Abstract #2261

STRESS GENERATED BY LAMINATED ALIGNERS FOR CLASS III MANDIBULAR DISTRACTION

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Introduction

Class III malocclusions with origins in the mandible are often associated with functional and esthetic concerns. Treatments range from surgical retractions to conventional camouflage orthodontics or a combination to achieve reasonable results. Alternatively, Rapid Canine Distraction, a new technique has been proposed where the periodontal ligament at the location of Distalizer is distracted with the goal of eliciting an osteogenic response and rapid retraction of the canines, ultimately a distal movement of the anterior segment. This technique is initiated with bicuspid extractions followed by alveoplasty and expeditious retraction of canines with a mechanical Distalizer appliance. However, the nature of metal based appliances often deviate from configurations that require comfort and practicality for the end-user. The use of clear removable orthodontics may be an alternative to the mechanical Distalizer appliance. Use of clear laminated aligners with soft internal lining has demonstrated potential for lower stress to the teeth and bone, greater patient comfort, and longer term force application for tooth movement. The question is raised as to the efficacy of laminated aligners during parasurgical orthodontics toward rapid distraction cases.

Purpose

The purpose of this investigation was to evaluate the effectiveness of anterior-sextant distraction with clear laminated aligners compared with a mechanical Distalizer device.

Materials and methods

A photoelastic model of a dentulous adult mandible was fabricated using different teeth and bone simulants. The first bicuspid was missing bilaterally to represent recent first bicuspid extractions.

1.One appliance was the rapid canine Distalizer made with conventional Hyrax screws and steel bands.
2.A second appliance was a laminated clear orthodontic aligner (NuBrace, Beverly Hills, CA) which entailed:
   a. Clinician taking a PVS impression of the model and CT scanned.
   b. Lower anterior sextant (cuspid to cuspid) digitally captured and moved disto-lingual by approximately 1mm. The modified digital file was fabricated using a 3-D printing process.
   c. A laminated clear aligner was prepared using CAD/CAM technology.
3.Both appliances were inserted over the photoelastic model and resulting stresses observed in the field of the polariscope and photographed.
4.Stress data for the two systems was analyzed using a computer graphics program to quantify stress intensity by fringe number counting.

Figure 1. PHOTOELASTIC INTERPRETATION
Above represents load exerted on a photoelastic model. Note the increased stress in the proximity of the load-model interface. Number of fringes and proximity of fringes decrease as the distance from direct load increase. To the right is a color scale to determine intensity of stress by colors.

Results

Figure 5. NO APPLIANCE INSERTED ON THE PHOTOELASTIC MODEL
Above is the photoelastic model with no orthodontic appliance. 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.

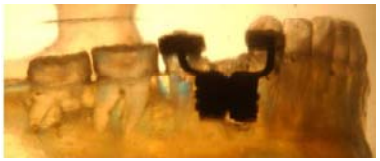

Figure 6. DISTALIZER INSERTED OVER THE PHOTOELASTIC MODEL
Distalizer has two ring bands for retention. In addition, the appliance allows for movement by a torque screw to allow for rapid distalization of the canine. Notice high level of stress concentration localized along the mesial and distal abutments of the Distalizer appliance.

Figure 7. NUBRACE LAMINATED ALIGNER INSERTED
Laminated aligner inserted over the photoelastic model allows for a more uniform stress distribution along both molar and premolars distal to the freshly extracted first premolar in conjunction to stress distribution to the teeth mesial to the extraction site.

- Both Canine Distalizer Appliance and NuBrace clear laminated aligner demonstrated localized compressive stress along the mesial crestal bone and associated roots mesial to path of tooth and bone movements and tensile stress distal to path of movement.
- Laminated aligner demonstrated more uniform stress as compared to the Distalizer.
- Conventional Canine Distalizer demonstrated localized stress along the brackets required for appliance retention.
- Laminated aligner possessed no brackets or attachments and therefore, had no focused stress.

TEST PROCEDURE

•Orthodontic appliances (Canine Distalizer and laminated aligner were inserted on the photoelastic model and resulting stresses observed in the field of polariscope and digitally
•Stress data for the two appliances were analyzed using a computer graphics program to quantify stress intensity by fringe number count.

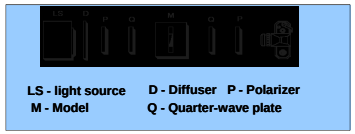

Figure 2. SCHEMATIC REPRESENTATION OF THE PHOTOELASTIC SET-UP

Circular polariscope is designed to allow light behind the photoelastic model and polarized filters in front of the camera to separate out the various lights associated with stress concentration and stress intensity in the photoelastic model produced from the two orthodontic appliances.

Figure 4. NUBRACE LAMINATED ALIGNER
Above is picture of the laminated aligner used for this study. Note that through CAD/CAM technology, all teeth to the lower anterior sextant mesial to the freshly extracted first premolars were digitally moved distally by 1mm in order to simulate canine distraction and retraction of the anterior sextant of the mandible into the extracted first premolar site.

Figure 3. MANDIBULAR DISTALIZER
This appliance was attached to the coronal section of both the canine and the second premolar in order to allow for rapid mandibular distraction of the canines into the freshly extracted first bilateral incisor socket space just mesial to the attachment of the Distalizer.

Discussion

1.The periodontal ligament may have osteogenic properties that mimic that of the suture on the mid palate. It may be possible to utilize this property with the goal of distal tooth movement or retraction in cases of moderate Class III malocclusion.
2. Clinical evidence shown that premolar extraction in conjunction with parasurgical alveoplasty and the administration of an appliance with constant force over a short time span, may aide in repositioning the canine and anterior teeth segment.
3.The use of a Mechanical Canine Distalizer may provide focused tooth movement, however, there are concerns on esthetic and patient compliance setbacks due to irritation, poor oral hygiene and micro-lacerations to soft gingival and mucosal tissue.
4.Both Distalizer and laminated orthodontic appliances demonstrated similar stress patterns during anterior sextant distraction.
5.The clinician may wish to select laminated aligners for rapid distraction as benefits include; ease of hygiene, lower risk of allergic reactions, unwanted stress to teeth and bone outside of the region, esthetics, and or greater patient comfort.

Conclusion

1.Both conventional and laminated orthodontic appliances can provide distalization for the rapid canine tooth movement. The laminated orthodontic aligner has benefits of concertedly moving the canine in addition to the anterior segment during the distraction period.
2.Both conventional and laminated orthodontic aligners demonstrated similar stress patterns during the rapid canine distraction method.
3.The laminated aligners may have benefits where ease of hygiene, lower risk of allergic reactions, unwanted stress to teeth and bone outside of the region, esthetics, and or greater patient comfort are mandated.

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