themselves and practice with the items and manikin before starting the trial (AirSim; TruCorp, Armagh, Northern Ireland). Once the participants started, they were timed on 5 intubations with 1 technique and then switched to the subsequent technique and completed 5 more trials. This was then repeated for each participant in the second simulated position (ground vs. helicopter). In total, each participant completed 10 HAVL and 10 SGVL trials.

For each attempt, the time to intubation was measured from the start of the participant touching the laryngoscope to lung rise with a bag valve mask. First-pass success and Cormack-Lehane grade views for each attempt were also recorded. At the end of each simulation, qualitative data were gathered through a survey. The qualitative survey included subjective data on the perceived ease with each device, the views obtained, and the preferred technique before and after the study. We defined statistical significance in this study as $P < .05$ (2-sample t-test).

Results

All 15 subjects completed all required trials and surveys in the study. Overall, there was no statistically significant difference in the time to intubation when using HAVL versus SGVL in each simulated prehospital environment (Fig. 2) (ground: 15.02 vs. 14.88 seconds, $P = .86$; helicopter: 16.11 vs. 16.14 seconds, $P = .93$). Furthermore, there was identical 100% first-pass success with both techniques in both scenarios (Fig. 3).

Regarding the laryngoscopic view (Fig. 4), more grade 1 views were obtained in this study overall with HAVL than with SGVL (147/150 vs. 134/150, respectively).

Most physicians in our study preferred HAVL overall (Figs. 5 and 6). Many felt that HAVL required less force (9/15 grounded manikin and 10/15 helicopter manikin) and led to the best chance for first-pass success (11/15 grounded manikin and 10/15 helicopter manikin).

Discussion

VL has become ubiquitous in emergency medicine practice since the introduction of the GlideScope (Verathon Inc., Bothell, WA) in

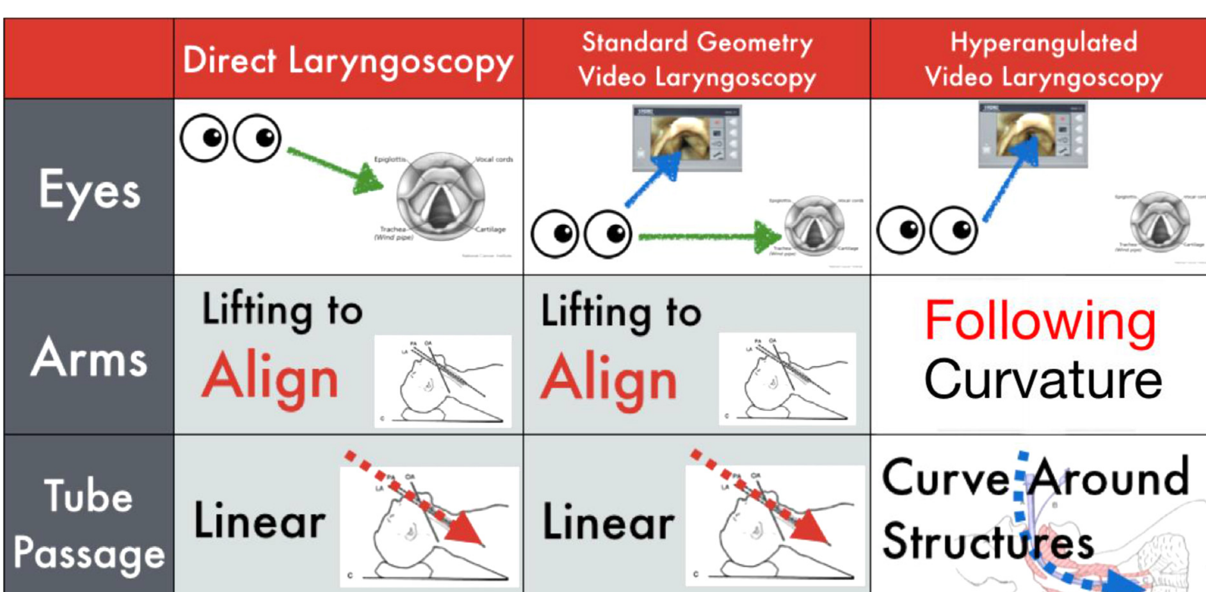

Figure 1. Standard Approaches to Laryngoscopy and Line of Sight. (Adapted with permission from TamingtheSRU.com.)

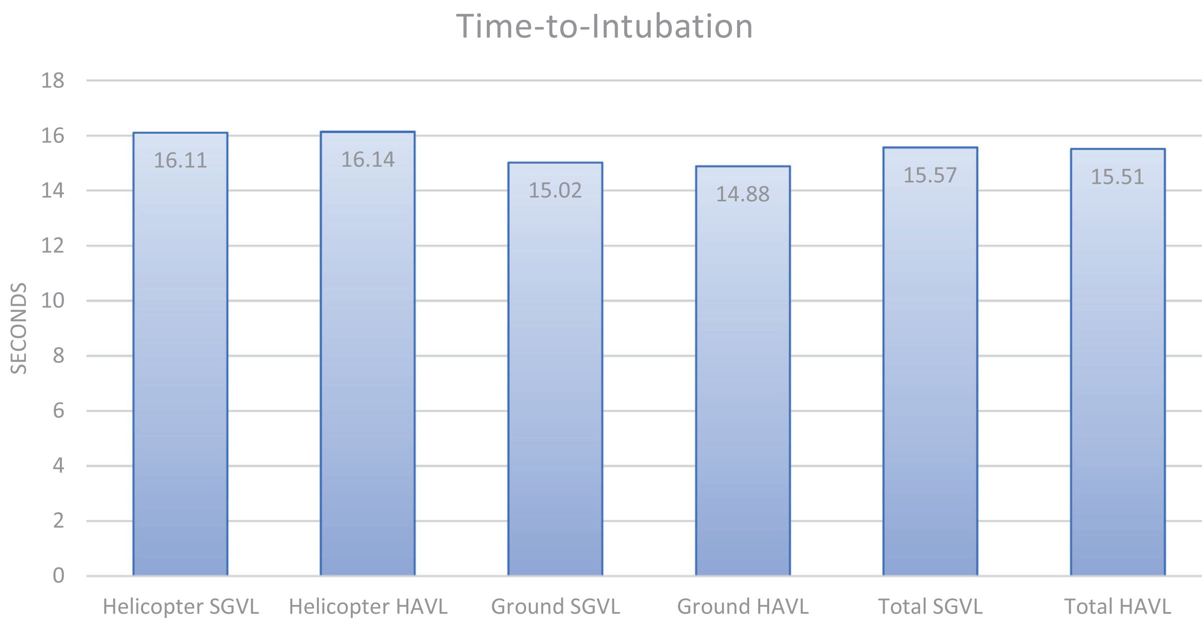

Figure 2. Average Time to Intubation.

2001.[12] Its use has been extensively documented within the emergency medicine literature. Today, there are multiple VL platforms available in the United States, including the GlideScope and CMAC.

There is general consensus today that VL is useful in the emergency department setting, especially when predictors of difficulty are encountered.[12-15] With respect to prehospital care, the utility is less well understood, but investigations completed to date do seem to show the feasibility of use in that environment as well.[2-9]

Not well examined to date is the use of the differing VL techniques that are required as a function of the blade shape being used. Unfortunately, many prior studies, editorials, courses, textbooks, and educators have conceptualized VL as a monolith. Rather, VL is only a term that describes how an operator is visualizing tube passage and not other aspects of the procedure, specifically how forces are being applied and tube passage is being accomplished. We suggest that not recognizing this can drastically impact the laryngoscopist's ability to successfully and facilely intubate his or her patient. This is becoming especially critical as common VL platforms are becoming equipped with both standard and hyperregulated geometry blades. For example, a common platform is the Karl Storz CMAC, which offers both SGVL (MAC 3/4) and HAVL (D-Blade) options.

Again, we define SGVL as the use of a blade that maintains the traditional geometry of a Macintosh laryngoscope to apply force vectors that align the native curvatures of the airway into a straight line followed by linear passage of a tube under direct sight line or indirect video visualization. It should be immediately recognized that this is

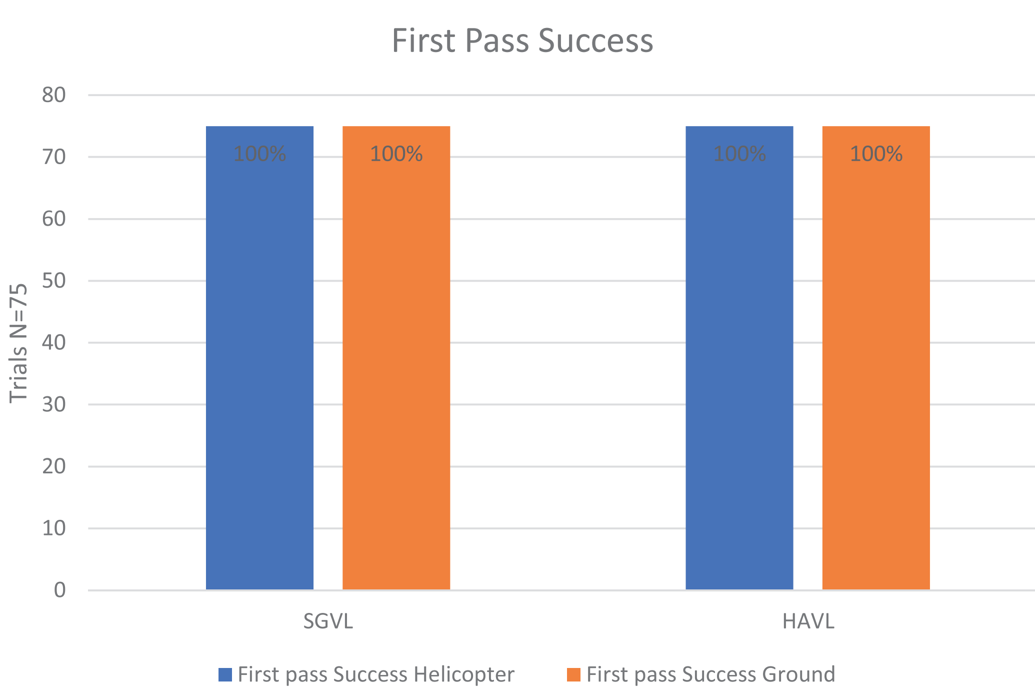

Figure 3. First Pass intubation success with HAVL vs SGVL.

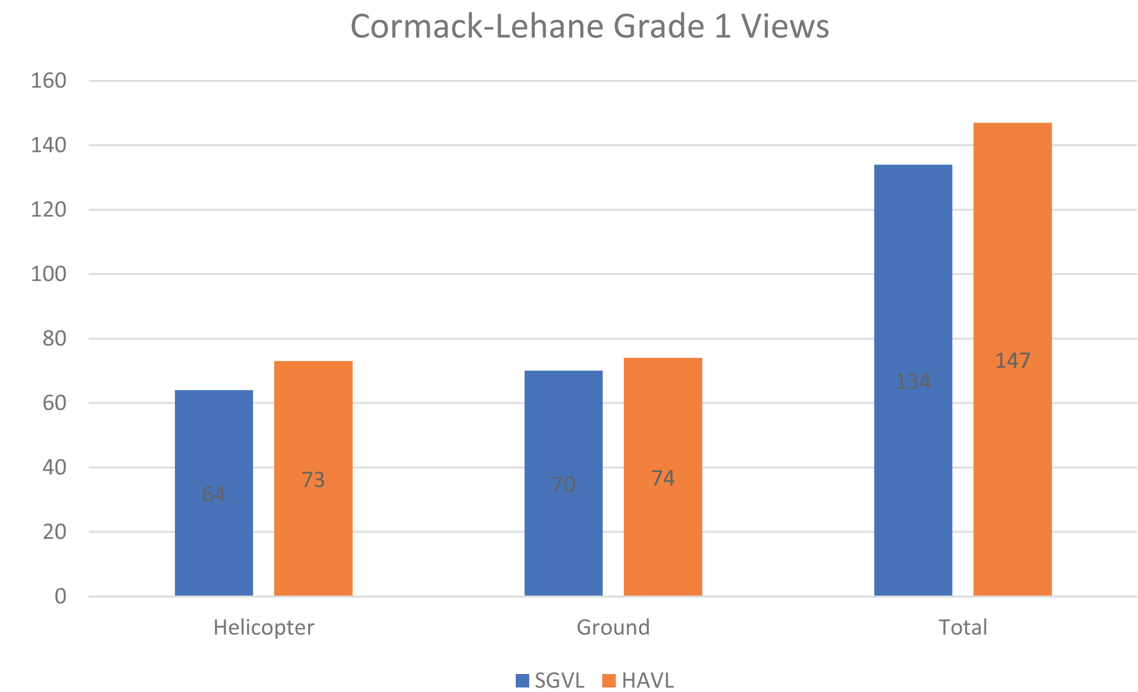

Figure 4. Cormack-Lehane Grade View for each Technique.

no different than direct laryngoscopy using traditional devices without video cameras, except that in that case visualization is required with eyesight. It is extremely important to note that clinically this allows an operator to revert to direct laryngoscopy if the lens becomes soiled. We define HAVL as the use of a blade that has a much more acute curvature to follow the native curvature of the glottis, with subsequent curvilinear tube passage under indirect video visualization.[10,11]

In many prehospital settings, patients are often less than optimally positioned for airway management. They can be entrapped in an automobile, in the back of an ambulance or helicopter, or at ground level without a stretcher when needing intubation. Given this, we hypothesized that technique selection may be even more important prehospital than in the hospital. In other words, considering the ergonomics of prehospital intubation and the need for optimizing axes with standard geometry VL, we predicted it may be easier and faster to obtain successful endotracheal intubation with HAVL than SGVL in patients in some prehospital settings.

In this study, we examined the use of SGVL and HAVL in 2 different simulated situations: with the patient in the back of a helicopter and with the patient on the ground. Our study did not find any specific benefit in time to intubation for either technique in either

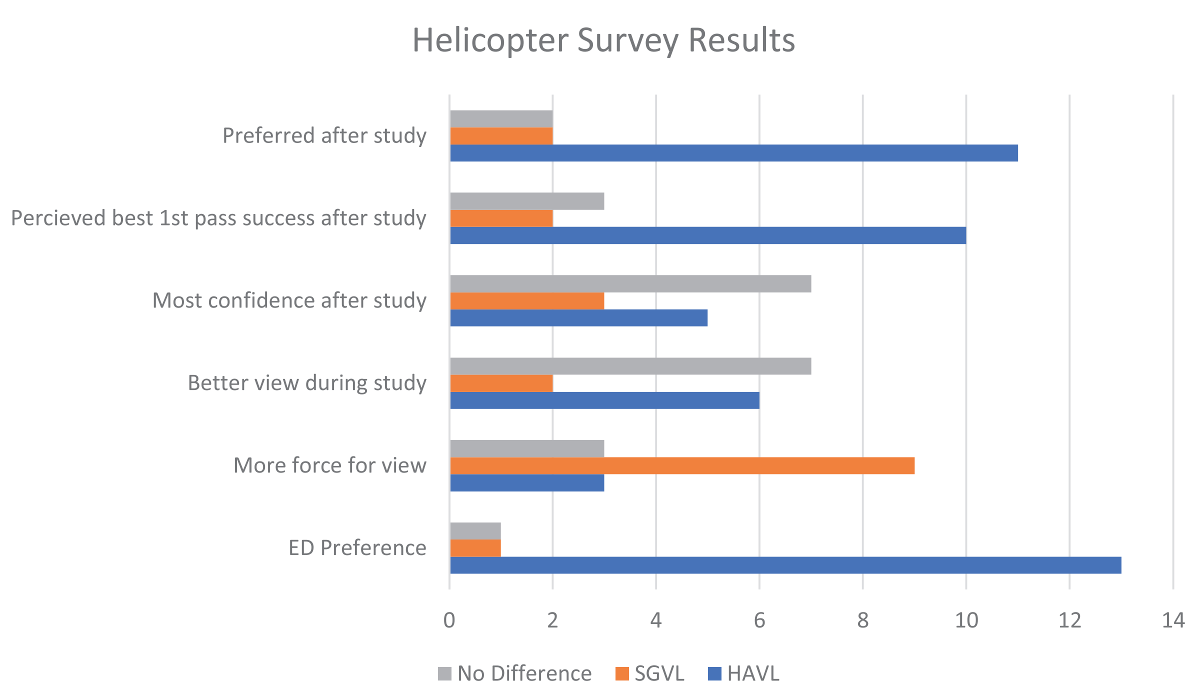

Figure 5. Physician Preferences in Helicopter.

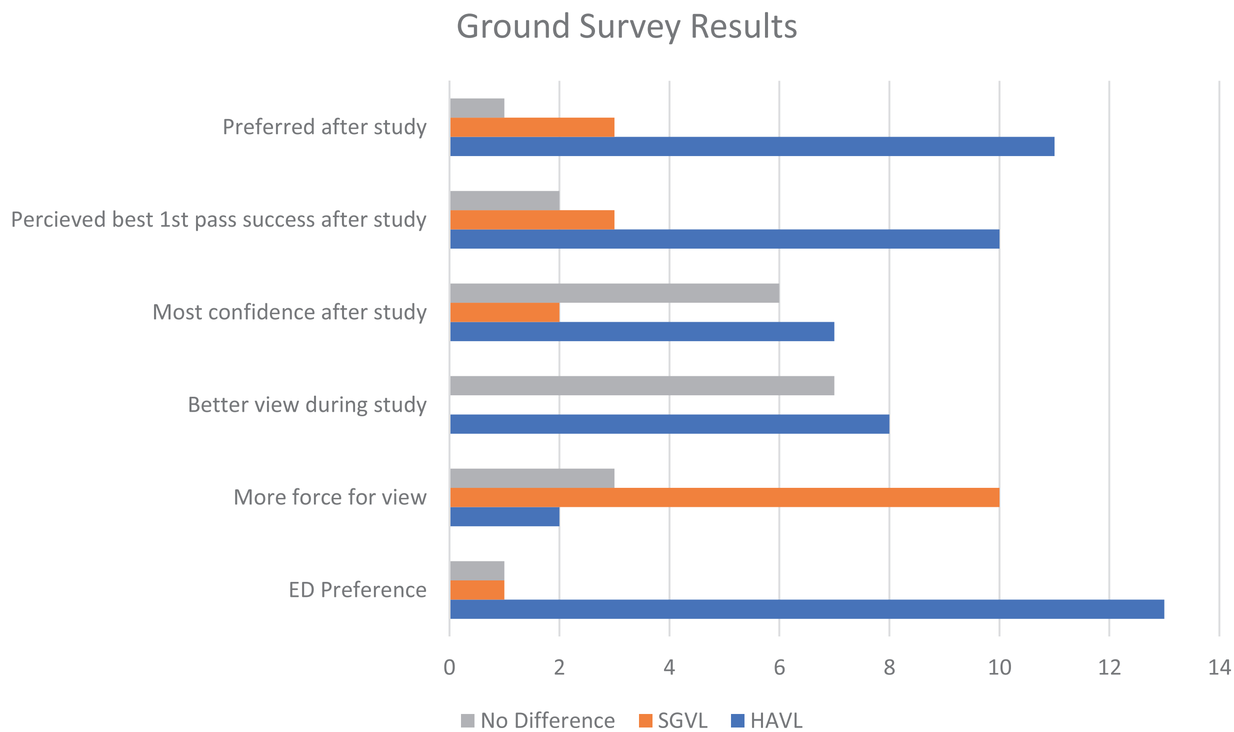

Figure 6. Physician Preferences on the Ground.

situation but was obviously limited by the nature of a manikin. Perhaps our results would have been different in a clinical trial of human patients given the unique anatomy of each patient. The clinical condition of patients in the prehospital environment (blood/vomitus in the airway, spine immobilization, etc) may influence the intubating conditions, and, therefore, familiarity with multiple techniques is likely indicated.

However, this study does demonstrate the effectiveness of both techniques when used by well-trained airway operators. All of our operators were attending emergency physicians who function as flight physicians who received specialized instruction on both techniques. Both techniques were highly successful and allowed for excellent views of the glottis and 100% first-pass success in a timely manner.

Interestingly, physicians preferred HAVL because of perceived ease of use. This may be due in part to their individual prior training experiences. Furthermore, the helicopter EMS team historically used a VL platform that only permitted a hyperangulated technique. Future research that extends the focus of this research to other prehospital providers (ie, EMS) may provide additional information regarding the preferred technique in providers with different training. The single-center nature of this study may also have influenced this result (ie, that has become the group's culture). It should be noted that HAVL did appear to provide better views of the glottis, but this did not affect the rate or time to success.

This study supports the idea that both HAVL and SGVL appear to be efficacious options in prehospital airway management, with no obvious superiority for either technique. More data on real patients are desperately needed to further this area of research.

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