Three-Dimensional Printed Facial Models in Rhinoplasty

Tristan Klosterman, MD1  Thomas Romo III, MD, FACS2

1 Head and Neck Institute, Lenox Hill Hospital, New York  
2 Department of Otolaryngology, Manhattan Eye Ear and Throat Institute, New York

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Abstract

Digital patient photography and morphing software have become an important part of rhinoplasty over the past few decades. Presented is a novel technology incorporating 3D photography and printing to produce life-size models for use in patient evaluation and treatment. Surveys were conducted to assess patient response and were universally positive. Early surgeon experience also indicates benefit for intraoperative use.

Methods

Six patients (1 male, 5 females, average age: 22) undergoing primary cosmetic rhinoplasty were electively asked to participate in this study using 3D printed model technology (MirrorMe3D Inc.). Standard evaluation practices were performed with both conventional and 3D (Canfield H1 Camera) photography. Computer morphing evaluations (Vec- 

tra Sculptor Software) were performed with the patients to produce 3D digital models. As with all morphing, patients were educated on the nature of simulation and discretion was used by the surgeon to produce models that were surgically feasible.

These 3D computer baseline and morphed models were then sent to MirrorMe3D Corporation for creation of life-sized 3D printed models of the patient’s face (Projet 660 using gypsum, wax, and cyanoacrylate). These models extended from the lateral pupil to lateral pupil and from the forehead to just above the chin (Fig. 1). Models were produced overnight (5–8 hours) by the company’s production facility and colored. Prices for individual models averaged U.S. $225 as of July 2016 and were purchased at retail price. There are no financial or academic affiliations between the authors and MirrorMe3D.

The baseline (base) and simulation printed models were then displayed to patients preoperatively and used to confirm procedure goals. Models were able to be referenced
intraoperatively by the surgical team (►Fig. 2). Close approximation of the model to the operative patient provided real-time feedback to the surgeon. Patients are seen for a routine postoperative visit where a 10-point postoperative survey was conducted regarding experience with the models and future model use (►Fig. 3). The models were additionally used as an outcome reference by the surgeon. Patients were otherwise followed in standard postoperative fashion. This project was approved by the institutional review board through the Human Research Protection Program at Northwell Health.

Results

Patient responses were highly complimentary of the models. All scored a 3 or 4, (somewhat or definitely agreed) with all categories (►Table 1). The only exception was that one patient reported that the models would not influence her choice of surgeon (score of 1).

Patients strongly agreed that the 3D models were useful and noted that they would request the use of models in the future. Patients expressed unanimous interest in using 3D models for future rhinoplasty or other cosmetic procedures. Comments from the survey showed a high regard being able to compare the preoperative and simulation model in real time, using tactile and visual feedback. Patients and their families reported a significant positive emotional response with the initial presentation of the models. At routine postoperative visits up to 6 months, subjective satisfaction remained high. Pre- and 6-month postoperative photography of the first patient to use the models is seen in ►Fig. 4.

The models were referenced intraoperatively in all cases. Specific comparisons such as bridge height, projection, and rotation facilitated decision making to better approximate the simulated model. The presence of intraoperative models allowed for minor modifications of surgical plan in a significant portion of the patients.

Discussion

Digital photography, morphing software, and 3D cameras have offered patients and surgeons advanced tools in rhinoplasty, offering increasing patient satisfaction and cosmetic results.4 Like many new technologies, adoption relies on proof of concept and data. We present a novel technology that is highly regarded by patients and advances existing technology.

These initial data are promising for the use of the 3D printed models for rhinoplasty. While this represents a focused view and primarily addresses the patient perspective, it introduces a technology that has application to many different plastic surgeries as well as rhinoplasty. Models can be created for facial augmentation (genioplasty and malar implants), otoplasty, rhytidectomy, blepharoplasty, and combined procedures with exciting promise. Survey data suggest that models may be requested by patients in the future, and their availability might affect their surgeon choice. Significantly, patients reported improved satisfaction.
and understanding of the goals of the procedure. Two patients reported that tactile interaction was specifically helpful in translating conceptual models into reality. Patients expressing apprehension or anxiety may benefit from the added feedback of a model before proceeding with surgery.

An additional facet of these models is as an intraoperative aid for the surgeon. Having both baseline and simulation models pre- and intraoperatively allow for added surgical precision. Full-sized morphed models can be held up to the patient as the operation progresses to better assess progress and goals. In our surgical practice, we have subjectively noted higher surgeon intra- and postoperative outcome satisfaction with the use of the models while also positively affecting surgical decision making. Significantly, this is an introductory study and is limited by its size and design. Further data are needed to fully assess these findings. Specifically, to compare this with other technologies and better identify the role of 3D printed models in contemporary rhinoplasty.

**Conclusion**

Rhinoplasty is an incredibly complex and difficult surgery that has benefited from new technology in the planning and operative stages. Three-dimensional photography and

### Table 1 Patient survey results with the number of individual answer selections

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Abbreviations: F, female; M, male.
printed models are a novel advance that holds significant promise in the field of facial plastic surgery. These initial data are an important step in introducing and supporting this technology. Rhinoplasty-printed models are an exciting tool for assisting patients and surgeons in their planning and interventions.

References


Fig. 4 Pre- (A, C) and 6-month postoperative (B, D) images of second model pair in » Fig. 1.