Introduction

Cleft lip and palate is a birth defect that affects 1 in 1000 births each year in the United States. This condition occurs when the palate or lip does not close properly during fetal development, resulting in a gap in the oral cavity. Parents who are told that their child will be born with a gap in their lip and/or palate need to build a strong foundation about this condition in order to provide support and choose the best treatment plan for their child. The lack of models currently available limits physicians to the use of 2D images and hand motions to explain the anatomical and physiological defects caused by a cleft.

Proposal

In order to provide an efficient learning method for parents, we proposed creating a library of tangible models illustrating this birth defect. We designed two sets of models that portrayed the range of conditions associated with cleft lip and palate. The first set of models is a modular set that can easily be assembled and disassembled for visibility of inner structures of the oral cavity. The second set of models is a series of surface models portraying the surface characteristics of the cleft lip. With a library of these models, physicians are better able to illustrate to parents what is affecting their child and the best treatment approach.

Methods

Materialise Mimics and 3-Matics are utilized to generate 3D images from CT scans before printing. Once the models are modified, they are sent to the following 3D printers:
- Connex 350
- Fortus 400
- Zprinter 650

From the materials available in these 3D printers:
- Skin and palate tissue are printed in TangoPlus on the Connex
- Bone tissue is printed in ABS plastic on the Fortus
- Surface models are printed in a gypsum composite on the Zprinter

Results of Modular Models

After assembling the models, we surveyed random individuals to gauge the effectiveness of the models. None of the survey participants identified as parents of cleft lip and palate patients. Individuals were asked to rate their understanding of the condition, once after receiving information without the models and once with the models. Overall, the tangible examples were found to be useful in gaining a better understanding of cleft lip and palate.

Result of Surface Models

Conclusion

- Successfully created models that provided better understanding of cleft lip and palate
- Used materials that closely resemble the stiffness of anatomical structures
- Created files and models of both modular and surface models for reproducibility
- Obtained positive feedback on the improved understanding of cleft lip and palate with the addition of models

Ethics

In the course of this project, we were careful to protect patient information. To protect the identities and privacy of the patients from which the data was sourced, files were anonymized and identifying features were removed to the extent possible.

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