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RAPID PROTOTYPE MODEL OF AN ANIMAL BONE REGENERATION USING 3D PRINTING TECHNOLOGY

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Abstract

3D Printing is a process of making three dimensional solid objects from a digital file. It starts with the creation of 3D model in the computer. Then Slicing process is done which divides a 3D model into hundreds or thousands of horizontal layers and it is done through Slicing software. When 3D model is sliced , then it is feed into 3D Printer. This can be done via USB,SD or Wi-Fi. It really depends upon the brand and the type of 3D Printer. Stereolithography(STL) is one of the most common file types that is used for 3D Printing process. The polymer materials that are used in 3D Printing technology are Nylon, Co polyester, Polycarbonate, Polyamide, Hydroxyapatite, etc. 3D printing is becoming popular due to the ability to directly print porous scaffolds with designed shape, controlled chemistry and interconnected porosity. The scaffold produced is biodegradable and have proven ideal for bone tissue engineering. In this work fabricate animal bone using ABS material.

Key words: 3D printing, stereo lithography, Bio fabrication, animal bone,ABS.

1. INTRODUCTION

3D Printing is a manufacturing process in which objects are made by fusing or depositing materials such as plastic, metal, ceramics, powders, liquids or even living cells in layer by layer to produce a 3D object. The concept of tissue engineering was formalized in 1993 when Langer and Vacanti published in a historical milestone in Science , in which characteristics and applications of biodegradable scaffolds were first detailed.Out of more than 40 different 3D printing techniques, fused deposition modeling (FDM), Stereolithography , Inkjet Printing , Selective Laser Sintering (SLS) and Colorjet printing appeared to be most popular , due to their ability to process plastics. The medical sector contributed almost 16% of overall revenues by 3D Printing Technology. In this project the animal bone is drawn in AutoCAD using X-Ray and it is converted into STL file and then printed by using 3D Printer.Hermann Seitz et al (2005) conducted experiments on Three Dimensional Printing of Porous Ceramic Scaffolds for Bone Tissue Engineering. They concluded that the fabricated ceramic matrices have enough mechanical stability to serve as a scaffold for initial cell attachment and bone tissue engineering and as a implant for bone replacement. Susmita Bose et al (2013) conducted experiments on Bone tissue engineering using 3D printing. They concluded that 3D printed scaffolds have also been used for growth factor to enhance bone growth in scaffolds.Pedro F Costa et al

(2014) conducted experiments on Bio fabrication of Customized Bone Grafts by combination of Additive Manufacturing and Bioreactor. They concluded that significant advance in implementing the currently available bio fabrication towards development of automated customization of tissue engineered products. Riccardo Levato(2014) conducted experiments on Biofabrication of tissue constructs by 3D bioprinting of cell-laden microcarriers. They concluded some of the key findings to build advanced constructs for bone and cartilage tissue engineering. Furthermore, the printability of bioinks with high MC concentrations opens possibilities. Chritopher M.O'Brien BS (2014)conducted experiments on Three Dimensional Printing of Nanomaterial Scaffolds for Complex Tissue Regeneration. They concluded that they believe that if more 3D Printable nanomaterials with improved performance are created advanced 3D Printing modalities can be explored, more ideal biometric complex for tissues or organs can be created for human and animal implantation in neaby future. Jia An at al (2015) conducted experiments on Deign and 3D Printing of Scaffolds and Tissues. They concluded that Researchers current task in the field are to accelerate the standardization and certification of 3D printed medical devices. Shailly H.Jairwala at al (2015) conducted experiments on 3D Printing of Personalized Artificial Bone Scaffolds. They concluded that for Engineering perspective low mechanical strength , limited resolution and slow degradation of 3DP structures are major challenges in developing composite scaffolds for bone substitutes. Pranav S Pranav et al (2016) conducted experiments on Rapid Prototyping Assisted Scaffold Fabrication for Bone Tissue Regeneration. They concluded demand for 3D printing for bone regeneration will increase in coming years due to the ability to make custom medical devices that can be tailored for patient specific and defect specific clinical needs. Farah Asa Ad et al (2016) conducted experiments on 3D Printed scaffolds and Biomaterials: Review of Alveolar Bone Augmentation and Periodontal Regeneration. They concluded that scaffolding matrices can also be used as membrane and grafting material in periodontal tissue generation and scaffold should be biocompatible, biodegradable and bio active and should be made of biomaterials. Raquel Counto de Azevendo Goncalves Mota et al (2016) conducted experiments on 3D Printed Scaffolds as a New Perspective for Bone Tissue Regeneration. They concluded that the advent of 3D printing allows us to overcome limitations of traditional scaffolds manufacturing techniques,because the structure is built layer by layer, according to a predetermined computer model which provides better control of scaffold's architecture and geometry .They concluded that the strength and elasticity of a 3D printed sample depends generally on the print orientation for a given materialAll the above researchers conducted experiment on 3D Printing process in which different materials are used for printing and they analyzed mechanical properties, medical properties, so we are decided to conduct experiment on 3D Printing Technology by comparing two polymer materials and characterized by mechanical testing, medical testing and analysed by ANSYS software.

2. Experimental setup

2.1Experimental detail:

Fused filament fabrication is a 3D printing process that uses a continuous filament of a thermoplastic material. This is fed from a large coil, through a moving, heated printer extruder head. Molten material is forced out of the print head's nozzle and is deposited on the growing workpiece. The head is moved, under computer control, to define the printed shape. Usually the head moves in layers, moving in two dimensions to deposit one horizontal plane at a time, before moving slightly upwards to begin a new slice. The speed of the extruder head may also be controlled, to stop and start deposition and form an interrupted plane without stringing or dribbling between sections. In Fused Deposition Method, filaments are heated into a semi-fluid state within a chamber, and forced out of the chamber through a nozzle. The extruded plastic is then moved along the x-y-z plane to create a single layer 3D shape. Subsequent 3D layers are added on top of each other where layers are fused to solidify into final product. The quality of printed parts can be controlled by modifying printing parameters, for example, layer thickness, printing orientation, raster width, raster edge and air hole.

Fig.1. Fused Deposition 3D Printing Machine

Fig.2.3D Printed Bone

3.Result and Discussion

The printed material is then analyzed by means of ANSYS software and the results are tabulated as follows:

S.No.	Parameters	Result
1	Young's Modulus	2.6e+009 Pa
2	Poisson's Ratio	0.3
3	Bulk Modulus	2.1667e+009 Pa
4	Shear Modulus	1e+009 Pa
5	Compressive Yield Strength	2.5e+008 Pa
6	Tensile Yield Strength	2.5e+oo8 Pa
7	Tensile Ultimate Strength	4.6e+008
8	Compressive Ultimate Strength	0 Pa

The damaged bone of animal is fabricated using Fused deposition method and additive manufacturing method.The similar bone size dimensions are taken from X ray view.The actual values are created by ANSYS software and attached to 3D printer.The animal bone is produced by additive manufacturing method and fabricated by 3D printing Technique.

4.Conclusion:

This paper reviews the potential of polymers to be widely used in tissue engineering due to its biological safety and physical properties which can be tailored by controlling several parameters In this work we fabricate the animal bone artificially using ABS for implantation of animal damaged bone.In the upcoming years, 3D printing plays a very important role in medical applications especially for bone scaffolds by using Polymers. This is due to their mechanical properties and biological properties such as biocompatibility and biodegradability. Thus additive manufacturing will play a potential role in upcoming years.

5 .References:

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