STUDY OF EXTRAORAL FORCE DELIVERY SYSTEMS USING HOLOGRAPHIC TECHNIQUES

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1. INTRODUCTION

Extraoral traction is still one of the most reliable methods used during active orthodontic period especially in growing patients [1]. It is a practical and cost-effective method for attaining extra anchorage in a variety of treatment situations and it can be used either with orthodontic or orthopaedic purposes [2-3]. It is imperative for the clinician to consider the quality of the force systems, taking into account the degradation of its components, due to loss of elastic memory and material fatigue. Thus it is utterly important to understand the characteristics and mechanical behaviour of the extra oral device elements.
This investigation intended to compare extraoral force delivery systems through the study of the mechanical behaviour of the plastic strap component. For this study two methods were chosen, a non-experimental technique, Finite Element Analysis (FEA), and an experimental technique ESPI. Two different manufacturers of extraoral traction systems were selected based on their market price, one of them being significantly more expensive than the other. The assessment of this data may validate the choice criteria between these two market options.

2. SCOPE AND METHODOLOGY

Extraoral force delivery systems can be presented in different shapes and made from different materials. The study presented in this work will relay in a particular type of extraoral force delivery system as presented in figure 1. This orthodontic study is the result of a combined research involving the Engineering and Dental Medicine Faculties of Oporto University. The specimens were chosen from two different manufactures, Ormco® (California, USA) and Ceosa® (Madrid, Spain), and their selection was based on their market price.

Figure 1. Medium force modules from Ormco® and Ceosa®

To improve the clinics it is important to understand the limitations of the materials and techniques used because the success of most procedures is highly dependent on the understanding of the biomechanics associated. Several methods have been used to analyze the biomechanical behaviour of systems used in orthodontics. FEA is being increasingly used due to their capacity to evaluate the distribution of stresses/strains. Being a non-experimental technique, FEA may contain errors during programming, which can distort or change the results. In order to ensure and validate the computer model it is necessary to compare the obtained data with experimental results. Optical techniques are well adapted for these applications due to their high resolution field measurements which can be performed with no contact [4-6].
In the available optical techniques ESPI was the one chosen for this study due to completely non-intrusive, non-destructive, with sub-micrometer resolution, non-contact application over diffused surfaces with no special preparation.
ESPI is a speckle interferometry technique that uses laser radiation and an optical setup where the interferometric patterns are recorded on a video camera [7]. The basic principle of the ESPI technique is that the speckle pattern intensity distribution is a function of the relative phases of two interfering plane waves. ESPI results are obtained as interferometric fringe patterns representing the regions of equal displacement in the direction of the sensitivity vector [8]. Using temporal phase modulation the deformation phase map can be assessed.

3. CONCLUSION

The objective of this work was to study the mechanical behaviour of the extraoral force modules and to show how optical techniques can be used to assess the displacement fields. In particular we want to measure the displacements in the plastic strap component of the extraoral force delivery systems. The experimental results will be described and used

to implement a numerical model using a commercial FEA package. The relevance of the obtained results could be used as a selection criteria between these two market options.

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