

Occlusion Timeline Analyses with T-Scan III System in Subjects with Neuroocclusion

Vesna Trpevska¹, Gordana Kovacevska², Alberto Benedetti³, Lidija Kanurkova⁴

¹PHO Dental Clinical Center, Sv. Pantelejmon", Clinic for orthodontics, Skopje, R. Macedonia,

²Faculty of Dental Medicine, University, Ss. Kiril i Metodij", Department of prosthodontics, Skopje, R. Macedonia

³Faculty of Dental Medicine, University, Ss. Kiril i Metodij", Department of oral and maxillofacial surgery, Skopje, R. Macedonia

⁴Faculty of Dental Medicine, University, Ss. Kiril i Metodij", Department of orthodontics, Skopje, R. Macedonia

Abstract: Occlusion evaluation based only upon static parameters in such a dynamic masticatory system is insufficient. Therefore, timeline analysis with T-Scan III System is important in diagnose, therapy plan in all phases of orthodontic treatment in every day clinical practice. The aim of this study is to analyse the occlusal force and occlusal contacts distribution over the course of time with the T-Scan III System precise analysis in subjects with neuroocclusion. We included 30 subjects with neuroocclusion, Angle Class I, at the age of 16-29 years, describing the time and force moment statistics of occlusal contacts in the sagittal and transverse axes of the occlusal plane. We analysed the bite in every 0,15 seconds from the first registred antagonistic tooth contact at inicial time t1 until terminal time t10. At time t1, 40% from the subjects with neuroocclusion occluded first in the anterior region. At time t10, subjects had dominant occlusal contacts in the premolar and molar region with 36,3%. Occlusal force distribution in the right and left halves of the dental arch changes in time. Changes in the total occlusal force (TOF) modifies the distribution of occlusal contacts. Our detailed analysis of occlusion over elapsed time showed that initially the central incisors are the teeth that come together in occlusal contact. This is a result of their role of guidance. Analysis of masticatory cycle in time shows tendency for force distribution towards the posterior region at the end of the bite.

Keywords: T-Scan III System, Occlusion Timeline Analyses, Neuroocclusion

1. Introduction

Orthodontic treatment aims to include good facial morphology, stable treatment results and good occlusion with proper bite force and articulation that creates anatomical and physiological harmony in the jaws and muscles [1]. Dental occlusion refers to the way teeth come together in the act of closure of dental arches. "The key of dentistry", as it is called, occlusion is the way the incisal edges and occlusal surfaces of the upper and lower teeth come together in the act of closure of dental arches [2]-[5]. Occlusion is the static relationship of the teeth and is basic to all aspects of dentistry. The alignment and occlusion of the dentition are extremely important in masticatory function. Basic orofacial functions such as mastication, speaking and deglutation depend on the position of teeth in the dental arch and their relationship with antagonistic teeth when they come together in occlusion. Tooth position is controlled by numerous factors such as dental arch width and the influence of surrounding soft tissues [6]-[8].

Another important factor that helps in tooth position stabilization is the occlusal contact, which prevents teeth extrusion keeping dental arch stability. In every mandibular closure a unique occlusal contact pattern of the antagonistic teeth together with the proximal teeth contact between adjacent teeth maintain the dental arch integrity and stabilization. Buccal cusps of mandibular posterior teeth and lingual cusps of maxillary posterior teeth occlude and are responsible for maintaining the vertical dimension of occlusion playing major role in the process of mastication [9].

Individual occlusal status depends on two major characteristics: the intraarch and interarch tooth relationship. According to Angle [5], first molar occlusal relationship is the most important during the occlusal relationship examination. The mandibular first molar is normally located more mesially than the maxillary first permanent molar. In subjects with Angle Class I, neuroocclusion, the mesiobuccal cusp of the mandibular first molar occludes in the embrasure area between the maxillary second premolar and first molar. The mesiobuccal cusp of the maxillary first molar is aligned directly over the buccal groove of the mandibular first molar. The mesiolingual cusp of the maxillary first molar is situated in the central fossa area of the mandibular first molar. Each mandibular tooth occludes with its counterpart and the adjacent mesial tooth. The contacts between molars occur on both cusp tips and fossae and cusp tips and marginal ridges. Occlusal contact pattern can vary in respect to the marginal ridges areas. In some instances a cusp contacts the embrasure area directly, resulting in two contacts on the area of the cusp tip. In other instances the cusp tip is positioned such that it contacts only the marginal ridge, resulting in only one contact on the cusp tip. The labial inclination of the maxillary anterior teeth and the manner in which they occlude with the mandibular teeth does not favor resistance to heavy occlusal forces. Therefore in normal occlusion, contacts on the anterior teeth in the intercuspidal position (ICP) are much lighter than on the posterior teeth. Absence of contacts on the anterior teeth in the ICP is not uncommon. The purpose of the anterior teeth, then, is not to maintain the vertical dimension of occlusion but to guide the mandible through the various lateral movements. The anterior tooth contacts that provide guidance of the mandible are called the

anterior guidance. The anterior guidance plays an important role in the function of the masticatory system. Its characteristics are dictated by the exact position and relationship of the anterior teeth, which can be examined both horizontally (horizontal overlap-overjet) and vertically (vertical overlap-overbite). An important characteristic of the anterior guidance is determined by the intricate interrelationship of both these factors [10]-[12].

Occlusion has a functional role, therefore occlusal evaluation in a base of static criteria in such a dynamic masticatory system is not adequate and sufficient. Occlusion is involved in different functions of the dentition such as mastication, speaking, deglutination and esthetics. Therefore, evaluation of the occlusal dynamic parameters over the course of time is essential and very important in the diagnosis of the jaws relationship. Timeline analysis of the occlusion is important to establish function of the masticatory system [13]. T-Scan III System use is important in diagnosis, therapy plan in all phases of orthodontic treatment in every day clinical practice accomplishing occlusal balance. Occlusal stability and harmony are factors that guarantee long term success in the orthodontic treatment. The aim of this study is to analyse the occlusal force and occlusal contacts distribution in time. T-Scan III System precise analysis of the correlation between occlusal force and time, location and trajectory of Center of Force (COF) and correlation between occlusal contacts distribution and total occlusal force provide us informations about the occlusal balance of the patients with neuroocclusion.

2. Materials and Methods

In this study we included 30 subjects with neuroocclusion, Angle Class I, at the age of 16-29 years. We registered the masticatory cycle of the mandible, describing the time and force moment statistics of occlusal contacts in the sagittal and transverse axes of the occlusal plane. We analysed the bite in every 0,15 seconds from the first registered antagonistic tooth contact at initial time t_1 until terminal time t_{10} . Trajectory and position of Center of Force (COF) in relation to the center of elliptic fields were registered. We analysed the occlusal contacts distribution for different total occlusal force (1/10 of Total Occlusal Force (TOF), 1/4 of TOF, 1/2 of TOF, 3/4 of TOF and TOF max.

Functional analysis was performed via the T-Scan III System (T-Scan III for Windows, Tekscan Inc., South Boston, MA, USA), (Figure 1.) in 30 patients with neuroocclusion. This technology eliminates the subjectivity of clinicians content and replaces it with an objective process that employs precision digital measurement technology. The T Scan III analyzes the order of occlusal contact, while simultaneously measuring the force percentage changes of those same contacts, from the moment the teeth first begin making occlusal contact, all the way to the maximum intercuspitation. The data can be saved on the hard drive to provide visual documentation of the recorded occlusal function. The system is composed of a computer with a specific board and software capable of converting information recorded by the sensor to visual and numerical information on tooth contact. The recording is taken by placing the sensor in the patient's mouth, with the

sensor support pointer between the two central incisors and keeping the scanning handle as parallel to the occlusal plane as possible. T-Scan digital occlusal evaluation was initiated by determining dental arch dimensions by measuring central incisor width [14]-[21].

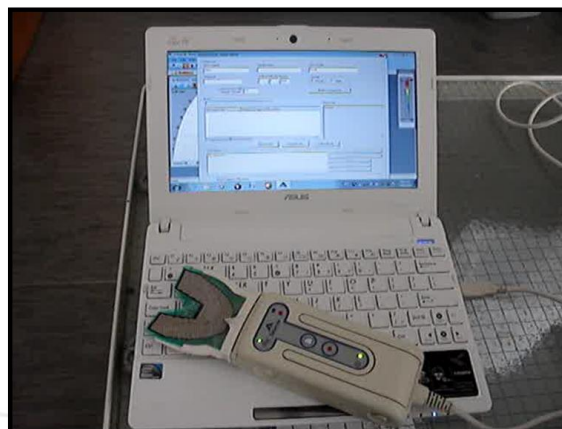


Figure 1: T-Scan III System (T-Scan III for Windows, Tekscan Inc., South Boston, MA, USA)

3. Results and Discussion

In subjects with neuroocclusion (Figure 2.) there is tendency of changing the relative masticatory force over time, starting with bigger force in the anterior region, continuing with increment of force in the posterior region over time with larger percentage of simultaneity of occlusal contact.





Figure 2: Intraoral view of subjects with neuroocclusion

At time t1, 40% from the subjects with neuroocclusion occluded first in the anterior region, 33% occluded first in the posterior region and 26,6% did have simultaneity in their occlusal contacts. At time t10, subjects had dominant occlusal contacts in the premolar and molar region with 36,3%. At t10 there is tendency to increase the occlusal contacts simultaneity. 50% of the subjects occluded simultaneously on anterior and posterior teeth at time t10. In anterior region there is tendency to decrease the occlusal contacts distribution in time. 40% of the subjects occluded first in the anterior region at t1 and only 13,3% occluded in the anterior region at t10 (Table 1).

Table 1: Mean values of relative masticatory force distribution in anterior and posterior region in the dental arch over time in subjects with neuroocclusion

Subjects with neuroocclusion n=30	t1	t10
Anterior region	40%	13,33%
Posterior region	33,33%	36,33%
Simultaneous contact	26,66%	50%

Occlusal force distribution in the right and left halves of the dental arch changed in time. At t1, 57,7% of the relative occlusal force is located in the right half of the dental arch and 42,2% in the left half of the dental arch. This situation changes at t10, and there is an increase in the bilateral simultaneity of the occlusal contacts with relative masticatory force distribution of 50,2% in the right half and 49,8% in the left half of the dental arch (Table 2).

Table 2: Mean values of relative masticatory force distribution in right and left halves of the dental arch, over time in subjects with neuroocclusion

Subjects with neuroocclusion n=30	t1	t10
Right half of the dental arch	57,76%	50,14%
Left half of the dental arch	42,24%	49,86%

The COF (Center of Force) trajectory shows the history of the path of the center of force from the beginning of the force movie recording to the current displayed frame (Figure 3.).

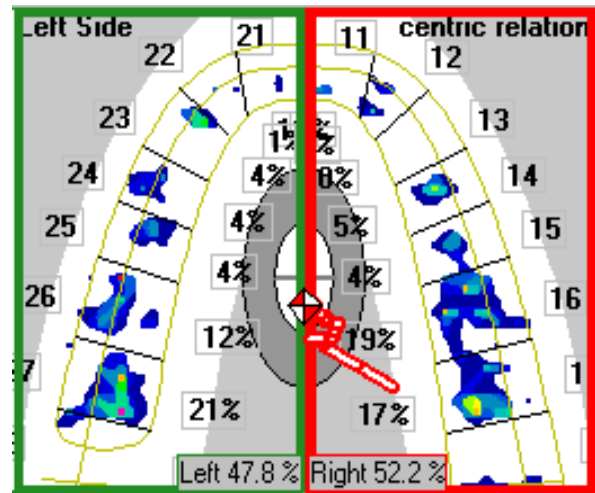


Figure 3: 2D view of Center of Force trajectory and occlusal contacts distribution

The movement of the COF trajectory can be observed by playing a force movie one frame at a time. The trajectory is represented on the computer screen by a red and white line that trails the COF marker. The COF trajectory illustrates how the summary of occlusal force changes location as sequential tooth contacts occlude throughout the recorded mandibular closure. The trajectory movement indicates where the force summary is directed when more of the patients' teeth sequentially come together [16].

According to the COF trajectory, at t1 COF was located in the anterior region in 46,7% of our subjects. At t10 this percentage decreases to 10%. 53,3% of our subjects had COF located in the posterior region at t1 and at t10 98,4% of our subjects had COF located in the posterior region of the first permanent molar. COF trajectory over time shows tendency of pathway movement directed posteriorly (Table 3.).

Table 3: COF trajectory over time

Subjects with neuroocclusion n=30	t1	t10
Anterior region	46,7%	3,33%
Posterior region	53,3%	96,67%

Our results are in concordance with Kerstein results [22]-[25]. In subjects with neuroocclusion there is normal distribution with tendency of bilateral, balanced symmetrical COF localization. In 55,2% from our subjects COF is located in the white ellipse, in 41,3% COF is located in the grey ellipse and there is dislocation of this center in only 3,4% from subjects with neuroocclusion (Table 4).

Table 4: COF localization over time

Subjects with neuroocclusion n=30	White ellipse	Grey ellipse	COF dislocation
COF localisation	55,2%	41,3%	3,4%

The percentage of occlusal contacts distribution is changed in correlation to the amount of total occlusal force (TOF). For 1/10 of TOF 40,1% of occlusal contacts are distributed in the left half of the dental arch and 59,9% in the righthalf of the dental arch. Changes in the total occlusal force modifies the distribution of occlusal contacts. For TOF max

there is distribution of 50,17% on the left side and 49,83% on the right side of the dental arch (Table 5.).

Table 5: Mean value percentage of occlusal contacts distribution for different total occlusal force (TOF) (1/10 of Total occlusal force, ¼ of TOF, ½ of TOF, ¾ of TOF and TOFmax

Subjects with neutroocclusion n=30	1/10 of TOF	¼ of TOF	½ of TOF	¾ of TOF	TOFmax
% left occlusal contacts	40,1%	40,76%	43,22%	46,73%	50,17%
% right occlusal contacts	59,9%	59,24%	56,78%	53,27%	49,83%

4. Conclusion

T-Scan III System is practical, quantitative method that enables and provides occlusal balance evaluation over the course of time. Subjects with neutroocclusion at t10 are characterized with ideal physiological, balanced occlusion and harmony in the masticatory system function. Our computerized system for occlusal analysis indicated that in subjects with neutroocclusion there is a tendency for bilateral equality of the tooth contacts about the sagittal axis with high degree of force equality per half arch. Location of the center of force for the antero-posterior occlusal contacts, which was measured from the incisal axis of occlusal plane, at t10 was also located in the first molar region and is symmetrical bilaterally. COF trajectory also shown tendency for pathway movement directed posteriorly. Our detailed analysis of occlusion over elapsed time showed that initially the central incisors are the teeth that come together in occlusal contact. This is a result of their role of guidance. Analysis of masticatory cycle in time shows tendency for force distribution towards the posterior region at the end of the bite.

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