Research for the Use of 3D Printed Organs

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Introduction

The growth of 3D Printing can be attributed to the inexpensiveness of computer hardware and the internet. This allows for anyone to create and share designs without even leaving the home. President Obama has even stated that "3D Printing is the Wave of the Future". In the article "3D Printing in Technology and Engineering Education", they state that 3D Printers fill nearly all the *Standards for Technological Literacy: Content for the Study of Technology* (*STL*) (ITEA/ITEEA, 2000/2002/2007). These include STL 1-4, which are: the "characteristics and scope of technology", "core concepts of technology", "relationships and connections between technology and other fields", and "cultural, social, economic, and political effects of technology" (Martin, Bowden & Merrill 2014).

Today, digital files are used to create printed objects using many sorts of material, including metals and plastics. 3D printing is used to create things from prosthetics to aircraft parts, with these printers allowing for increased customization than from parts from mass production facilities. The possibilities of 3D printing is endless, with 3D printed organs and computer internet technology (cloud points) mentioned in detail. The 3D printing industry leaders have given opinions about 3D printing. Medical centers, such as the Wake Forest Baptist Medical Center's Institute for Regenerative Medicine, where the scientists there joined the discussion, where 3D printing could help reduce the need for a black organ market and such (ROYTE 2013).

Literature Review

The three uses of 3D printing within medicine are: "creating models for surgical planning, practicing, and teaching; creating implantable prosthetics; and biologic tissue engineering" (Klein, Lu, & Wang 2013). Since the beginning of 3D Printing, advancements have been made in artificial limbs, artificial bones and joints. Today there are companies that specialize in creating 3D printed organs. This sector is expected to become an $8.4 billion industry by 2025. For example, a pair of University of Toronto graduates created the Printalive Bioprinter, which prints skin using a patient's cells. This new iteration is much faster, compact, and less expensive than other bioprinters, with older ones acting similar to standard ink-jet printers. In fact, inkjet printing technology can end up killing cells. One possible usage of this device is on burn victims, with bypasses the skin grafting portion of the procedure. Aspect Biosystems, a company created by the University of British Columbia, uses hydrogel in conjunction with printing cells. Using 3D bioprinting, pharmaceutical companies can test more effectively to see whether or not a solution works on humans, as well as cease the testing on animals. There is also the reduction in clinical trial cost, which is currently USD$40 billion (McCULLOUGH 2014). Other possibilities of 3D printing in medicine is in organ emulation. This year, surgeons used 3D printers to emulate the hearts of conjoined twins. This allowed the surgeons to practice the surgery beforehand, so that the chance of failure during the actual surgery would be lowered. Fortunately, the operation was a success. Dubbing the new process “Simulated Inanimate Models for a Physical Learning Experience” (SIMPLE). Using Ultrasound imaging and MRI scans and converting them to 3D STL files for printing. In the end, the faux organ will work like the real thing, where it will feel like the real thing and bleed as well (Pierce 2017).

Anthony Atala (known as the father of 3D Printed Organs), before 3D printing, created lab-grown bladders for seven children, using hand-molded scaffolding and lab-grown cells identical to the cells of the children’s. These seven children have not been found to have defects to date. Anthony Atala, now the director of the Wake Forest Institute for Regenerative Medicine, has helped create the Integrated Tissue and Organ Printing System (ITOP). This system will allow for those in need of organs to get replacements without having to find a donor, as well as reducing the possibility for a future organ shortage. According to the article “MIRACLE MAKER”, the ITOP system has been able to create “cartilage, bone and muscle tissue” and “had been successfully implanted in rodents and two months later, the tissue had developed a system of blood vessels and nerves” (SHAER 2016). The article then states that “tests on human patients will likely follow in the next year or so, pending government approval” (SHAER 2016).

In fact, multiple countries are experimenting with the technology. In Japan, the government and multiple startup companies are starting to use 3D printing and promote its expansion. New Energy and Industrial Technology Development Organization (NEDO), a semi-public organization, states that the advancements in 3D printing will increase Japan’s international competitiveness, compared with countries with larger production capacity, such as the US or China. NEDO is currently spending JPY¥2.5 Billion (USD$22.3 Million) on regenerative medicine, using Induced Pluripotent Stem Cells (IPS) and 3D printers, until 2020. This field may supplement the lack of blood vessels, cartilage and cardiac muscles today. The government of Japan even estimates the growth of the industry, from JPY¥9 Billion (USD$80.4 Million) in 2012 to JPY¥1 trillion (USD$8.9 billion) in 2030. The article, “3-D printers take center stage in Japan's regenerative medicine”, also states that 3D printed organs can be used to bypass animal testing, as well as being more accurate. Tsuyoshi Takato, a professor of tissue engineering at the University of Tokyo's School of Medicine and supported by NEDO, has stated how 3D printing could be used to help those with disabilities or deformities, such as microtia. For example, children with microtia (a disease that requires cartilage transplant) can be given 3D printed cartilage in place of transplanted cartilage later in their lives (Nagata 2015).

Analysis

3D Printed Organs (both surgical models and biological tissue) are a step forward in regenerative medicine. Using surgical models, surgeons can be taught to operate in different conditions without using real organs, allowing for more organs to be spared to those in need of organs. This will also allow for surgeons to prepare for very special cases, such as those of conjoined twins. With the introduction of 3D bioprinting (the printing of biological tissue and/or scaffolds that cells populate), the need for organ donors, black markets, and immune system suppressants would diminish. There will also be a lower need for animal testing, and thus, will be more accurate data for human use. Within two decades, it is likely someone will refine the technology and will be able to produce organs at a much faster and more efficiently using much more advanced techniques used here.

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