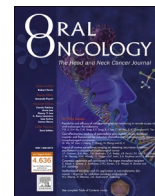




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Letter to the editor

Using 3D-printed nose models in nasopharyngeal swab training



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ABSTRACT

Background: The COVID-19 pandemic has swept across the globe with massive effects on health care systems as well as global economies. Enhanced testing has been put forward as a means to reduce transmission while awaiting the development of targeted therapy or effective vaccination. However, achieving accurate testing necessitates proper nasopharyngeal swab techniques.

Methods and results: We aimed to design and investigate the utility of an anatomically accurate three-dimensional (3D) printed model of the nose in the training for nasopharyngeal swabs. These models were implemented during training sessions for healthcare workers. All participants surveyed felt that the 3D printed models were useful and beneficial in the training of nasopharyngeal swab techniques.

Conclusions: 3D printed nose models are a useful tool in nasopharyngeal swab training. Their usage may help to facilitate the training of potential swabbing manpower in the upscaling of testing capabilities and volumes in this COVID-19 era.

Introduction

In line with the World Health Organization's strategic objective of preventing community transmission of COVID-19 by rapidly finding and isolating all cases, enhanced diagnostic testing has been increasingly applied to various degrees in the healthcare setting, as well as on a broader, population front. Whilst fairly straightforward, the diagnostic nasopharyngeal swab procedure has potential pitfalls which may impede the accuracy of specimen acquisition such as too large an angle of entry resulting in the swabbing of the skull base, or inadequate depth of insertion. This often stems from an erroneous understanding of nasopharyngeal anatomy [1]. We report the use of an anatomically accurate three-dimensional (3D) printed model of the nose in the training of healthcare workers to perform nasopharyngeal swabs.

Methods

A series of swab training sessions were conducted by the Department of Otolaryngology-Head and Neck Surgery for healthcare workers planned for deployment as swabbers. These began with a short, narrated video, followed by guided practice on a set of four 3D-printed nose models.

These 3D-printed nose models were jointly developed and designed by the NUH Department of Otolaryngology – Head and Neck Surgery and National University Singapore School of Design and Environment as a learning tool for medical students. Computed tomography (CT) scans of 30 patients were first evaluated in Syngo fastView™ (Siemens Healthineers, Pennsylvania). Four CT scans (normal anatomy, left and right septal deviation, inferior turbinate hypertrophy) were shortlisted and processed with a 3D medical imaging reconstruction and data processing software. 3D-printing in conjunction with elastomeric casting techniques and silicone colorants were used to attain nose models

with realistic tactile quality (Fig. 1). The nose models were mounted onto a head model, which could be tilted to a suitable angle to mimic the manoeuvres required during a nasopharyngeal swab collection (Fig. 2).

Participants were sent a survey to evaluate the training session 1-month post training session.

Ethics approval for this study was granted by the National Healthcare Group Domain Specific Review Board.

Results

Of the 110 participants who were sent the online survey, a total of 23 participants responded. Seventeen (74%) had never performed nasopharyngeal swabs prior to the session. A majority (61%) of participants were not confident of performing an effective and accurate swab prior to the training. After the training, all participants were more confident of performing a successful swab with minimal discomfort. All participants indicated a preference for having 3D-printed nose models for swab training.

13 participants went on to perform swabs on real patients, 10 of whom had no prior swab experience. All 13 felt that these models were useful in preparing them for doing swabs on real patients. Seven (58%) felt that it helped them appreciate the structure of the nose, 11 (85%) felt that it helped them understand the nuances in navigating the nose, and 5 (38%) felt that it helped them understand where the nasopharynx is.

Discussion

With escalation in testing requirements, healthcare workers and even laymen who may not be familiar with nasopharyngeal anatomy have been tasked to swab patients. In order to fill the gap in anatomical knowledge and skills, various videos and illustrations have been

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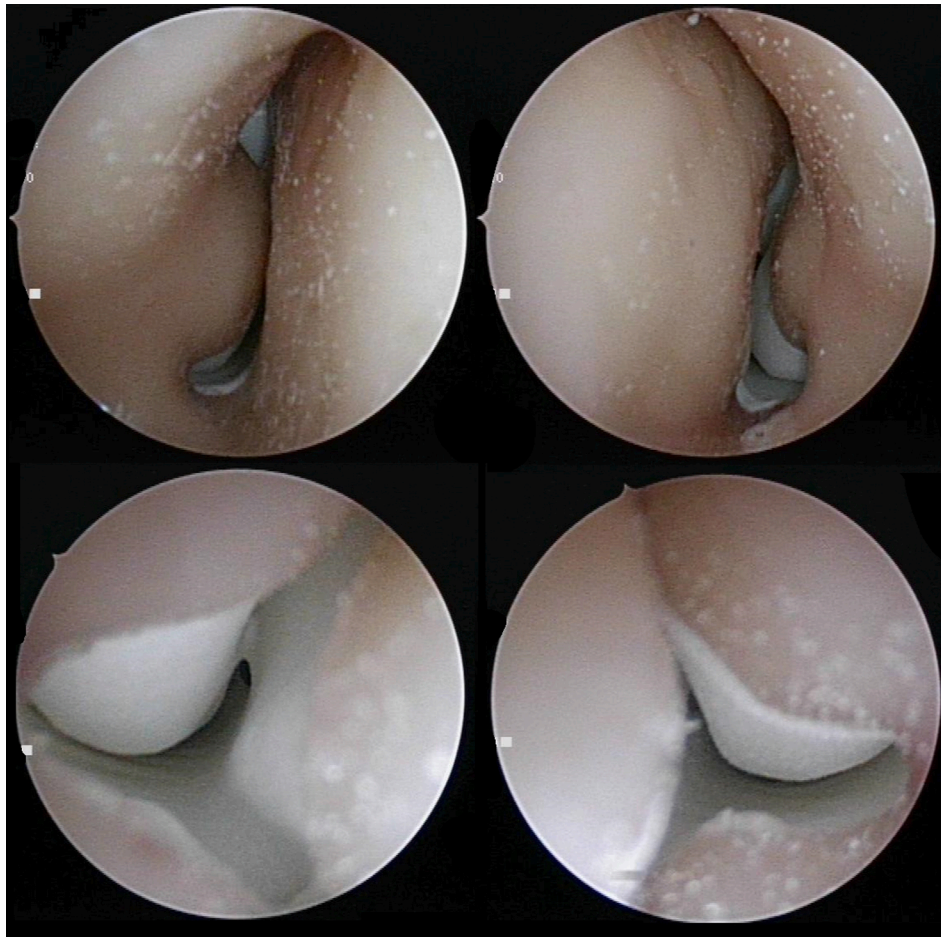


Fig. 1. Endoscopic (internal) views of the 3D-printed nose models.

published in both journals and the media [2]. Unfortunately, the accuracy of some of these instructions has been found to be wanting [3]. Tagliabue et al. [4] proposed a hands-on endoscopic demonstration of the nasal and nasopharyngeal anatomy in the training of healthcare professionals. Recognizing manpower, timing and financial constraints, Francesca et al. [5] in response proposed using a mannequin that could be opened on the midline to observe a sagittal section of nasal cavity.

3D-printed models have been used to assist with training of rhinology procedures including septoplasties and endoscopic sinus surgeries [6,7]. As compared to a generic mannequin nose with a straight septum and an open, smooth nasal cavity, 3D-printed nose models, with anatomical variants, provide more realistic representation of real-life nasal anatomy of the general population. The usage of elastomeric material in creating the anterior nose also more accurately reproduces the tactile sensation in swabbing a real-life nose.

Our brief survey has highlighted the effectiveness of using 3D printed nose models during swab training sessions in improving confidence levels in healthcare workers performing nasopharyngeal swabs. In particular, participants felt that the 3D model was useful in preparing them for the real-life nasopharyngeal swabs, irrespective of their experience in swabbing. Further studies need to be performed to assess if usage of these models translate to good swab techniques.

Conclusion

Usage of 3D-printed models of the nasal cavity helps swabbers familiarize themselves with nasopharyngeal anatomy and hence helps with adherence to good techniques. This enhances realistic, efficient, and safe nasopharyngeal swab training, and helps to ensure that swab

results are as accurate as possible.

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Ethics approval

Ethics approval was obtained from the National Healthcare Group (NHG) Domain Specific Review Board (DSRB).

Consent to participate

Consent was obtained from participants prior to administering the survey.

Consent for publication

Not applicable.

Availability of data and material

The authors will share data upon reasonable request.

Declaration of Competing Interest

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any

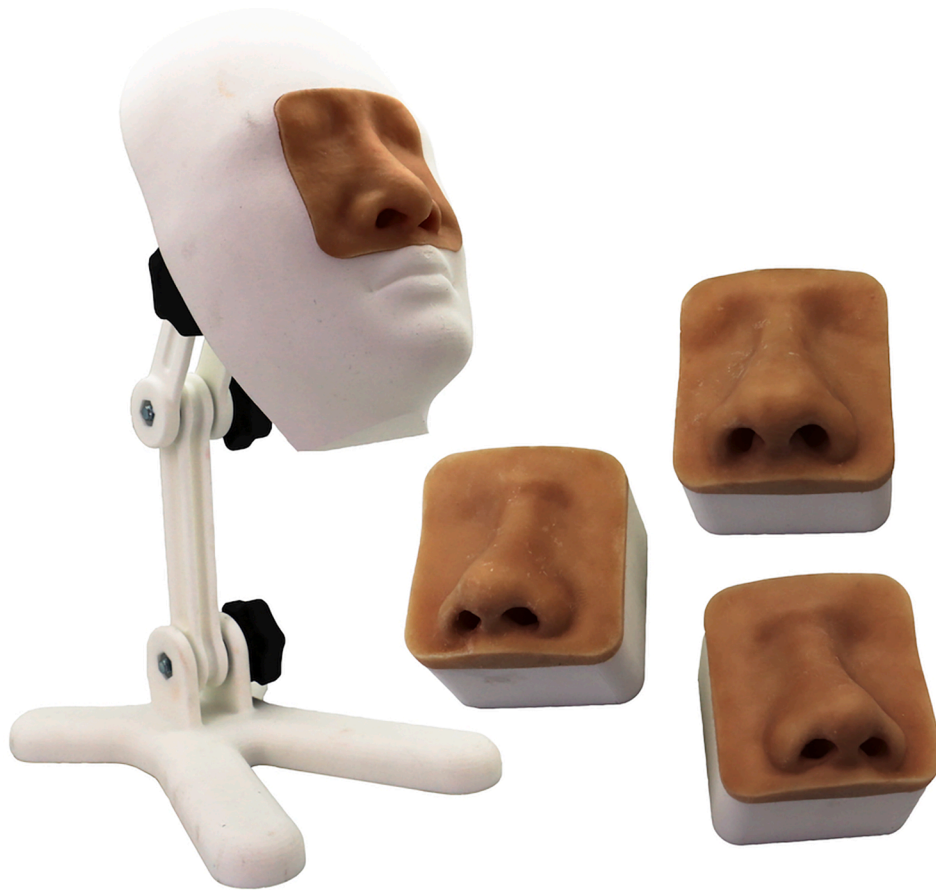


Fig. 2. External views of the 3D-printed nose models.

organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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