

EFFECT OF ORTHODONTIC ALIGNER LAMINATE THICKNESS ON STRESS PRODUCTION

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Introduction

Orthodontic aligners have increased popularity due to enhanced esthetics and ease of application by the general practitioner. A primary concern of orthodontic treatment is root shortening and bone resorption. Studies have demonstrated that inclusion of a lower modulus laminate on the internal aspect of aligners allow less localized stress to teeth and bone. Additional concern is super eruption during aligner use as there is limited tooth to tooth contact. This is as a result of an approximate 3:1 differential between anterior and posterior teeth. Therefore, an equal distance of super eruption to the overall dentition may alter centric relation. Thinner aligners may minimize super eruption. As a result, question is raised as to optimum aligner thickness required to exert sufficient load for orthodontic movement while minimizing the potential for supereruption.

Purpose

The purpose of this study was to assess stress production as a function of laminated aligner thickness.

Materials and methods

- Photoelastic model of dentulous adult maxilla was fabricated using different teeth and bone simulants.
- PVS impression was taken of the photoelastic model for CT scan and an "altered" model was fabricated using CAD/CAM technology after making the following lingual movements:
 - Maxillary lateral incisors 0.2mm and
 - Maxillary central incisors 0.6mm.
- The following three different thickness aligners were tested:
 - Thick laminated aligner: 0.75mm.
 - Medium laminated aligner 0.50mm.
 - Thin laminated aligner 0.25mm.
- All three aligners were fabricated from the digitally altered model (Figure 1 below) and inserted over the photoelastic model to assess stress distribution.
- Results were observed in the field of a polariscope and photographed.

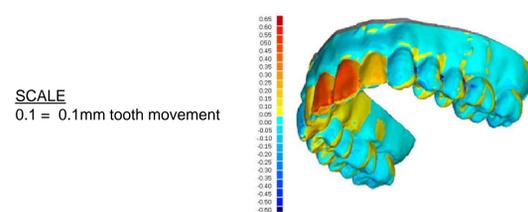
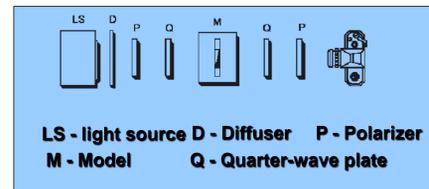


Figure 1 – Demonstrates orthodontic lingual movement of centrals by 0.6mm and laterals by 0.2mm using OrthoMove proprietary reverse modeling software. Image courtesy of NuBrace Inc.



TEST PROCEDURE

- The three laminated aligners were inserted on the photoelastic model and the resulting stresses observed in the field of polariscope and digitally photographed. (photo above).
- Stress data for the three aligners were analyzed using a computer graphics program to quantify stress intensity by fringe number counting..



Figure 2. 3D RAPID PROTOTYPE / PRINTED MODELS
Above left is the unaltered model printed from the CT scan of the PVS impression of the photoelastic model. On the right is the altered model using CAD/CAM technology to alter the position of the centrals lingually by 0.6mm and the laterals lingually by 0.2mm.

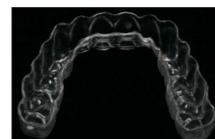


Figure 3. THICK ALIGNER = 0.75mm
Above is the thick laminated aligner which consists of a lower modulus internal lining.



Figure 4. MEDIUM ALIGNER = 0.50mm
Above is the medium laminated aligner occlusal view



Figure 5. THIN ALIGNER = 0.25mm
Above is the thin laminated aligner occlusal view

Results

- All laminated aligners demonstrated mild stress to laterals and moderate stress to centrals.
- The number and proximity of fringes associated with the thick (0.75mm) and medium laminated (0.50mm) aligners demonstrated similar results.
- Both thick and medium laminated aligners demonstrated greater concentration and intensity of stress than the thin laminated (0.025mm) aligner.
- The amount of stress outside of the maxillary laterals and centrals were minimal for all aligners tested.



Figure 6. Above is the photoelastic model with no aligner. Notice that there are no stress associated with any of the teeth and the model is stress free prior to testing. Stress is visualized as areas demonstrated by rainbow like banners with different colors reflective of various intensity. The closer the fringes are to one another the higher the concentration of stress and the greater the number of fringes denotes greater intensity of stress.



Figure 7. THICK ALIGNER 0.75mm
Above is the photoelastic model with the thick aligner (0.75mm) inserted. The study using CAD/CAM technology requested a movement of 0.6mm to the centrals and 0.2mm to the laterals. Notice the number of fringes and proximity of fringes to the central incisors are greater than the lateral incisors which required less movement.



Figure 8. MEDIUM ALIGNER 0.50mm
Above is the photoelastic model with the medium aligner inserted. Notice that the stress distribution in both number of fringes and proximity of fringes are similar around the centrals and laterals, area of tooth movement.



Figure 9. THIN ALIGNER 0.25mm
Above is the photoelastic model with the thin aligner inserted. Notice that the stress distribution in both number of fringes and proximity of fringes are less around the centrals and laterals, area of tooth movement.

Discussion

- This study demonstrated that the thick (0.75mm) and medium (0.50mm) aligners may allow greater amount of force to teeth than the thin (0.25mm) aligner.
- Considerations for orthodontic tooth movement are:
 - Sufficient force to move teeth and
 - Minimal aligner thickness to minimize supereruption and enhance patient comfort.
- Given that the thick and medium aligners demonstrated similar stress patterns, the medium aligner may allow for less supereruption.
- Clinician should consider using the medium thickness laminated aligner (0.50mm) as it allows for similar stress patterns as the thicker aligner (0.75mm), but may allow for less supereruption.

Conclusion

- Results indicate potential for greater degree of tooth movement and longer duration of tooth movement by using the thick (0.75mm) and medium (0.50mm) laminated aligners.
- The clinical implications of this study are that faster orthodontic treatment may be achieved by using the thick and the medium thickness laminated aligners as compared to the thin (0.25mm) laminated aligner.
- Follow up study is presently underway to assess stress patterns on an ongoing timeline by various aligner thicknesses.

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