CREATING AN INTERACTIVE ALGORITHM
For Improved Management of Micrognathic and Retrognathic Infants

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Abstract

Infants born with micrognathia face risk of injury when anesthesia is required, due to facial anomalies that cause airway obstruction and difficult intubation. Lack of training resources prevent physicians from acquiring the experience necessary to adequately care for these patients. A web application was created to teach and reinforce the recommended techniques for intubation on micrognathic infants in order to contribute to their safety inside and outside the operating room. A unique interactive algorithm within the application allows the user to learn about micrognathic infant airway management through text, illustration, 3D models, and animation.

Introduction

Figure 1. Pierre Robin sequence infant [1]

Some infants are born with congenital disorders that cause an underdeveloped jaw. This condition is known as “micrognathia” or “retrognathia”. Micrognathia is associated with a number of disorders, most notably Pierre Robin sequence (Figure 1). A physician unfamiliar with the anatomy and the techniques needed for intubating a micrognathic infant can cause severe injury during airway management.

Current educational resources such as the Society of Anesthesiologists’ Difficult Airway Algorithm are made only for adult patients, and intubation mannequins (Figure 2) are cost prohibitive and inaccessible. The goal of this project was to create a unique, interactive algorithm that would fill current educational gaps and provide an accessible resource for anesthesiology and otolaryngology residents as well as certified registered nurse anesthetists.

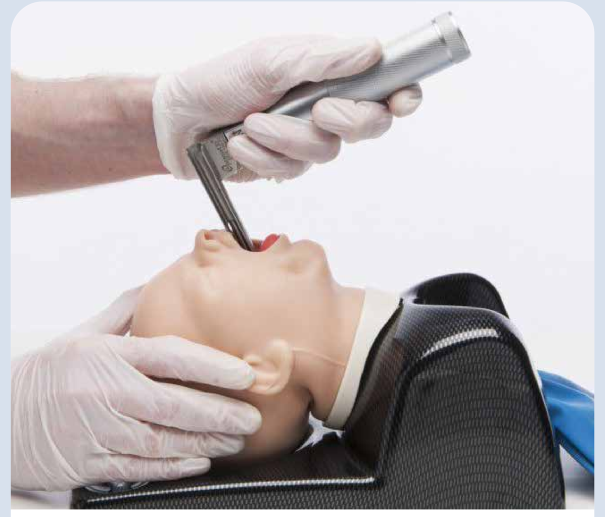

Figure 2. AirSim® Pierre Robin Training Manikin [2]

Materials & Methods

Creating the unique algorithm required discussion with subject matter experts to summarize the techniques and equipment that a physician needs to be aware of to properly intubate a micrognathic infant. The research was compiled into a flowchart using the online program Draw.io and designed in Adobe Illustrator (Figure 3 (A)). The 3D model was built with reference and CT data from the Department of Otolaryngology at Johns Hopkins Hospital. Meshes were segmented from the data in Osirix (Figure 3 (B)), and other anatomy was sculpted in Zbrush and Cinema 4D. Everything was exported for use in Unity (Figure 3 (C)).

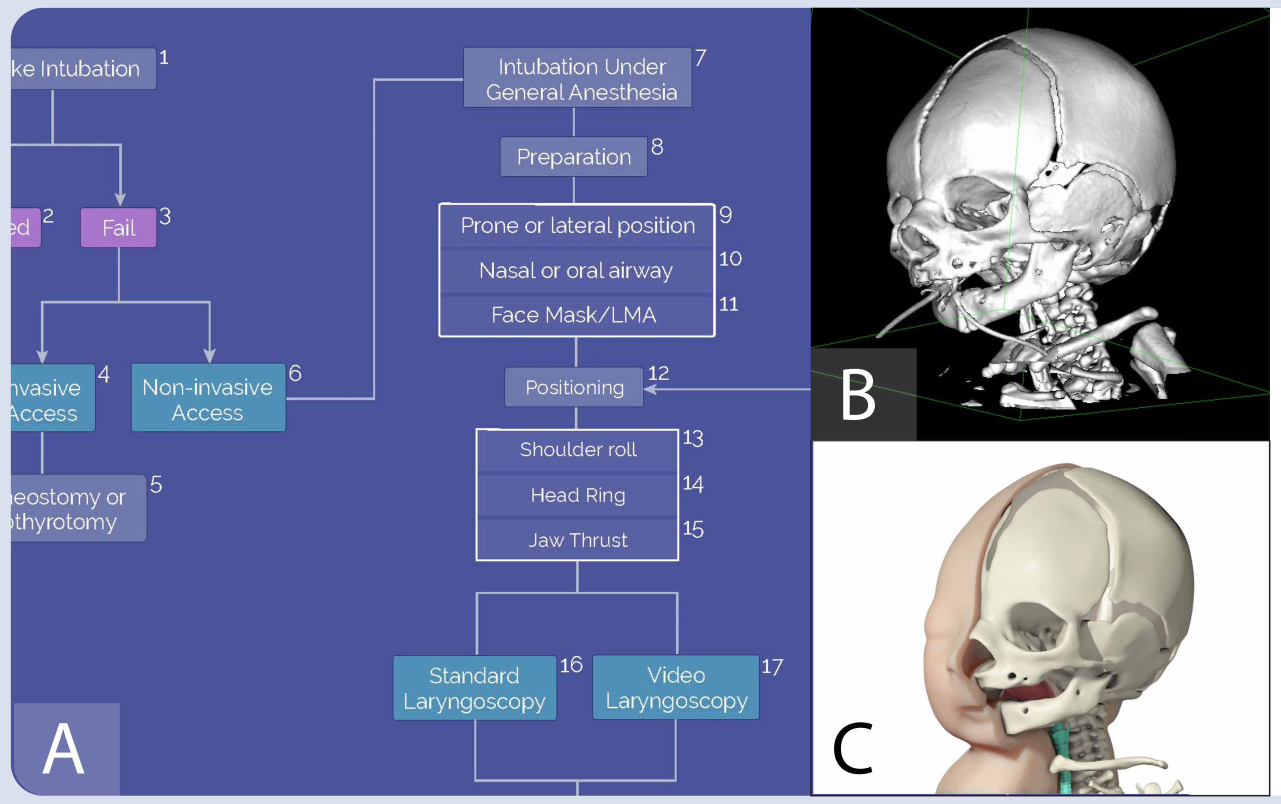

Figure 3. In-progress screenshots. (A) Section of Difficult Airway Algorithm for Micrognathic Infants. (B) Skeleton in Osirix. (C) 3D render from Cinema 4D

Artwork was created in Adobe Illustrator and Photoshop (Figure 4 (A, B)). Some of the art was brought into Adobe After Effects to create animations.

In unity, the user interface was designed for each scene of the application (Figure 4 (C)). Assets were brought into each scene and C# programming was used to make user interactions within the application. Scripts were written to pan, rotate, and zoom the 3D model, turn features on and off, change materials, show and hide scroll panels, and many other actions that make a web application interactive.

Once the application was built, it was exported to WebGL format.

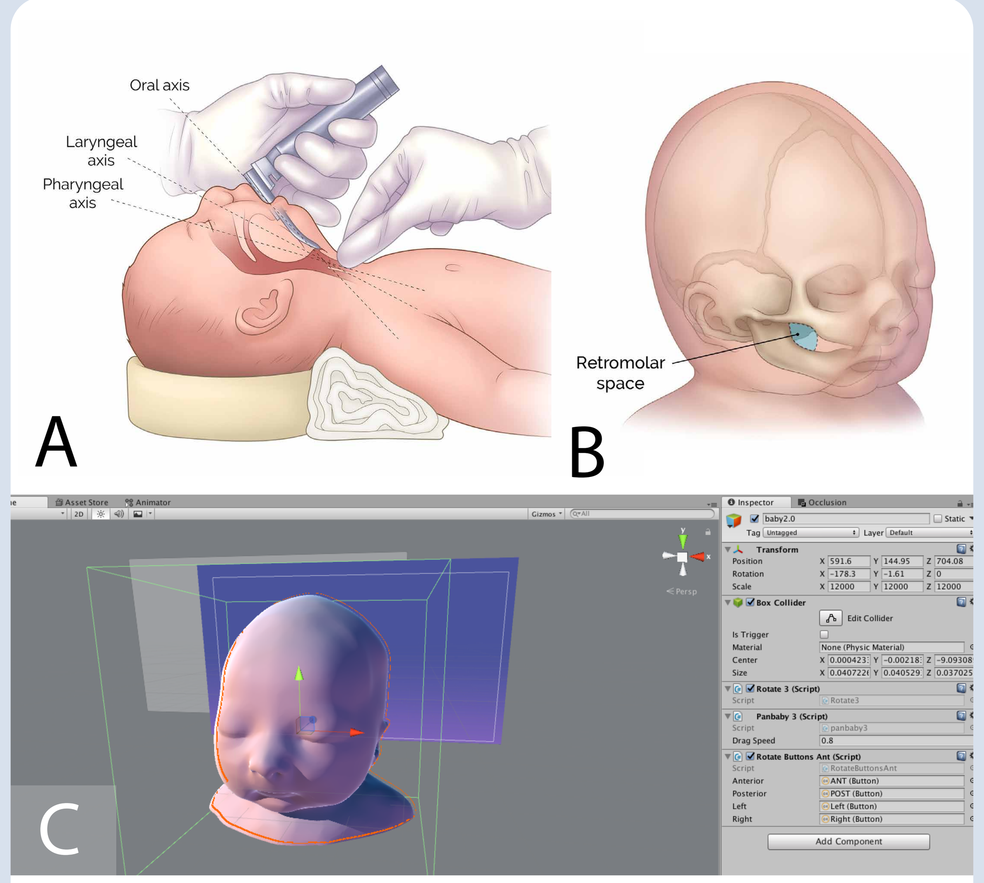

Figure 4. Additional in-progress screenshots. (A) Retromolar intubation illustration. (B) Retromolar space illustration. (C) Box collider in Unity

Results

The resulting visuals are: 1 interactive 3D model, 1 interactive algorithm, 60 illustrations, 4 animations, and 1 online PDF. This application (Figure 5) will be implemented into future resident education at Johns Hopkins Hospital.

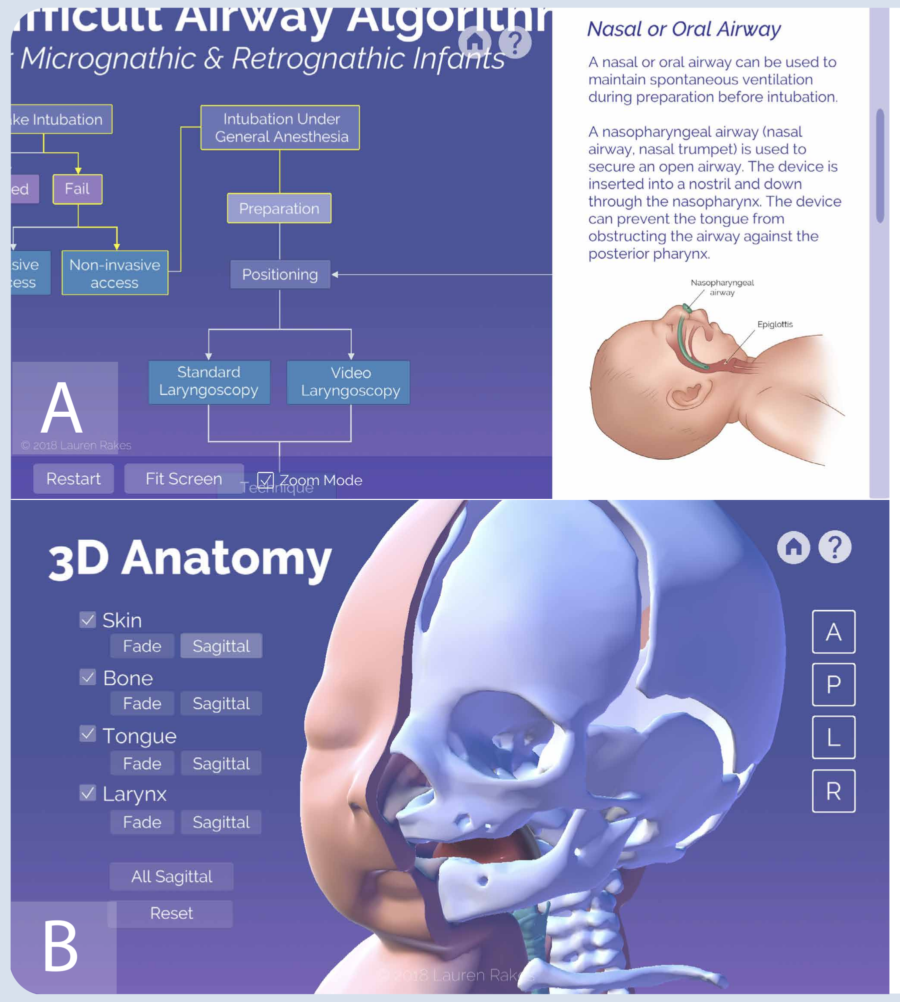

Figure 5. Screenshots from final web application. (A) Difficult Airway Algorithm for Micrognathic and Retrognathic Infants, Nasal or Oral Airway information. (B) 3D Anatomy section

Discussion & Conclusions

A future plan for this project is to add specific case-driven examples to the algorithm, including both emergent and non-emergent scenarios with a virtual patient. In this version, the focus would be placed on the decisions the users make and the resulting outcomes for the patient. The idea behind the interactive algorithm that is the heart of this project can be applied to teach many different medical topics, such as first aid, pain management, and emergency medicine. Utilizing it in these fields could lead to improved mental preparation, better decision-making skills, and optimal patient outcomes.

Bibliography

1. ”Pierre Robin Sequence Gallery.” Craniofacial Team of Texas. http://craniofacialteamtexas.com/craniofacial-gallery/pierre-robin-sequence-gallery/.
2. Apfelbaum, et al. “Practice Guidelines for Management of the Difficult Airway.” Anesthesiology 118, no. 2 (2013): 251-70.