ABSTRACT

Three-dimensional (3D) printing has emerged in the past decade as a promising tool for the world of medicine. The focus of this poster is to review how 3D printed models have been used in medical education. PubMed was the article database used, and the search criteria included the terms 3D printing and education. The exclusion criteria filtered out articles that were older than 10 years, were not in English, and did not target a human population. There were 90 discovered articles, and 38 appropriate articles were determined after reviewing titles and abstracts. Three main themes emerged from this process: general medical education, surgical education, and patient education. The more specific findings can be further divided into: using 3D printed models for teaching anatomy and simulation training; and preoperative planning, intraoperative guidance, and postoperative evaluation.

INTRODUCTION

The advancements of 3D printing or additive manufacturing has been realized in industries such as manufacturing, engineering and aerospace. There is also an increase in the use of 3D printing in the general population due to more affordable printers; stemming from the opening up of several patents. One such type of Desktop 3D printer is pictured below (Figure 1). In medicine, the applications of 3D printing have been noted in a variety of areas, such as bio printing, customized prosthetics, and education. The focus of this poster is to review the literature documenting medical education and 3D printing.

METHODS

- The literature review occurred January 2016 through the PubMed database.
- Search terms included 3D printing and education.
- Screening and filtering was carried out by the author.
- Filtering included articles: written in English, published since 2006, and using humans (patients, trainees, and physicians).
- Filtering excluded articles: not related to medicine, articles using 3D printing for transplantation, lab medicine, prosthetics, or creation of novel instruments.
- An initial 90 articles were discovered, and 38 were deemed appropriate.
- The present review includes 10 review articles, 9 pilot studies, 9 randomized controlled trials, 6 case studies, 3 prospective cohort studies, and 1 editorial.

RESULTS

Education defined for this review involves using 3D printed haptic models to teach or understand a certain topic, principle or case. After reviewing all of the appropriate articles, there were three main themes determined: general education, surgical education, and patient education. These themes can be visualized in Figure 2.

General Medical Education

This section is specifically focused on two major areas that have been highlighted: learning anatomy, including associated pathology and structure function; and using 3D models as a part of simulation training. The trainees under discussion in this section include medical students and residents. The education that trainees received was from both general anatomical models and patient-specific models, allowing for both broad and targeted learning experiences.

Anatomy

All articles showed promising results for learning anatomy from 3D printed models. An example of a 3D printed anatomical model is apparent in Figure 3. A few of the major points are listed below:

- 3D printed models were superior for anatomy teaching over cadaver/plastinated specimens, CT and 3D imaging, and digital/took learning.
- Models were easy to store, reproduce, relatively cheap, scalable, capable of showing rare cases, dissecible, and did not entail the same ethical/legal issues as the previous methods of teaching anatomy.
- Trainees had an increased understanding of anatomy and organ functions, various pathological, and how disease process may occur.

Surgical Education

Preoperative planning.

Simulation training is a vital part of a training curriculum, however preoperative planning differs in that it is targeted as a rehearsal for an upcoming surgery. An example of preoperative planning can be seen in Figure 4. Residents and staff noted that through using 3D printed models they were able to:

- Appreciate patient specific anatomy.
- Practice procedures prior to the operation (making note of potential difficulties).
- Map out the best surgical routes while determining the most appropriate tools.
- Cut down on operating room time and increase efficiencies while operating.

Postoperative evaluation.

The 3D models helped staff in reflecting on how procedures went, and in further learning from their operations. For example, physicians were able to use a patient’s model to assess the accuracy of an orthognathic surgery they performed in one study.

Patient Education

Patients had an increased understanding of procedures and outcomes, such as possible complications and unintended results through use of pre and post-surgical models. In one study, all patients rated the models to be of “very high value” and “high value.”

CONCLUSION

The findings from this review are consistent with other similar reviews, in that 3D models have a major benefit towards medical, and more specifically towards surgical education. The future of medical education modeling may be in printing models with varying materials, and working vasculature, thereby featuring an even more realistic model. It is important to note that this field of research is evolving at a rapid rate, supporting the current work as timely. The future of 3D printing and medical education is bright and will certainly influence the advancement of medicine.

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REFERENCES