



Aligners in Orthodontics and its Health and Environment Hazards

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ABSTRACT

As with time, demand for more esthetic orthodontic appliance is increasing among adult patients. A risk or danger that develops as a result of the requirements or working environment of a specific job is referred to as an occupational hazard. Dental practitioners and their patients are more at risk for harm because of the multiple occupational dangers they are exposed to. Various professional risk factors in orthodontics may injure orthodontists and their staff in addition to basic exposures impacting orthodontists. An essential component of orthodontic education should be the identification and eradication of these risk factors in a common practise monitoring programme. Aligners have vast advantages over conventional orthodontic treatment but there are some limitations such as intrusion, extrusion and closure of extraction spaces. This review highlights various health and environmental hazards which are caused by clear aligners. As they are made up of nonbiodegradable plastic, they take 100 of years to decompose in landfills. Due to Bis-Phenol A (BPA) release, they can harm the overall health and well-being of patient. Further advancement in the material is required to minimize the deleterious effects on health and to enhance better treatment outcomes of aligners.

Keywords: Clear aligners, BPA, health hazard, biomedical waste, limitations.

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INTRODUCTION

We are living in an era where people are seeking orthodontic treatment for various esthetic concerns, even there is increased demand for more esthetic appliances over conventional orthodontic appliances. Earlier metal and ceramic brackets were used which were made up of monocrystalline or polycrystalline ceramics. With introduction of clear aligners in orthodontics, there is an alternative for adult patients which can radiate the natural tooth color and hence they are more esthetic [1]. Clear aligner therapy includes treatment with a series of aligners which are made up of thin sheet of plastic with thickness of less than 1 mm and are manufactured with CAD-CAM. Patient is given a set of aligners which will be worn for 15-30 days to attain desired tooth movement.

As the inner surface of these appliances are always in contact with the enamel surface so any changes in the pH value due to accumulation of plaque or saliva, can affect the enamel structure. Many studies have showed a positive co relation between the use of clear aligners and release of Bisphenol A (BPA). BPA can cause many endocrine disturbances, infertility in males and females, degenerative effects in the growing fetus². Increased use of single use plastic in the manufacturing of clear aligners is causing detritus effects on the environment. So, even with many advantages, clear aligners are a biomedical hazard for environment as well as the patient using it [2].

HISTORICAL BACKGROUND

Clear aligners can feel like a new technique of orthodontic treatment, the first concept dates back in early 20th century. It all started with FlexOTite appliance which was introduced by Remensnyder. After that, Keslingin 1945 introduced a rubber based tooth adjustment aligners and given the theory of wearing the aligner in successive manner to gain a gradual and incremental tooth displacement. Nahoum (1960) introduced first clear thermoplastic appliance which was able to do orthodontic tooth movement with successive wear [3]

Advantages of Clear Aligners:

1. They are more esthetic (specially for adult patients)
2. They are more convenient.

3. Oral hygiene maintenance is easier.
4. One can avoid pitfalls of traditional metal brackets.
5. Treatment is planned digitally, so patient know what to expect from treatment.

Composition and Properties of clear aligners:

Polyethylene terephthalate glycol (PET - G) is used now a days for aligner production. In 2013, polyurethane was introduced, and usually regarded as the best suitable material for aligner manufacturing. Polyurethane sheet comes in a variety of thickness ranging from 0.50-1.5mm. the colour stability of the material is good up to 2 weeks and it can easily be stained with the carbonated drinks, coffee and food with preservatives. So patient is advised to remove the aligner during eating or drinking anything other than water. For better translucent properties the amorphous polymers are used over crystalline polymers. There is decrease in the surface roughness post 1 week of usage and it tends to further decreases after wearing for subsequent weeks. Roughness deterioration will further have an undesirable effect on retention and orthodontic pressures [4].

Mechanism of Orthodontic tooth movement Via Clear Aligners:

Teeth move with clear aligners under two main prospective:

1. Displacement driven system.
2. Force driven system.

In displacement system, simple tooth movement occur such as levelling alignment and tipping. Aligners are made in the shape of the expected tooth movement and displacement of tooth takes place. Mostly root movements take places in this type of system, whereas in the force system, shape of the aligners are changed so as to accomplish desired tooth position (Fig. 1). The shape of clear aligners are altered by adding pressure points or power ridges. Power ridges helps in controlling the axial movement whereas the pressure points helps in up righting of teeth. Even after all these developments in clear aligners, some tooth movements like extrusion and intrusion of teeth remained very difficult. For such movements, composite attachments are given at the required places (elastics can also be given with these attachments) [5].

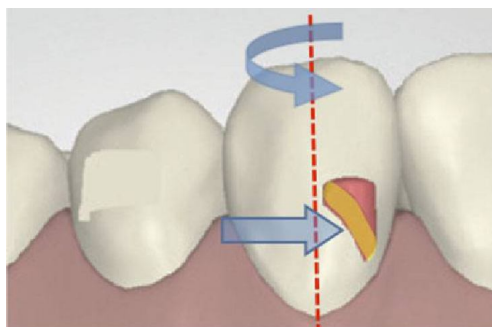


Fig. 1: Mechanism of orthodontic treatment by clear aligners

Effectiveness of Clear Aligners:

According to Djeu *et al* (2005), there was no statistical difference between the outcome of clear aligners and conventional orthodontic treatment. The assessment of the treatment outcomes is done by using ABO grading system for treatment outcome [6]. A study done by Kravitz *et al* [7] concluded that 40 percent of expected tooth displacement was achieved by clear aligners as compared to the conventional orthodontic treatment. Kunchio *et al* [8] studied chances of relapse after treatment after clear aligner therapy. They did a 3 year follow up with only Essix retainer and no fixed retainer was given. It is noted that relapse occurred in both the groups in terms of general alignment, but clear aligner group showed higher relapse in the maxillary anterior region. A systemic review was conducted by Gay *et al* [9] in 2017 to compare the apical root resorption caused by clear aligners and conventional orthodontic treatment. They stated that aligners can cause root resorptions at the end of the treatment but it is less as compared to the conventional orthodontic treatment.

Limitations of Clear Aligners [10]:

Clear aligners have some clinical limitations as well and hence they cannot be used in every orthodontic case, some of the limitations are:

1. They can't correct spacing and crowding more than 5 mm.
2. Cases with posterior or anterior open bites.
3. Proclination of teeth is more than 45 degrees.
4. Extrusion or intrusion of teeth to be done.

5. Multiple teeth are extracted or already missing (as they cannot keep the teeth straight during space closure).
6. Treatment time is increased.
7. There are centric relation problems.

HEALTH HAZARDS OF CLEAR ALIGNERS

Clear aligners are supposed to snugly fit the whole dentition and due to which they can sometime irritate the oral mucosa. There can be accumulation of plaque and saliva under the clear aligners which can promote the growth of *P. gingivalis* and hence cause various periodontal problems. Some patient have also shown hypersensitivity reaction to clear aligners (anaphylaxis). Other problem caused by clear aligners is dry mouth, swelling of lips and headaches.

Bisphenol-A (BPA) is a man-made chemical which is known to disrupt endocrine function and have weak estrogenic properties. In clinical dentistry, BPA is a precursor of the bisphenol A glycidyl methacrylate (Bis-GMA), bisphenol A dimethacrylate (Bis-DMA), and bisphenol A ethoxylateddimethacrylate (Bis-EMA) monomers which is found in dental sealants, adhesive resins, and composite resins[11].According to Kotyk *et al*[12], under extreme thermal and mechanical stresses, BPA was leached from the acrylic retainer and cured Transbond XT adhesive after three days of immersion invitro saliva.Alhendi *et al* [13]compared four different types of aligner brands for leaching of substances and found that there is no significant amount of BPA release. S Katras *et al*[14]conducted an in vitro study to evaluate the amount of BPA release in 4 different types of aligners. The difference in amount of BPA was not statistically significant. They found that, almost majority of BPA was released in first 24 hours of use. Elidaes *et al* [15] found in their in vitro study that there was nosignificant of cytotoxicity on human gingival fibroblasts and they do not stimulate the Michigan Cancer Foundation MCF-7 cells (Fig 2).There are many health related risk factor of BPA if it is released more than that of the tolerative value (5mg/kg/day). In human beings, free unconjugated state of BisPhenol A is synthesized with rapid glucuronoor sulfonoconjugation and it is eliminated by kidneys. It is found in urine of 90% population (0.2–1.6 ng/mL) and also in bloods, maternal milk and amniotic fluid[16]Some studies also revealed that exposure to BPA might increase prevalence of type II diabetes. In experiments, adult male mice who have been exposed to BPA developed both increased levels of insulin in blood and insulin resistance because BPA pancreatic cells. They also affect insulin signal transduction at the level of peripheral tissues (muscle, liver, adipose tissue) [17].

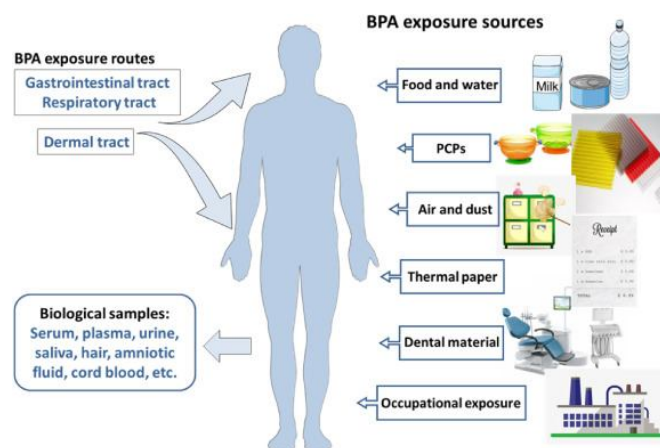


Fig. 2: Effects of BPA on health

Clear Aligners As Biomedical Waste:

As we know that aligners are made up of plastic which can take 100 of years to decay in landfills. An estimated amount of 25 million of aligner trays are discarded in landfills per year all over the world which is causing a great amount of damage to our environment. Once they are used by the patients, they are commonly discarded in common trash which may cause infection spread as they were worn in oral cavity and discarded in general trash. Due to this problem in certain countries like USA clear aligners are classified as Contaminated Bio Medical waste. When clear aligners are incinerated, they release cyanide particles thus causing a great harm to the environment. The only practical and safest methods for the proper management of aligners is Mechanical or Secondary recycling [18]. In this the used material is converted in granules and further used in manufacturing of other materials. All the patients are advised

to collect and bring all the used aligners back to their orthodontist who can properly sanitize them and discard them in proper medical waste bag. Nowadays there are many companies who are aiming on recycling of clear aligners as they are made up of many types of the plastic structures so they need a different method of recycling. Certain types of bags and small boxes are available which can store used aligners until sanitized and recycled.

CONCLUSION

With increased demand on aesthetics during the orthodontic treatment, there is a need of proper use and disposal guidelines for the clear aligners. Many studies have supported the fact that there is not a significant release of BPA from the clear aligners, but there are still controversies that even a small amount of BPA can cause deleterious effect on health. Clear aligners also damage the environment by producing non-biodegradable plastic waste which is left out into landfills. A proper sanitization and recycling protocol should be implanted for proper disposal of aligners. We should emphasize on both pros and cons of clear aligners in a way that we can carry out better treatment objectives without harming the environment and patient's health.

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