INTRODUCTION

Soft tissue models of the face can aid providers in the visualization and diagnosis of injuries. Three-dimensional photography, along with rapid prototyping techniques, can provide surgeons with a clinically accurate representation of the injury site for upcoming procedures. In addition to the 3D models of the injured area, models can be digitally adapted to create an ideal situation/state. Templates can then be constructed based on the digitally created ideal model.

Techniques, such as using a template for a rhinoplasty, are not new. The previous methods used to achieve these templates, however, are quite complex. Utilization of foil that has been folded and crimped has long been the gold standard. Another method involving thermo plastics has also been used to make a three-dimensional representation of the defect, which is then transferred into two-dimensions by making releasing cuts. The two-dimensional plastic is then used as a guideline for forehead flaps [1]. Another institution used facial mousses to create models of patients faces and then subsequently sculpted an anatomically correct nose using wax. This new face was then scanned and rapid prototyped. Templates were then constructed and molded [2]. No published studies, however, show a transition from three-dimensional photography to digital manipulation, template design, and manufacturing.

Using digital technology and rapid prototyping, surgeons can visualize the desired outcome before each procedure. After a “digital rhinoplasty” is performed, templates are easily designed and manufactured to serve as a surgical guide for an upcoming operation.

METHODS

Three-dimensional Acquisition

• Soft tissue contours of the patient captured using 3dMDcanal system (3dMD, Atlanta, Georgia), a non invasive imaging system with an accuracy of <0.2mm in a two-millisecond window. (Figure 1)
• Data exported from the 3dMD system as a .vmtl, .lst, or .obj file
• Thickness was added to the tissue surface using Magics Software (Materialise, Ann Arbor, Michigan).

Computational Rhinoplasty and Template Design

• Defective part/section of the nose was digitally removed and replaced with an “ideal nose” from another individual. The ideal nose was scaled and transitions were smoothed using Magics (Materialise, Ann Arbor, Michigan) and FreeForm Modeling Plus (SensAble Technologies, Woburn, MA) Software. (Figure 2)
• If pre-injury pictures are available, it’s beneficial to scaling and contouring
• Templates created digitally by using an offset algorithm on the ideal face

Original face, ideal face, and templates were saved as a STL files

Template Manufacturing

• STL Files are processed on a build platform using Light Year (3D Systems, Rock Hill SC).
• Files are rapid prototyped using a Stereolithography Apparatus, by local curing resin using an Ultraviolet laser layer by layer in the Z-direction at 0.125 mm increments.
• Models are then sterilized in an autoclave and stored in a cool, dry place.
• Supports (lattice structure) are stripped from the model, followed by the models being post-cured (Post Curing Apparatus, 3D Systems, Rock Hill SC) to achieve smooth transitions to surrounding facial tissue. Pre-injury pictures can provide addition information, such as width and depth, to the surgeon/engineer; thus making it easier to create the desired “ideal” nose.

RESULTS / DISCUSSION

The virtual and physical models can provide information not easily obtained by standard photography/examination. Digital manipulation and models prove helpful to surgeons when evaluating the full extent of the injury, and when creating a surgical plan. Rhinoplasty can be performed before taking the patient into the operating room. In addition to the examples shown, surgeons can use the information to create a “half-nose” rhinoplasty guide, laying next to the face, is made from PMMA. The transparency of the PMMA is an added benefit to the surgical procedure. Cheek and forehead indexing tabs are located on the surgeon to verify proper translation/rotation with respect to the patient’s face.

REFERENCES