A Case Review

Occlusal Indicators- A Simplified Approach

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Abstract: Knowledge about occlusion is critical to good clinical practice in dentistry. Among clinicians there has been an increasing interest on treatment planning focusing on the biomechanical elements associated with occlusion. All disciplines of dentistry require
that the clinicians assess the articulation of the teeth/prosthesis with respect to simultaneous contacts, biting time and biting force. However, measuring dental occlusal forces has been an inexact science, often requiring complex and subjective decisions.

Occlusal indicators are widely used to obtain information on tooth contacts during occlusion in the fitting of prosthetic devices. A wide range of indicatorsexist ranging from articulating ribbons through to the T-Scan pressure measurement system. These devices differ not only in their measurement characteristics but also in their material properties such as thickness and plasticity. The aim of this article is to provide an insight to various occlusal indicators available in the clinical world of prosthetics.

Introduction

Knowledge about occlusion is critical to achieving satisfactory clinical outcomes in dental practice. Luckily, clinicians have shown an increased interest in the biomechanical elements associated with occlusion[1,2]. Based on the glossary of Prosthodontics terms (2009), dental occlusion is ‘the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues’. [3]However, the clinical concept of occlusion incorporates dynamic interactions of the movement of the mandible and to the static morphological teeth contact interactions. The dynamic morpho-functional interactions include the entire masticatory system, namely the teeth, the periodontal tissues, the neuromuscular system, the temporo-mandibular joint, and the craniofacial bones.

IMPORTANCE OF OCCLUSAL ANALYSIS

Uneven distributions of pressure on occluding teeth that often do not contact simultaneously result in occlusal trauma. This may be produced due to unusual occlusal contacts and excessive occlusal height of a restoration. It has been demonstrated that dental and periodontal tissues suffer from occlusal trauma and even dental implants may deteriorate under excursive overload and/or higher bite forces, eventually leading to bone loss and failure complications.

Moreover, temporo-mandibular joints may be harmed especially in atypical protrusive interferences[4-6] by moving the mandible into a physiologically unsound position leading to muscle pain (myalgia). If premature or interfering contacts (such as excursive on the non-working side) points are not detected, they would lead to destructive forces through the masticatory system and could even result in parafunction such as clenching[7,8]. This may further lead to sore neck and facialmuscles, and endanger nerves within the temporo-mandibular joint (TMJ), as has been seen in various temporo-mandibular disorders (TMDs) [9].

In contrast, a low occlusal height mayresult in disorders such as disuse osseous atrophyand/or unstable centric occlusion [10]. Therefore, assessment of the occlusion is crucial to remedy these occlusal issues. Clinicians use various occlusal indicators to analyze occlusal contacts. [11]

CLASSIFICATION OF TOOTH-CONTACT PATTERNS [11]

The tooth contact patterns were classified into four groups as follows:

1. Cuspid protected occlusion: contact of canines on the working side.
2. Group function occlusion: contact of canines, premolars, and/or molars, or contacts of premolars and molars on the working side only.
3. Full balanced occlusion: tooth contact patterns with group function or cuspid protected occlusion on the working side plus multiple tooth contacts of posterior teeth on the nonworking side.
4. Others: occlusal patterns other than those described. Contact of incisor teeth, if any, were included in this classification.

Hellman described four ways in which teeth contact: 1. surface 2. cusp tip and fossa 3. ridge and groove 4. ridge and embrasure.

OCCLUSION INDICATORS - TYPES [11]

The occlusion indicators can be broadly divided as qualitative and quantitative indicators, the principal difference being that the quantitative indicators are capable of measuring the tooth contact events.

Qualitative indicators

• Articulating paper
• Articulating silk
• Articulating film
• Metallic shim stock film
• High spot indicator

Quantitative indicators

• T-Scan occlusal analysis system
• Virtual dental patient

Qualitative indicators

Qualitative indicators are the most commonly used materials for registering the occlusion owing to their lower cost and their ease of application. With these materials, only the localization of the occlusal contact points is possible. The disadvantage is that the sequence or the density of the occlusal contacts cannot be determined, although an opinion can be derived from the density of the contacts according to the darkness of the marks. Further, these materials lack the quantitative time and force descriptive capacity and are incapable of measuring tooth contact events.

Articulating paper: Articulating papers are the most frequently used qualitative indicators to locate the occlusal contacts intraorally. They differ in terms of width, thickness and the type of the dye impregnated. They are hydrophobic in nature. Their basic constituents are a coloring agent and a bonding agent (e.g., Transculase-Bausch Articulating paper) between the two layers of the film. On occlusal contact, the coloring agent is expelled from the film and the bonding agent binds it on to the tooth surface. The characteristic marking is observed as a central area that is devoid of the colorant and surrounded by a peripheral rim of the dye. This region is called "target"or "iris" owing to their appearance, and it denotes the exact contact point. The density of these markings does not denote the force of the contact; instead, heavier contact tends to spread the mark peripheral to the actual location of the occlusal contact. Only the central portion in heavy contact areas indicates the interference requiring correction.

In practice, there is a tendency to use cost-effective materials such as carbon papers. These are made up of hydrophobic waxes that tend to smudge the tooth surface and fail to mark the contact spots clearly. Articulating papers, despite being the most commonly used occlusion indicators, have the following inadequacies. They are easily ruined by saliva and hence require usage in a dry field. Their thickness of 40 μ is well above the thickness perception level of the patient and their relatively inflexible base material leads to the formation of a large number of pseudo-contact markings.

Articulating silk: It is made up of a micronized color pigment, embedded in a wax-oil emulsion.

Since it has a soft texture, pseudo markings are not produced during the use and it is effective when used intraorally. However, it loses its marking ability when stain components are dried and can be ruined by saliva. Hence, its storage in a cool, closed environment is essential. It is highly suitable for use on highly polished surfaces, particularly ceramic and gold in lab models, where one strip can be used as many as ten times.

Articulating film: The Artifol articulating film (Bausch Inc.) has only a thickness of 8 μ, which is much less than the thickness perception level of the patient. It is made up of an emulsion with a thickness of 6 μ, which is hydrophobic and contained inside a polyester film. It must be used with special holders in a dry environment. It is universally applicable, both intraorally and on lab models.

Metallic shim stock film: The shim stock film has a metallic surface on one side and the other side is colour coded. It is mainly indicated for use in the occlusal splint therapy in order to accurately mark the contacts on the soft splint in the laboratory.

High spot indicator: This is supplied in the liquid form and is indicated for use in the laboratory to check the proximal contacts of crowns, inlays, onlays, telescopic crowns and clasps. The liquid is applied with a brush on the proximal surface of the coping and it forms a film with a thickness of 3 μ. The dye is then seated in the cast, and on removal, the proximal contact area is delineated as an area of show through in the base material of the crown.

The two-phase occlusion indicator method: In this method, the sequential use of the articulating paper and the articulating film highlights the actual interference areas accurately and clearly. The articulating paper is initially used to mark the contacts represented as a clear central region surrounded by a peripheral rim of the dye. In the next step, the articulating foil of a contrasting colour is used to mark the contact spots in the center of the contact areas highlighted by the articulating paper markings previously. It is the central areas marked by the articulating foil that are the actual interferences and are to be eliminated.[11]

LIMITATIONS OF QUALITATIVE OCCLUSAL ANALYSIS METHODS

Articulating papers cannot measure occlusal load, since there is no scientific correlation between the depth of the color and the mark, its surface area, amount of force, or the contact timing sequence that results as that paper mark is made[12,13] .In addition, articulating papers are susceptible to being destroyed by saliva; they are subject to tearing and crumpling under bite force, are usually thick, and have a relatively inflexible base material. These factors are believed to result in a high proportion of pseudo contact markings.[14-15]Similarly, shim stock strips (12 mm thick), occlusal waxes, and silicone pastes do not accurately reproduce occlusal contacts. In addition, the sensitivity and reliability of these techniques is highly susceptible to inaccuracy due to the thickness, strength and elasticity of the materials in the oral environment, resulting in distortion of the impressed marks. An indicator should ideally mark only the designated contacts by negating positional errors influenced by tooth displacement and extended mandibular movements. Nevertheless, a false contact may occur when the indicator interferes with closure. A false contact is an area registered that does not exist, although it may be reproduced across multiple tests. Near occlusal contacts may also appear as actual contact areas, depending on the type of marking indicator used.[16-18]Most importantly, the accuracy of occlusal analysis using these systems is highly dependent upon subjective interpretation and may vary between clinicians. Furthermore, these methods are restricted to measuring the position and quantity of tooth contacts with no capacity to quantify occlusal load.

Quantitative occlusal analysis techniques have been developed to overcome the limitations of qualitative assessment, such as subjective interpretation. Moreover, the sequence and density of the contacts can be differentiated from the quantitative methods. Photoocclusion and the T-Scan system are the most commonly known quantitative systems for determining occlusal relationships.[19-21]

Photo-occlusion system

The photo-occlusion system consists of a rather rigid photoplastic film layer that is positioned on the occlusal surface of the teeth, making it difficult to measure the acting occlusal force precisely.[22]The patient bites on the 98 mm (0.1 mm) thick film for 10–20 seconds, and then the film layer is inspected under a polariscope light to obtain the relative tooth contact intensity. It has been shown that the photoelastic wafer enhances posterior contact intensity and diminishes that of the anterior region. Furthermore, investigators have concluded that the photo-occlusion method consists of a complicated technique used for occlusal analysis and is not highly reproducible.[23–25]

T-SCAN SYSTEM

In 1987, the T-Scan Occlusal Analysis system manufactured by Tekscan, Inc. (South Boston, MA, USA) was developed by Professor William L. Maness in partnership with M.I.T.19 The T-Scan III system consists of a hand-held device with a USB port to be connected to a laptop or a Windows-based PC; the hand-held device contains a U-shaped pressure measuring sensor that fits into the patient's mouth between the occluding teeth. The pressure-measuring sensor is a grid-based, Mylar-encased recording sensor that is 60 mm (0.06 mm) thick and consists of 1500 compressible sensitive receptor points made of conductive ink. When the patient bites on the sensor, the electrical resistance of the conductive sensor is lessened, since the force applied compresses the particles together; this is recorded as quantitative force data. It records the sequence of occlusal contacts from the first point of contact to maximum intercuspation (MIP), which can be seen as a movie in real-time on the computer screen to analyze occlusal contact information.[26,27]The occlusion is scanned in time increments of 0.01 seconds to record the relative forces among the occlusal contacts, teeth with excessive forces, and occlusal contact timing sequences, which illustrates the exact order of tooth contacts and the intensity of the associated forces.

ADVANTAGES OF THE COMPUTERIZED OCCLUSAL ANALYSIS TECHNOLOGY

The conventional static occlusal indicators such as articulating paper and waxes only reveal the contact size and location whereas the T-Scan has an additional ability of quantifying occlusal contact timings and forces.[28]The computerized system presents a superior alternative to conventional occlusal registration methods due to its ability to record dynamic tooth contact relationships as force and timing data. Additionally, the computerized system can display the relative occlusal force variance from the first point of contact to MIP, in real time.In contrast, a study on articulating paper marks made at various occlusal force loads showed that more than 80% of the marks have no correlation between the mark size and the load applied. This establishes the inadequacy of articulating paper marks in describing the occlusal load. The study mentioned earlier on paper mark inaccuracy demonstrated that the largest mark corresponds to the highest force load only 38% of the time and that the dentists would be subjected to choosing and modifying the wrong tooth at least 62% of the time.[29-30]The data available during T-Scan recordings improves the precision and treatment outcome of the occlusal adjustment procedure. Occlusal analysis technology adds dynamic and quantifiable value to the many non-digital, conventional occlusal indicators; thereby, clinicians no longer have to rely completely on subjective interpretation using static indicators.

LIMITATIONS OF THE COMPUTERIZED OCCLUSAL ANALYSIS

While T-Scan occlusal analysis technology provides quantifiable time and force variance from the first point of contact to MIP as the subject bites onto the occlusal sensor, it does not have the capacity to measure absolute bite force. The sensor thickness is 100 mm (0.1mm) that compresses down to 60 mm under bite force, which may arguably interfere with intercuspation. The company claims that the highly compressible capacity of the sensor also provides bilateral interference during mandibular movement, providing improved occlusal force data when compared with unilateral interference of articulation paper strips that are frequently used to determine excessive contact areas on one side of the arch only. The challenge many clinicians face is the increased chair-time during computerized occlusal adjustment procedures, since a good T-Scan recording requires a number of skills. The significant learning curve involves getting familiar with appropriate sensitivity settings, orally guiding the patient through the needed mandibular movements, observing the screen to follow the center of force trajectory, and recognizing what is taking place within the recording. By interpreting and analyzing the recorded data, clinicians can target the teeth for adjustments (Appendix). While clinicians may feel that operating the device may be too time-consuming, the increased chair-time allows them to complete their objective accurately, without having to make multiple adjustments common among conventional practices.[31]As described in the 'advantages of the computerized occlusal analysis technology' section, there is vast evidence that supports this technology use and benefits as an occlusal indicator. However, evidence must be interpreted with caution, since most studies are case series reports. Therefore, further studies, such as clinical trials, are recommended to confirm the computerized technology superiority over the conventional occlusal indicators.

Conclusion

The various occlusal registration indicators available have been discussed. Their characteristics and sensitivity delineate their usage in different situations.

1. Qualitative recording materials can establish the location and number of contacts. These materials are primarily preferred because of their low cost and ease of application.

2. The marking ability of all qualitative recording media is negatively affected by the presence of saliva; hence, it is recommended that they be used only once when used intraorally and that the teeth be dried prior to testing.

3. The T-Scan system identifies the time and force characteristics of occlusal contacts, and hence, establishing true and measurable bilateral simultaneous occlusal contacts is a clinically attainable reality by using this system.

Conflict of Interest: None

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