

3D Printed Aligners, The Next Revolution.

Diana Ashok¹, Thulasi Ram², M S Kannan³

Post graduate¹, Senior lecturer², Professor and head of department³ Department of Orthodontics, Sree Balaji Dental college and hospital, BIHER.

Corresponding author:

Dr. Diana Ashok,

Post Graduate,

Department of orthodontics,

Sree Balaji dental college and hospital,

BIHER.

Mail id: marjoriediana@gmail.com

Abstract:

Clear aligner therapy (CAT) has been gaining increased popularity in the recent years. With the advent of technology and with the help of Digital Orthodontic offices, the ease of managing and treating a patient's malocclusion with CAT has led Orthodontist's worldwide to accustom CAT in their practise. This paper will review the recent trends in CAT – 3D printed aligners.

Key words: *Aligners, CAT, Clear aligners, Invisible braces, 3D printing, STL, recent trends*

INTRODUCTION:

Clear Aligner therapy was developed at the end of 1990s.¹ With the increase in demand for aesthetic smiles, there is also increase in demand for aesthetic options while correcting the smiles. Patients who are older and who have concerns regarding the braces showing off, seek more aesthetic options. One such aesthetic option is the Lingual Appliance. The Lingual biomechanics is different from the labial system and the treatment time is also longer than the labial appliance. It may also interfere with the patient's speech. One another alternative would be the Clear Aligners. Clear Aligners have added benefits of removing the braces while brushing and eating.²

Thermoplastic Materials:

The clear aligners are made of thermoplastic materials or their combinations. The various thermoplastic materials used in dentistry are – polyvinyl chloride, polyurethane, polyethylene terephthalate and polyethylene terephthalate glycol (PETG).³

PET is a thermoplastic resin which turns into a semi-rigid polymer once it is thermoformed. PET is hygroscopic, meaning it absorbs water once and when heated, the water hydrolyses the material thereby making it less resilient, thus the material is air dried before it is thermoformed.

Scope of CAT:

CAT provides better aesthetics, comfort, increased oral hygiene, is good for periodontal health as well as it helps with lesser chairside time and lesser emergencies. The patients show increased psychosocial benefits with CAT when compared with conventional FA. The oral hygiene maintenance is easy and also there is no retention of the periodontal pathogenic bacteria, thereby aiding in maintaining the periodontal health. The pain of CAT when compared with FA and patients reported significantly decreased pain.

Advantages Of CAT:

Lesser visits to the orthodontist. The patient's treatment can be carried out at the comforts of their house. Patients can have the replacement aligners delivered at their doorstep, in case any aligner doesn't fit or gets broken. They can wear the old aligner in the mean time.

Manufacturing Of CAT:

The models of the patient need to be made either as a digital copy by means of an STL file with the help of an intra-oral scanner, or with the help of plaster casts. The stage models for each aligner with the simulated tooth movement is then recreated³. On these stage models, the aligners are fabricated. The aligners are made by either pressure forming or by vacuum forming of the thermoplastic materials. Pressure forming is found to produce a better fit for the aligners. The intra oral scan resulted in better accuracy of the digital models when compared with the plaster models. The stage record of these digital models were further designed in the software by simulating the tooth movement. Each stage is then printed as a 3D model, on which the aligners are then fabricated.⁴

Stability Of The Aligners In-Vitro And In-Vivo:

Significant changes in the material properties have been reported with the thermoforming process.⁵ The materials showed increase in water absorption, surface hardness, decrease in transparency of the material.

Other studies have reported that the temperature,⁶ humidity and salivary enzymes affect the aligners. They modify the shape of the aligners and also change their mechanical properties. These effects on the aligners might in turn affect the treatment efficacy.

A better alternative to such manufacturing procedures which affect the materials properties, is the 3 dimensional printing of the aligners.⁷

3D Printing Of Aligners:

3D printing technology has been gaining attention in the recent year.⁸ Their application in dentistry is not far behind their increased application in the health care systems. Their uses in dentistry include Surgical implant guides⁹, prosthodontics, restorative dentistry, orthodontics, implantology and instrument manufacturing. This technology allows to manufacture components layer-by-layer, instead of common manufacturing methods that rely on moulding, machining or other subtractive methods. This technology can be used for direct printing of clear aligners, too. Multiple 3D printing processes may be used for the direct printing of clear aligners, such as fused deposition modelling, selective laser sintering, selective laser melting, direct pellets fused deposition, stereolithography, multi-jet photo cured polymer process, or continuous liquid interface production technology.

Current Evidence:

Jindal¹⁰ presented a successfully 3D printed clear aligner which was of 0.75mm thickness. It is thicker than the conventional clear aligners and its use for CAT is questionable.

Edelmann¹¹ reported that the 3D printing of the aligners increased the wall thickness by 0.2mm which may have a deleterious effect on their clinical orthodontic use.

CONCLUSION:

3D printing of clear aligners shows a promising future. Although we are not there yet, the increase in research and development in the field will enable us to start implementing 3D printed aligners in our practise soon.

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