Domestic three-dimensional scanner and printer in patients undergoing rhinoplasty

Uso de digitalizador e impressora doméstica em 3 dimensões em rinoplastia

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■ **ABSTRACT**

The principles for a successful rhinoplasty include preoperative consultation and planning, as well as a comprehensive clinical analysis and defining rhinoplasty goals. Three-dimensional domestic scanning and printing have recently become available. We sought to objectively describe this method as an intraoperative aid in patients' anatomy. This method can be used trans-operatively to help surgeons compare the results of his or her technique, check adherence to the surgical plan, and improve his or her surgical decision-making. We found that the application of 3-dimensional printing had a positive effect on the treatment of patients with aesthetic nose disorders.

Keywords: Rhinoplasty; Imaging, three-dimensional; Reconstructive surgical procedures; Bioprinting; Image processing, computer-assisted; Image interpretation, computer-assisted.

■ **RESUMO**

Os princípios para uma rinoplastia bem-sucedida incluem consulta e planejamento pré-operatório e uma análise clínica abrangente que defina as metas da cirurgia. Mais recentemente, a digitalização e a impressão doméstica em 3 dimensões tornaram-se disponíveis. O objetivo deste estudo é descrever um método de digitalização em 3 dimensões e de impressão doméstica da anatomia real do paciente para ser usada como ajuda intraoperatória. Nós apresentamos uma forma de uso desta tecnologia no transoperatório, auxiliando o cirurgião a comparar os resultados obtidos após suas manobras, verificar a sua adesão ao plano cirúrgico previamente estabelecido e melhorar a sua tomada de decisão durante a cirurgia. Em conclusão, a aplicação da impressão doméstica em 3 dimensões demonstra um efeito positivo sobre o tratamento de alterações estéticas do nariz.

Descritores: Rinoplastia; Imagem tridimensional; Procedimentos cirúrgicos reconstrutivos; Bioimpressão; Processamento de imagem assistida por computador; Interpretação de imagem assistida por computador.

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INTRODUCTION

Preoperative consultation and planning, as well as comprehensive clinical analysis and defining rhinoplasty goals, are essential for successful rhinoplasty[1]. Systematic nasal analysis is critical to establish the goals of surgery. Plastic surgeons can adopt numerous methods in their practices to help patients better understand the surgical results to expect following rhinoplasty[2].

Currently, there is no gold standard to redesign a nose as a team with the patient. Some surgeons prefer to use tracing paper overlying the patient facial pictures, while others prefer to show before and after pictures of patients they operated. Surgeons also use computer morphing to set goals for rhinoplasty[3].

The development of polymer filaments, laser, and computer-aided design has permitted the creation of three-dimensional (3D) scanning and printing technology. Three-D domestic scanning and printing have recently become available[4]. It allows the surgeon and patient to view a sculpture of the nose. This technology goes beyond a simple 3D-shaded visualization on a flat monitor and allows for the labored mold to be palpated, rotated, and viewed from many angles.

OBJECTIVE

We sought to objectively describe using a domestic 3D scan and print of the patients' anatomy as an intraoperative aid.

METHODS

Patients undergoing rhinoplasty for aesthetic purposes had a preoperative facial scan taken using a hand-held scanner (Sense 3D Scanner; 3D Systems, Rock Hill, S.C.). The reference model was then cropped, trimmed, and solidified using the 3D software (Sense software, 3D Systems, Rock Hill, S.C.) on the patient scan (Figure 1). The file was transferred to a 3D printer (Cube 3D printer, 3D Systems, Rock Hill, S.C.) to create a statue of the nose with Polylactic Acid filament (PLA) preoperatively (Figure 2).

During their preoperative visit, patients discussed the intended results with their surgeon using the printed effigy. The sculpture is taken to sterilization for 4 minutes at 270°F in a pre-vacuum sterilizer. It can then be used trans-operatively to help the surgeon to compare the obtained results following his or her technique, check adherence to the surgical plan, and improve his or her surgical decisions (Figure 3).

All patients provided informed consent to participate in this study. The study was conducted according to the International Ethical Guidelines for

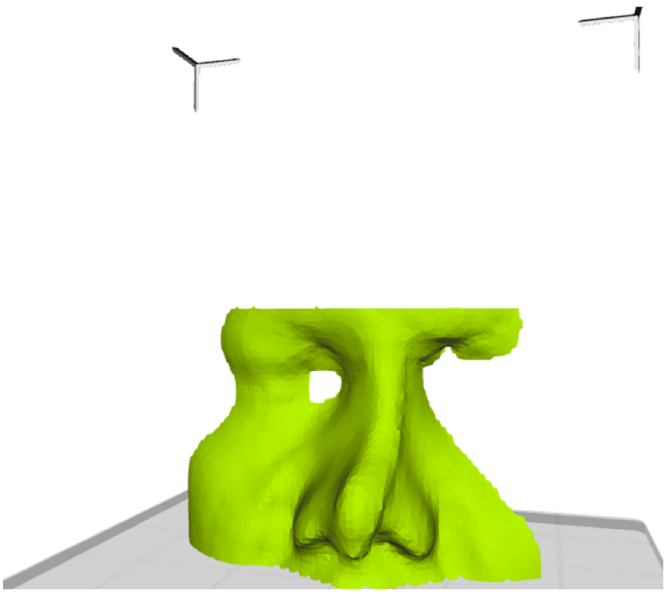

Figure 1. 3D reconstruction in the scanner software.

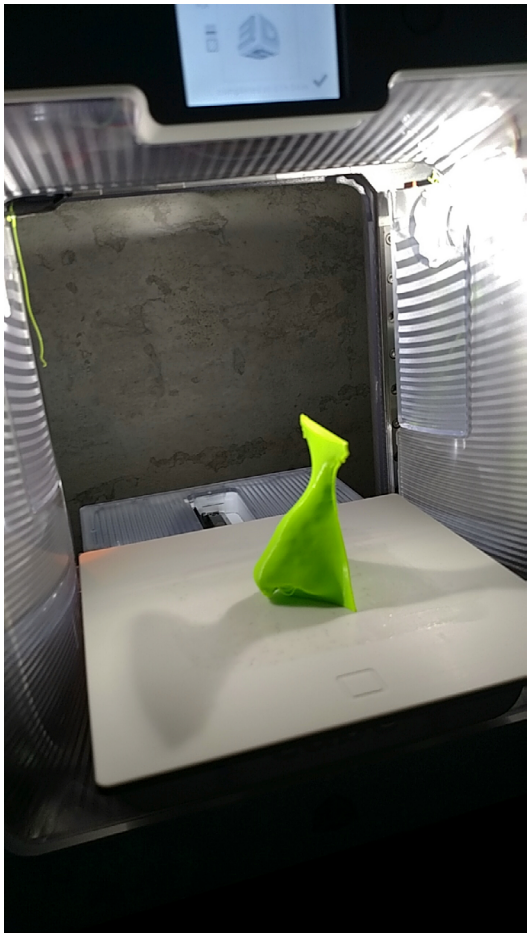

Figure 2. 3D mold in the printer.

Figure 3. 3D mold used in surgery.

Health-Related Research Involving Humans from the Council for International Organizations of Medical Sciences of the World Health Organization.

RESULTS

Preoperative facial scans were printed, and the molds viewed in 12 patients undergoing rhinoplasty for aesthetic purposes. All of the patients underwent surgery.

DISCUSSION

Three-dimensional printing was first introduced in 1986, and now approximately 30,000 3D printers are sold worldwide annually[5]. Validated low-cost 3D printers could represent a step toward better accessibility of rapid prototyping technologies in the medical field[4]. In this study, we described how to use 3D printing of patients' nose anatomy as an intraoperative aid.

PLA is the default recommended material for many domestic 3D printers because it is useful in a broad range of printing applications, and is odorless and has low-warp. In addition, 3D printing provides a quick and inexpensive way to create model replicas[6]. This material was used in our study because it is easy to sterilize and inexpensive; each nose printed costs approximately $400.

Accurate 3D surface imaging aids allow surgeons to communicate with patients before surgery adequately and set an appropriate surgical plan. Planning the surgical procedure and selecting the intended techniques were determined preoperatively based on the observation and measurements of the physical 3D printed models. Successful aesthetic facial surgery depends on the surgical result as well as on meeting the patient's expectation. Our study supports this concept.

3D reconstruction has been widely used to assess rhinoplasty results[7]. Physical models provide better visible and tactile information than other common visualization modalities. The cost of production allows for its broad application for educational purposes. It is surprising to see patients' reaction to what they perceive when looking in a mirror versus holding a nose model and seeing what other people see. Using a 3D model during the preoperative visit allows for a novel experience where patients can discover his or her appearance.

Intraoperatively, the 3D model provides surgeons with accurate anatomical information with less frequent reference to other visualization modalities such as photographs[8], thus improving their confidence during the procedure. Much of the actual rhinoplasty maneuvers are performed based on experience rather than through established guidelines or recommendations.

These techniques are difficult to learn, teach, quantify, or duplicate. They are a learned set of skills that come from watching, assisting, and performing rhinoplasties[9]. However, 3D planning can eliminate some of the guesswork for surgeons by simplifying and replicating certain surgical steps that have been more conceptual than physical. The comprehensive anatomic information provided by the 3D models helps surgeons achieve satisfying results.

More 3-D analyses and assessment tools are available. Incorporating simulation is the next logical step. It is easy to perform rhinoplasty on a computer because picture editor software flawlessly creates amazing visual effects. Although final results resemble it, it will never look identical to the sculpted image.

Less experienced surgeons must be careful not to give patients an unrealistic expectation of what can be achieved during these simulations. One must know the limits of what is possible biologically and what may happen with time, with tissue settling, and scar contracture. More conservative simulation should be performed to avoid giving a false expectation or representation of what can feasibly be achieved[10].

We are in the process of seeking the approval of our Ethics Committee to perform a study using printed 3D images of a nose preoperatively, during the surgery planning progress, as well as in the operating room to serve as a reference point during the procedure.

CONCLUSION

Using 3D printing of the anatomy of patients' nose as an intraoperative aid has a positive effect in patients with aesthetic nose disorders. Prospective controlled studies with a larger sample size are needed to explore and elucidate the efficacy of this technology.

COLLABORATIONS

DSV Analysis and/or interpretation of data; statistical analyses; final approval of the manuscript; conception and design of the study; completion of surgeries and/or experiments; writing the manuscript or critical review of its contents.

NS Final approval of the manuscript; writing the manuscript or critical review of its contents.

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