

Clinical and experimental research on occlusal implications of orthodontic treatment

ABSTRACT

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The purpose of the clinical and experimental research was to elaborate methodologies to objectively evaluate parameters of initial malocclusion and occlusal changes during the phases of orthodontic treatment, correlating between morphological and functional aspects. Data was collected using special devices both on patients and specific orthodontic simulators before, during and after orthodontic treatment.

REVIEW OF THE LITERATURE

In the first chapter, ***Ideal dental occlusion. Normal occlusion***, theories and contemporary criteria for defining and assessing morphological occlusal relationships are summarized, addressing terminology and characteristics of ideal and normal occlusion.

Chapter 2, ***The concept of functional occlusion***, systematically presents the evolution of gnathological and functional theories through contemporary criteria for assessing occlusal relationships from modern orthodontic treatment. Chapter 3, ***Evolution and current classification of dento-maxillary anomalies***, reviews the progress of classification systems of dento-maxillary anomalies and current classifications, based on morphological criteria (Angle), followed by etiopathogenic, functional, dento-facial (Proffit) and gnathological criteria, up to the current concepts of neuromuscular dentistry. Chapter 4, ***Evaluation methods of occlusal contacts***, analyzes and systematizes of the main methods of evaluation of occlusal contacts from articulating paper up to modern technology (T-Scan, Prescale).

PERSONAL CONTRIBUTION

Chapter 5. Experimental study on characteristics of conventional occlusal indicators

The objective was to evaluate the accuracy of six conventional occlusal indicators based on occlusal areas marked by each indicator. **Materials and methods** Six indicators were studied, 4 papers and 2 articulating foils, which markings were made on a typodont under the same applied force. Markings areas were calculated on standard photographic images using a computerized application. **Results** Total area marked by the six indicators left on the molars the varied in size. A correlation was established between the thickness of the occlusal indicator and the size of the area marked. Significant difference was found between the contact areas of 200 μm paper and 12 μm foil. **Conclusions** A thick articulating paper can be used for locating occlusal contacts, but finishing of an occlusal adjustment requires thin foil (12 μm).

Chapter 6. Comparative clinical evaluation of occlusal contacts using conventional and computerized T-Scan III methods

The objective was comparative analysis and determination of reliability between 40 μm articulating paper and 12 μm metal foil in assessing the most forceful contact in the dental arch. Relying on computerized occlusal registrations, the accuracy of the indicators in identification of the most forceful occlusal contact was determined. **Materials and Methods** Eighteen subjects were asked to perform maximum intercuspation on two indicators, followed by intra-oral photographs of maxillary arches and T-Scan III computer records. Nine dentists evaluated the most forceful occlusal contact on posterior teeth. **Results** The intraclass correlation coefficient was 0.711 for articulating paper and 0.725 for foil. Internal consistency for each examiner showed variable results. Subjective and objective observations were matched in 35-42% of cases. **Conclusions** Subjective assessment of the most forceful contact using conventional occlusal indicators led to variable

results. Classical indicators compared to T-Scan III show in most cases false interpretation that can lead to therapeutic errors. Association of conventional indicators with computerized method for occlusal forces measurement is recommended.

Chapter 7. Experimental research on occlusal changes after orthodontic treatment

The objective was to determine the variability of occlusal parameters in a group of typodonts with similar malocclusions by reducing as many variables related to the subjects or methods of treatment. Another purpose was to analyze the difference between the clinically evaluated occlusion and by objective means. **Materials and methods** Twenty-nine electro-typodonts, simulating a malocclusion, were treated by a group of orthodontics residents using the same technique and orthodontic means. All typodonts were subjected to occlusal registration procedures before and after treatment using the T-Scan III system. **Results** Total occlusal contact area increased significantly ($p < 0.0001$) after treatment. Occlusal distribution changed significantly ($p < 0.001$) without describing a balanced situation in every case. **Conclusions** The variability of the results after treatment is dependent on factors related to typodont (teeth mounting, resistance of roots, wax quantity around each tooth) and physician-related factors (skills related to bending transpalatal arch, archwire ligation). Finishing orthodontic cases is necessary to obtain occlusion close to ideal. Using the Angle classification is insufficient, occlusal relationship requiring vertical plane analysis.

Chapter 8. Clinical and technical assessments of occlusal implications of orthodontic treatment

The objective was to develop the bases of a protocol for objective evaluation of occlusal changes during orthodontic treatment and to highlight its practical uses. **Materials and methods** The study was conducted on sixteen orthodontic patients with malocclusions. Each patient performed a computerized occlusal registration and three parameters were studied: occlusion time, occlusal contact area and force size when reaching maximum intercuspation (MIP). **Results** Average occlusion time was 0.519 ± 0.337 seconds. Average relative force at the beginning of MIP was 76.24% and occlusal contact area $67.2 \pm 2.37 \text{ mm}^2$. Between occlusion time and occlusion area there was a very weak association, statistically non significant. Strong association ($r = 0.5022$, $p < 0.001$) between relative force and occlusal contact area in MIP was found. Significant correlation ($r = 0.5022$) was observed between the occlusal contact area and the relative force achieved at the beginning of MIP. Three detailed clinical cases are presented demonstrating the proposed protocol. **Conclusions** Occlusal contact area is lower in patients with malocclusion than normal occlusion. The shorter the period from the first contact to MIP, the higher force achieved in MIP. Orthodontic occlusal correction must be accompanied by an objective assessment of functional occlusion, allowing the doctor to decide any necessary adjustments for optimal occlusion, both aesthetically and functionally.

Chapter 9. Occlusal characteristics during Hawley retention evidenced by computerized T-Scan III method

The objective was to assess the efficiency of Hawley retainer by evaluating occlusal contacts after appliance removal (T1) and after a month of retention (T2). **Materials and methods** Twelve subjects (17.4 ± 3.8 years), orthodontically treated to molar and canine first class, were evaluated in T1 and T2 using T-Scan III. **Results** Average occlusal contact areas slightly decreased in T2, without statistically difference between T1 and T2. Most cases had a tendency for symmetrization, in two particular cases force distribution on the two hemi-arches became more asymmetrical. **Conclusions** At the time of appliance removal, most cases showed a relatively good distribution of forces along arches. In some cases there were clinically undetected functional asymmetries, some of them being corrected in the first month of retention.

Chapter 10. Final conclusions

a. Due to the specific properties of the registration materials, information obtained from their use should be interpreted with caution, especially when opting for irreversible therapeutic procedures such as selective grinding. The results of the research showed that thickness of occlusal indicators is positively correlated with markings size ($p < 0.05$), therefore in occlusal adjustments

procedures a minimum thickness of film should be used.

b. Exclusive use of classical indicators can lead to misinterpretations and therapeutic errors. For occlusal adjustments, in order to evaluate the occlusal forces and sequence of contacts, the use of computerized T-Scan III analysis associated with thin occlusal indicators for locating and marking the occlusal contacts is indicated.

c. Experimental research on typodonts has shown that anticipation of occlusal outcomes of orthodontic treatment is possible. Computerized analysis showed a significant increase in occlusal contact area after treatment without always displaying a balanced situation. Applying a standard treatment protocol is not sufficient to obtain functional and stable therapeutic outcomes, requiring individualized finishing procedures.

d. Personal clinical observations support the utility of clinical and technical protocol proposed for assessing the occlusal orthodontic treatment implications. This helps the dentist (both in diagnosis and in the necessary adjustments to complete the case) to achieve optimal occlusion, both aesthetically and functionally.

e. The T-Scan III system is a useful instrument in the identification of functional and non-functional occlusal contacts. The T-Scan III records the timing and sequence of occlusal contacts, unlike articulating paper which marks all teeth. Thus, the clinician can quickly recognize inadequate stress and eliminate it.

f. Masticatory muscle activity can be recorded and analyzed independently or simultaneously by integration of BioEMG II module with T-Scan III system. Simultaneous analysis of occlusal contacts and muscle activity provides the clinician important diagnostic and therapeutic elements.

g. During retention, Hawley plate allows occlusal changes and settling, also preventing relapse. Patients need a long-term follow-up to assess the nature, the evolution of occlusal changes and effectiveness of Hawley retainer.

Keywords: occlusion, orthodontic treatment, occlusal indicators, computerized occlusal analysis.