

Tooth positioners and their effects on treatment outcome

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Abstract

Malocclusion can also be corrected by means of clear removable appliances called as “tooth positioners” or “aligners”. A tooth positioner is used to control settling and to minimize or eliminate relapse of the teeth after an orthodontic treatment. In this article, a complete review of the objectives, course of treatment, fabrication, and the materials used for fabrication of tooth positioners along with their importance and disadvantages were discussed. Tooth positioners did improve the overall orthodontic treatment outcome as quantified by the ABO (American Board of orthodontics) objective scoring method. But once the initial occlusal contact was achieved, the vertical movement of teeth was found to be inhibited.

Key words: Aligners, relapse and settling, tooth positioners

INTRODUCTION

Tooth correction is done by active orthodontic treatment for aesthetics, and function following which the corrected tooth is kept stable by retention appliances. The goal of retention is to achieve occlusal stability.^[1] Orthodontic treatment alters the contacts of the tooth during the early stages of treatment, but after completion, the number of contacts increases with settling of the occlusion.^[2] The occlusal contacts are the ones which are seen as centric stops on the functional cusps. The importance of orthodontic treatment is to achieve good occlusal contact and intercuspatation.^[3]

About 50 years ago, clear plastics were used to guide the teeth after fixed orthodontic treatment or to make minor adjustments and these clear removable appliances were called as ‘aligners or tooth positioners’.^[4]

Tooth positioners are well-known orthodontic appliances formed as an arch-shaped body of a (Silastic) resilient material fitting within a patient’s mouth between the upper and lower arches.^[4] It generally has a concave surface for bearing on the buccal and labial surfaces of the teeth of at least one arch and a convex surface adjacent to the lingual surface of the patient’s teeth.

CLINICAL IMPORTANCE OF TOOTH POSITIONERS

Forces on the teeth and jaws are made to come to a halt when orthodontic braces are removed. This brings about two changes, namely, settling and relapse. Settling refers to the process by which the teeth will attempt to settle together or shift slightly to equalize the bite so that maximum number of contacts between the teeth exists. Similarly, relapse refers to the teeth and the jaws will attempt to move back to their original mal-aligned position. However, relapse is an unwanted change which is not required for our goals.^[5] These changes take place shortly after the removal of the active appliances, during the period of post-treatment ‘settling’, or over a period of years.^[1]

The length of the retention period is important to prevent relapse and to provide stability of treatment. The ideal

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retention device should allow settling while ensuring a safety margin and reducing or eliminating the tendency toward relapse. It is thus referred to as an orthopedic retainer or a gnathological positioner.^[6]

Clinical success after orthognathic therapy is based on the combination of the following factors:

- Patient satisfaction
- Correct occlusal relationship
- Stability after 1 year of treatment
- Incisal/canine guide with posterior disclusion in protrusive and lateral movements
- Patient comfort while chewing, and
- No report of pain in the temporomandibular joint (TMJ).^[7-9]

These objectives can be assessed using Andrews's six keys to define the best occlusion when finishing a case. It is clinically accepted that occlusion control is transferred from appliances to a patient's neuromuscular system at the end of treatment.^[10]

Retainers are fabricated in order to eliminate occlusal contact and allow vertical settling. Short-term positioned wear improves the occlusion by a different mechanism and was evident from the study by Nett and Huang.^[11] It was also reported by Razdolsky^[12] *et al.* that relative vertical movements can continue up to 21 months after orthodontic therapy. If thermoplastic retainers are used, canine-to-canine Essix retainers, as introduced by Sheridan^[13] *et al.* or any other modification, can be designed to allow vertical settling.^[1]

Sullivan *et al.*^[14] reported fewer contact points in post-orthodontic patients with the number of contacts increasing with time. Further along in retention, occlusion is a dynamic condition influenced by the natural tendency to relapse, occlusal forces, the neuromuscular system, and the retention appliances themselves. Occlusal recovery involves many factors, and a variation in contact points is related to overbite/overjet modifications. In conventional orthodontic treatment, there is a 14% augment in the number of contact points at 3 months, which becomes 56% at 1 year.^[10]

Use of tooth positioners

Tooth positioners, in general, are used by clinicians after the removal of fixed appliances. However, it was also used for other applications such as to close band space and mandibular diastemas.^[15-17] Correction of second molar cross-bites^[15] and overjet were also tried with maximum success.

When a patient's occlusion is nearly ideal and further changes in wires or brackets could create new problems,

or when a patient's interest and cooperation have run out, we resort to finish the cases with a retainer.^[9,17,18]

Properties of materials

Clear thermoplastic appliances have been recommended for use as transitional retainers, finishing appliances,^[19] and even permanent retention.^[13] They are easy to fabricate, inexpensive, aesthetic, and comfortable, and thus have a high level of patient acceptance.^[1]

The chemical composition, thermal behavior, and mechanical properties of three tooth positioner materials, were investigated and found to be consisting of urethane P1 (P1), white rubber (WR) and elastocryl (EL).^[20]

Infrared spectrophotometry indicated the P1 polyurethane material to be of the polyether type, and EL to be a blend of poly (ethyl methacrylate) and poly (methyl methacrylate) while WR appeared to be filled *cis*-poly (isoprene) (natural rubber).^[21]

The glass transition temperature (T_g) for EL was determined as approximately 10°C, and for both P1 and WR, the T_g was less than -50°C. The stress relaxation behavior was assessed in compression by measuring the stress variation with time. The results for all three materials conformed to the super elastic theory of rubber elasticity. EL exhibited both a more rapid rate and a higher degree of stress relaxation than P1 and WR. Recovery from deformation was assessed by compressing cylinders for given periods of time and then measuring the level of reduced residual strain of the material with time.^[21,22]

All three materials exhibited significant residual strain ($\epsilon(t)$) over "clinically relevant" time periods, and the reduced residual strain ($\epsilon(t)/\epsilon(0)$) following deformation was greater for EL than for P1 or WR.^[23]

There was some indication that the three materials have some permanent set following deformation. It was concluded that, in considering desirable mechanical properties of tooth positioner materials, EL is the least suitable of the three examined, with none of the materials being ideal.^[21-23]

Tooth positioners were effective in improving the occlusal finish, but the effects were independent of an increase in occlusal contacts. Positioners primarily improved the first-order alignment by tipping teeth into an improved intercuspation.^[1]

Method of preparation of tooth positioners

The usual procedure required to finish cases, in practice,

is done.^[11] The final wires used are 0.018 arch wires with soldered spurs, and up-and-down elastics are placed in the buccal segments to “sock in” the occlusion, after which a positioner is given.^[24]

Tooth positioners for moving teeth into a more desired configuration are made by taking a cast of the upper and lower arches, moving teeth in the cast counterpart to more preferred positions, packing or pouring uncured material around the counterpart, curing this material to form a resilient arch-shaped body, and trimming the outer surfaces of the body as necessary to make a finished appliance.^[25,26]

A model of the teeth is created using a quick-setting thermoset liquid plastic casting compound. The liquid compound is poured into the tooth marks in the alginate impression, completely filling and covering all impression cavities in the alginate. Using a finely serrated blade, the crooked tooth is isolated by cutting through the plastic separating the tooth to be straightened from its neighbors. The mechanical tools used to move the tooth are rotational tool (movement of tooth around long axis of pin), tipping tool (movement of crown in one direction and its pin in the opposite direction), translational tool (bodily movement of tooth in a linear plane), vertical correction tool (intrusion/extrusion movement of tooth).

Holding the isolated tooth between thumb and finger, the user twists or pushes it into closer alignment with its neighbors. The degree of correction should be small, consisting of a change no more than a millimeter distance or a 5° rotation from its original alignment. The changes made must be slight and must affect only one tooth or two teeth. Anything more significant will result in an appliance that will not fit in the user’s mouth. The model is then set aside to complete the curing process and become completely hard. The arch reconstruction frame is placed inside the thermoforming machine to fabricate a tooth positioner on it.

Maintenance of arch dimensions during treatment and retention is essential for the stability of orthodontic success. There were studies showing significant difference in mandibular intercanine and maxillary intermolar width in pre-finished cases. However, open contact points, curve of spee were found to be mostly high in all reported cases in the literature. These features suggest that the positioners to be checked by individual arch dimensions before delivery to the patient.

Advantages of tooth positioner

A tooth positioner has got three advantages, namely (a) allows the fixed appliances to be removed sooner, (b) improves articulation of teeth and massages the gingival, which is swollen after orthodontic treatment,

and (c) develops lip competence and facial muscle tone.^[2]

The positioner does have the advantages of producing small amounts of detailed tooth movement (perhaps 0.25-0.5 mm) and conditioning the gingival tissues.^[25]

It has also been used in correction of molar cross-bites and control over jet while minimizing undesirable side effects.^[2]

An improper occlusion might cause excessive tooth wear, tooth breakage, tooth injury and loss, tooth sensitivity, head and neck muscle pain, headaches, TMJ pain, and clicking. In order to correct occlusion, tooth positioners can be used. Also, it acts as a retainer preventing relapse that is common after orthodontic treatment. Additionally, this appliance helps to condition the gingival tissues and also closes posterior band spaces.^[15,16]

Disadvantages of tooth positioner

Its disadvantages may be that it might increase overbite and requires good patient compliance.^[2,23] The major disadvantages are their tendency to open the bite and their low durability.^[1]

All the treatment revolves around the cooperation of the patient, and as the tooth position settles and adjusts in the mouth, sore spots might occur in the gums. After an initial occlusal contact occurs, vertical movement of teeth is inhibited. Maintenance of oral hygiene and the appliance is tedious for the patient as it requires continuous use initially.

CONCLUSION

A tooth positioner is not appropriate for finishing every patient, but in selected cases it can enhance and accelerate the detailing of orthodontic treatment.^[26] Tooth positioners are effective short-term adjunctive therapy for enhancing the finish of cooperative patients; the effect is achieved primarily by improving the first-order alignment. Judicious adjustment of occluding inclined planes is suggested because vertical movement of teeth is inhibited after an initial occlusal contact is achieved. It will also be suitable as a finishing appliance to achieve a proper occlusal relationship without interferences and are also effective as retainers. Although the effect was found to be independent of an increased number of occlusal contacts, tooth positioners did improve the overall orthodontic treatment outcome as quantified by the ABO objective scoring method.

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