Letter to Editor

3D printing of abdominal aortic aneurysm

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Petros Bangeas, Grigorios Voulalas, Vasileios Papadopoulos, Daniel Paramythiotis, Antonios Michalopoulos, Kiriakos Ktenidis

Propedeutic Surgical Department, Aristotle's University of Thessaloniki, Greece

Correspondence: Petros Bangeas, Propedeutic Surgical Department, A.H.E.P.A. University Hospital, Aristotle's University of Thessaloniki, PESTWN 32, Thessaloniki, Greece, Tel +306958605613, Email pbangeas@gmail.com

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Introduction

3D printing is a technology which allows the sequential addition of material layers and offers us the opportunity to print parts and components from different materials with different mechanical and physical properties. This method was coined in 1986, by Hull,[1] who patented it as a method. 3D printing for in vitro studies of aorta began to be applying before a few years ago.[2] Nowadays, these technologies are very useful in maxillofacial or surgery, reconstructive surgery, neurosurgery, pediatric cardiac surgery and in many other areas of medicine.[3]

Most important application is design and development of medical devices and instrumentations.[4] Rapid prototyping is being used by surgeons in order to plan and explain some complex operations. These models are useful for measurements and educational purposes. Major advantages of rapid prototyping techniques are the ability to increase our 3D spatial perception and to add tactile feedback.[5] A 68-year-old man was admitted to our hospital with upper abdominal pain and pulsate abdominal mass. On ultrasound examination an aortic aneurysm diameter (3,5cm) was found. We performed a 64-slice computed tomography (CT) of the patient's chest and abdomen visualizing the aneurysm that measured 3.5cm in diameter.

The patient was monitored and we decided to build a three-dimensional (3-D) model for better preoperative planning that could be helpful for the future decision making process. We used the ©Google Sketch up software. 2D computed tomography (CT) images Figure 1 were incorporated and reconstituted by the design program. By this way a fully rotated virtual 3D model was created (Figure 2).

Figure 1 Abdominal CT revealed arotic aneurysm.

Physical models of the resulting virtual 3-D surface models were created by a 3-D printer ©Makerbot with PLA (thermoplastic) filament Three-dimensional model was printed by thermoplastic material (Figures 3 & Figure 4). Preoperative model demonstrated the exact anatomy of the aortic root. The replica allowed us to better understand entity by increasing our spatial perception.

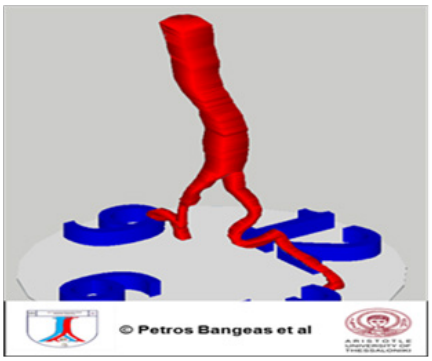

Figure 2 3D reconstruction of abdominal aortic aneurysm with ©google sketch up soft ware.

Figure 3 ©Makerbot 3D printers.

Figure 4 Our final model.

This is the first report of the use of 3D printing technology in patients with abdominal aortic aneurysm with or without complex anatomy. Future studies including more patients are expected to show improvement in preoperative planning and the use of computational fluid dynamics studies could enlighten and predict the process of the aneurysmal degeneration. For now, we successfully used this technology in complex cases for preoperative planning, simulation of procedures, intraoperative orientation, and postoperative evaluation of the outcome. Total fabrication time was 2h and 18min.Our experience in using rapid prototyping is small. However, we showed that 3d printing aorta models, is feasible to be created in order to be used in measurements and surgical planning of aortic aneurysm repair. Device testing and instrument development are alternative options. Although there are limitations, including small number of published studies and the cost of 3D printers. Main disadvantage of the method is the cost of commercial 3D printers. Since the technology is widely used to everyday practice, cost declines continually.

Conclusion

3D imaging of abdominal aortic aneurysms appears to be an effective and alternative method. In cases when anatomical difficulties hinder the preoperative study, three-dimensional printing offers the possibility of better and more personalized support. The interaction of 3D printing technology with tissue engineering is expected to be essential in the development of artificial vessels.[6]

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Conflict of interest

The author declares no conflict of interest.

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