

Simulated Angioedema in a Fresh Frozen Cadaver

A Novel Teaching Model for Airway Training

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Introduction: As educators, we are charged with preparing emergency medicine residents for successfully intubating patients with even the most troublesome anatomy. This situation is encountered during the intubation of patients with angioedema. These patients are uncommon in the emergency department, and as a result, it is difficult to ensure that each resident is well trained in this intubation scenario before graduation.

Educational Objective: Our goal was to develop an angioedema teaching model to increase resident knowledge, confidence, and proficiency at intubating in this clinical setting.

Curricular Design: Using a 22-gauge spinal needle and a 60-mL syringe, we were able to cause realistic distention of the lips, tongue, and pharynx when we injected approximately 300-mL of air bilaterally near the sublingual glands and into the tongue and lips. Before implementing the angioedema model into the curriculum, 5 board-certified attending emergency physicians evaluated the model for validation, and all agreed that it was high fidelity.

Participants performed both direct and video laryngoscopy on the simulated angioedema cadaver. At the conclusion of their intubation experience, the participants completed a survey describing their impression of the angioedema model.

Impact/Effectiveness: Participants included 29 emergency medicine residents, with participants from all year groups. In response to the statement, "The angioedema model was high fidelity," 12 residents strongly agreed, whereas the remaining respondents agreed. In response to the statement, "The angioedema model was a good training model for angioedema," 13 residents strongly agreed, whereas the remaining respondents agreed. When solicited for comments on the model, one participant wrote, "Awesome opportunity, I will be markedly less terrified when I get an angioedema/anaphylaxis case."

We have developed an angioedema training model using air insufflation in a fresh frozen cadaver. Our participants uniformly expressed positive impressions of both the fidelity and training quality of this model.

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Key Words: Angioedema, Emergency medicine, Difficult airway, Fresh frozen cadaver, Resident training, Intubation

Endotracheal intubation is an essential skill for the emergency physician, and providers must be prepared to manage any airway, regardless of the degree of difficulty. As educators, we are charged with preparing emergency medicine (EM) residents for successfully intubating patients with even the most troublesome anatomy. Likewise, residents in other training programs, such as anesthesia and otolaryngology, must learn to manage difficult airways.

In untrained hands, even uncomplicated airways have an unacceptably low success rate. For example, Nouruzi-Sedeh et al¹ found that novice airway managers completing standard intubation with direct laryngoscopy have a success rate of

intubation ranging from 35% to 65%. Complications of endotracheal intubation are also a major concern, as previous studies have shown that with direct laryngoscopy, the complication rate ranges from 9.3% to 14.9%.^{2–4} With a difficult airway, an increased complication rate can be expected. This is likely to happen because the leading cause of difficult intubations is insufficient laryngoscopic view.^{5–7}

One clinical situation occasionally requiring endotracheal intubation of the difficult airway is severe angioedema. Whereas angioedema accounts for 80,000 to 112,000 emergency department visits annually, the hospitalization rate is 18% with even fewer requiring intubation.^{8,9} As a result, it is both important and difficult to ensure that each EM resident is well trained in this intubation scenario before graduation and independent practice. There are commercial mannequins that allow for tongue swelling; however it has been shown that cadaver training is more realistic than simulators.^{10,11} We are unaware of any previously described cadaver models for teaching endotracheal intubation on patients with angioedema.

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Educational Objective

Our primary objective was to develop a teaching model to increase resident knowledge, confidence, and proficiency at intubating in the clinical setting of severe angioedema.

Curricular Design

The project took place at our fresh frozen cadaver course, which is a shared experience between 2 residencies each summer (Fig. 1). This 2-day course is taught by EM faculty and senior residents and entails basic airways, difficult airways, and other invasive EM procedures. Other difficult airway models used include the use of cervical collars during intubation, a pulmonary edema model using baking soda and vinegar, and filling the airway with cream of mushroom soup to simulate peri-intubation emesis. The simulated angioedema concept was a progression of these other difficult airway models.

We found that angioedema can be easily simulated by injecting the lips, tongue, and larynx. Initial efforts using large-gauge needles and normal saline created a realistic model, but the puncture sites leaked substantially, and the anatomy deflated rapidly. Attempts using small needles still leaked, although more slowly, and required frequent suctioning of the airway. As the experiment evolved, we hypothesized that a liquid with higher viscosity would remain in the tissue longer, and the saline was replaced with agave syrup. Even when using a large-gauge needle to overcome resistance, injection was very difficult, and the agave still leaked, again requiring frequent suctioning and making the setup time between trainees prohibitively slow. Heating the agave to lower its viscosity did not decrease time to distortion to a satisfactory level.

Our most practical model came from the insufflation of air bilaterally near the sublingual glands. Using a 22-gauge spinal needle and a 60-mL syringe, we were able to easily cause realistic distention of the lips, tongue, and pharynx when we injected approximately 300 mL of air (Fig. 2). Leaking still occurred, but reinsufflation was rapidly performed any time deflation was detected. In addition, the leaking did not fill the airways with liquid unlike our saline and agave models.

Before implementing the angioedema model into the curriculum, 5 board-certified attending emergency physicians from 2 separate residencies evaluated the model for



FIGURE 2. Insufflation of 300 mL of air through a 22-gauge spinal needle into the submandibular gland space resulting in characteristic angioedema anatomy.

validation of fidelity. Although no formal survey was performed, all 5 agreed that the model was a high-fidelity representation of an angioedema airway.

Participants then performed both direct and video laryngoscopy on the simulated angioedema cadaver. At the conclusion of the experiment, participants completed a survey describing their impression of the angioedema model.

Impact/Effectiveness

Participants included 29 EM residents, with representation from all 3-year groups. In response to the statement, "The angioedema model was high fidelity," 12 residents strongly agreed, whereas the remaining 17 respondents agreed. In response to the statement, "The angioedema model was a good training model for angioedema," 13 residents strongly agreed, whereas the remaining 16 respondents agreed. None of the participants answered strongly disagree, disagree, or neutral to either question. When solicited for comments on the model, one participant wrote, "Awesome opportunity, I will be markedly less terrified when I get an angioedema/anaphylaxis case."

Our model is limited in that it requires the use of a cadaver and will therefore not likely be available as a training model on a regular basis. In addition, because of the resources needed to conduct a cadaver laboratory, this high-fidelity high-yield model would require all trainees be present on the same day to benefit from it.



FIGURE 1. Fresh frozen cadaver before any airway alterations.

As educators, we are always looking for more realistic training models for our residents. Because angioedema requiring intubation is an uncommon phenomenon, many residents will never encounter this scenario during their training. We have developed a simple angioedema training model using air insufflation in a fresh frozen cadaver. Our staff and resident participants uniformly expressed positive impressions of both the fidelity and training quality of this model. Other EM residencies are encouraged to use this model in their own programs to facilitate training of the difficult airway in the angioedema patient, and we hope that training programs in anesthesia and otolaryngology will find it useful as well.

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