Application of 3D Scanning and Printing in Auricular Reconstruction Surgery for Patients with Unilateral Microtia

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Background:

Microtia is a congenital anomaly leading to malformed external ear [1-2]. Most widely used technique for auricular reconstruction involves usage of autogenous cartilage. Traditionally, surgeons used 2D transparent film/paper cut out template from the contralateral ear to design a new auricle. However, due to complex contour of ear, it is very difficult to achieve excellent results using only 2D data. Hence, there is a need of better reference models, which can help the surgeon in performing the surgery. Recently research groups [3-4] have tried to use 3D imaging data and 3D printed ear models as a tool to assist surgery, but these techniques are still not widely used in our locality. Current study aims at exploring the potential of usage of 3D printed ear models as a reference in auricle reconstructive surgery.

Methods:

For this study, auricular reconstruction was performed with the guidance of reference 3D ear models on eight participants (3 male and 5 female) with an average age of 12.5 years, using Nagata reconstruction technique [5]. 3D scans of contralateral ears were acquired using Artec Eva 3D scanner for every patient. Mirroring operation was performed on the acquired scans to develop 3D models of new auricles. These models were 3D printed and used as a reference during the surgery.

Discussion:

The most important part of the reconstruction surgery involves harnessing the costal cartilage from the ribs. Cartilage is conventionally harvested based on surgeon's judgement and experience, which can at times lead to shortage of cartilage [2]. However, with the help of 3D ear reference model, surgeons can better estimate the required size of cartilage and identify the optimal sites for harnessing the cartilage. In addition, while sculpturing the auricular

cartilage framework for the reconstruction, the 3D model can be used as a reference tool in deciding the shape, size and contour of the new auricle. This will help in maintaining the symmetry of both ears. Reference model also helps the surgeon in preparing and planning the auricle reconstruction site by providing the area and surface estimation details. Alternatives for costal cartilage like high density porous polyethylene implants [6] are being used currently yet the material cannot be 3D printed. With the advances in 3D scanning and printing technology, the future goal would be to print biocompatible customized implants, which can be placed directly under skin for auricular reconstruction, to reduce the operative time and avoid complications associated with costal cartilage harvest.

Conclusions: 3D printed reference ear model is a useful tool in addition to 2D templates in auricular reconstruction surgery. These models can help the surgeons in operative planning and carving of the cartilage framework.

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