

QUALITATIVE AND QUANTITATIVE OCCLUSAL MARKERS: A REVIEW

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Abstract

Achieving proper occlusion is crucial for the function and health of the masticatory apparatus. Each element plays a vital role, from the alignment of individual teeth to the harmony between occlusal contacts and the positioning of condyles and mandibular musculature. Any disturbance in this delicate balance can lead to various issues, ranging from trauma and periodontal disease to bruxism and temporomandibular joint dysfunction (TMD). In clinical practice, identifying and addressing occlusal interferences is paramount. Various occlusal indicators are available to assist clinicians in this task, each with its own characteristics, sensitivity, and method of usage. These indicators can range from simple articulating paper to more advanced systems like the T-Scan. However, it's crucial for clinicians to have a comprehensive understanding of these tools, including their limitations and proper interpretation of the markings they provide. By carefully evaluating occlusal contacts and utilizing appropriate indicators, clinicians can ensure that prosthetic replacements for missing teeth achieve optimal occlusion, thereby promoting overall oral health and function. A manual search of pertinent publications and a literature search utilizing the PubMed database. Relevant English-language articles published between January 1950 and May 2024 were taken into consideration.

Keywords: Articulating Paper; Articulating Silk; Articulating film; High Spot Indicator; Occlusal Indicators; T Scan

Introduction

Occlusal contacts arise when the mandibular and maxillary teeth come into contact with one another.[1] Noncontacts are regions where there is a 0.5-2 mm gap between the teeth, conversely, near contacts are defined as having a separation of no more than 0.5 mm between the occluding surfaces [2] The distinction between occlusal contacts, near contacts, and noncontacts is essential for understanding how the teeth come together during various movements.

"Occlusal interference" refers to any tooth contact that hinders the remaining occluding surfaces from creating harmonized and stable connections. "[3] It is necessary to eliminate occlusal interference as little as 15 μ since it may result in an unwanted result. While data suggests that occlusal interferences are not the cause of persistent jaw dysfunction issues, they can cause tooth pain or movement. [4,5]

Since all occlusal surfaces should connect at the same period during mandibular closure, there should be a time interval of 0 s between the first and the last occlusal contact. This is known as true occlusal contact time simultaneity.[6] Sufficient evaluation and management of occlusion are necessary to ensure optimal performance of the masticatory machinery. An

array of clinical symptoms, including tooth migration, broken enamel, periodontal tissue atrophy, gingival recession, migraines, and orofacial pain, can result from irregular occlusal contacts. [7-15].

The use of occlusal indicators plays a significant role in assessing occlusion and guiding treatment. While many indicators are commonly used, their accuracy can vary, especially in determining the sequence of occlusal contacts. Using qualitative indicators may lead to false markings and misinterpretations, potentially resulting in incorrect treatment decisions such as placing restorations in infra-occlusion. The thickness, tensile strength, and flexibility of the recording substance, the oral setting, and the dentist's interpretation all affect how accurate the applied approach is. [16, 17]

Therefore, selecting the appropriate occlusal indicator is critical for achieving precise occlusal therapy and ensuring optimal dental function and patient comfort.

Types of occlusal indicators

The two main categories of occlusion indicators are qualitative and quantitative, with the primary distinction being the latter's ability to quantify tooth contact events.

Qualitative markers

- High spot indicator; articulating paper; articulating silk; articulating film; metallic shim stock film

Quantitative markers

- Virtual patient; Occlusal analysis system T-Scan

Qualitative indicators

Articulating Paper

Articulating papers are the most commonly used qualitative markers for identifying intraoral occlusal contact locations. They vary in width, thickness, and the type of dye used. These papers are hydrophobic, with their primary ingredients being a coloring agent and a bonding agent (such as Transculase-Bausch Articulating Paper), which are placed between two layers of film. The bonding agent helps the coloring agent adhere to the tooth surface, while the coloring agent is released when occlusal contact occurs. The resulting mark typically shows a core region without colorant, surrounded by a rim of dye, which is referred to as the "target" or "iris," indicating the exact point of contact. The density of the markings does not correlate with the force of the contact, as heavy contacts tend to spread the mark

beyond the actual contact area. In larger contact areas, the interference requiring correction is most clearly visible in the central portion.

Some writers claim that the articulation paper's markings cannot be accurately interpreted since occlusal interactions are subjectively assessed, making it impossible to pinpoint the exact timing or intensity of the contacts.[18–21] The drawback of high-quality occlusal indicators is that they cannot determine the strength and order of interactions. Some authors contend that the marking's intensity is a flawed metric for determining how strong occlusal interactions are. [18]

Utilizing two distinct articulating paper thicknesses (23 and 60 mm thick) sandwiched between articulated ivory casts and obscured by a load cell at three distinct loads (150, 200, and 250 N), Saad et al. (2012) tested the reliability of articulating paper marking as well as the ability to describe occlusal force. The thicker paper produced more and larger markings, according to the scientists, while an increase in the applied weight had no discernible effect on mark size. They also mentioned that the professional needs to use "acumen" in order to interpret the marks subjectively and distinguish between false positives and true occlusal contact. [22]

600 paper marks produced by applying increasing occlusal pressures to articulated epoxy casts (between 0 and 500 N) were examined by Carey et al. in 2007.[23] According to the scientists, there was a significant variation in mark sizes for every test load, indicating that many mark sizes could be indicative of a single load. Additionally, they showed that no one tooth's mark area size increased in proportion to a little increase in load. Rather, they noticed that the articulating paper mark areas occasionally shrank in size when subjected to higher stresses. Ultimately, they discovered that the load that was applied and mark size only agreed by 21%, indicating a low likelihood of equal loads being displayed by marks of the same size.



Figure1: Bausch Articulating paper of various shapes

Source Courtesy: Bauschpaper.com

Articulating Silk

Articulating silk is composed of a color pigment that has been micronized and mixed with an emulsion of wax and oil. It is effective when used intraorally and does not generate pseudomarkings during use due to its soft texture. But as stain components dry, they lose their capacity to mark, and saliva can damage them. Therefore, it is imperative that it be stored in a cold, dry place. On highly polished surfaces, such as gold and ceramic in lab models, one strip can be used up to ten times, making it the perfect tool for the job. Some researchers claim that the most effective way to register occlusal interactions is by silk articulation.[24,25]



Figure 2: Bausch Articulating silk

Source Courtesy: Bauschpaper.com

Articulating film: The thickness of the Bausch Inc. Artifol articulating film is just 8 μ , far less than the patient's threshold for perceptual thickness. It is composed of a 6 μ thick hydrophobic emulsion encased in a polyester film. It must be used with specific holders in a dry environment. It works on lab models as well as intraorally and is generally applicable.



Figure 3: Bausch Articulating Film

Source Courtesy: Bauschpaper.com

Metallic shim stock film: One side of the film is colored coded, while the other has a metallic surface. It is mainly advised for use in occlusal splint therapy so that the lab can accurately mark the contacts on the soft splint.



Figure 4: Bausch Arti-Fol

Source Courtesy: Bauschpaper.com

According to Sharma et al., articulation foil is the thinnest occlusal indicator and registers occlusal interactions between teeth more accurately than paper and silk. [26] Using the Shimstock foil, it is possible to determine whether the antagonist teeth are in contact with one another. [27] A perfect occlusal registration strip, according to Halperin et al. (1982), should be thinner than 21 μ m, as this is the average proprioception of patients who present with normal dentitions.[28]

High spot indicator: This liquid indicator is recommended for use in laboratories to examine the proximal contacts. Using a brush, the liquid is applied to the coping's proximal surface, creating a 3 μ thick film. The proximal contact area is recognized as a show-through area in the base material of the crown upon

removal once the dye has been seated in the cast.



Figure 5: High Spot Indicator

Source courtesy: Yeti Dental

The two-phase occlusion indication method involves using articulating paper and articulating film sequentially to precisely identify interference points. First, the articulating paper is used to mark the contacts, creating a distinct central zone surrounded by a peripheral area filled with dye. In the second phase, articulating foil in a contrasting color is applied to pinpoint the contact locations within the areas previously marked by the articulating paper. The core areas highlighted by the articulating foil represent the actual interferences that need to be corrected.

Choosing the Qualitative Indices

The majority of patients perceive thickness at a level lower than the parameters to be taken into account when choosing these qualitative indicators.[29] This technique will allow for the accurate mounting of centric occlusion on a hinge articulator, the identification of occlusal contacts on newly restored teeth, the establishment of occlusal contacts on unrestored teeth, and the verification of occlusal precision in wax-ups. [30]

Locating the working and balancing interferences is another use for it.

- Thickness - Even in cases when there is no tooth contact between opposing teeth, registration strips can indicate tooth contact when their thickness exceeds the space between the teeth.[31] Furthermore, an overabundance of thickness may trigger a proprioceptive reaction, which may displace the jaw.
- Plastic deformation: Dentists can yank at occlusal registration strips with plastic deformation to assess occlusal contact since the

strips will stretch before tearing.

Tensile strength: While thinner strips would rupture before they could be used, those with plastic deformation will stretch before ripping.

- Marking ability: The coloring material ought to adhere to the tooth upon occlusal contact. The occlusal registration strip should be thin and flexible. Marking sensitivity ratings are highest for articulating foils and lowest for articulating paper. The teeth should be dried before using the registration strips because it has been discovered that saliva negatively affects the marking capabilities of all qualitative recording media.

Quantitative indicators

T-Scan

The T-Scan occlusal analysis system (Tekscan), a Microsoft-compliant system, has the ability to record a specific contact sequence in intervals of 0.01 seconds. It is made up of a sensor handle, a piezoelectric foil sensor, and hardware and software for data recording, analysis, and visualization. The distribution and time magnitude of the occlusal contacts are determined by the T-Scan.

In any circumstance when bilateral simultaneous occlusal contact is required, this device is advised. Complete dentures; Fixed or removable partial dentures; FPD-only complete arch reconstruction; full arch reconstruction utilizing implants; disclusion time reduction; occlusal splints; and mandibular repositioning devices.

The T-Scan system was deemed the best clinical instrument in 2016 by Afrashtehfar and Qadeer for the diagnosis of occlusion because it documented the distribution of contacts rapidly and accurately. [19] When utilizing the T-Scan system, the dentist obtains data that enables precise occlusal modification. [32,33]

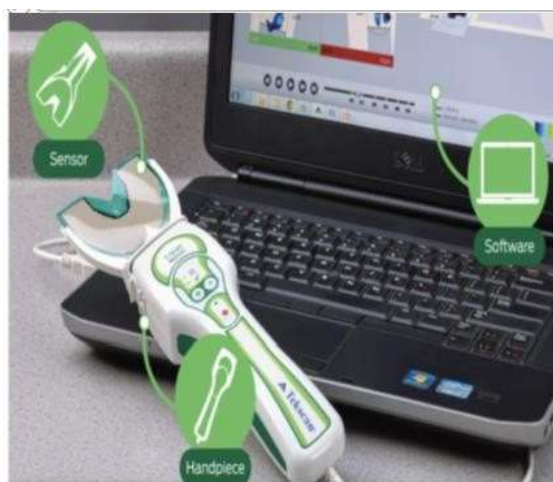


Figure 6: Teksan T- Scan

Source courtesy: Teksan

Virtual Dental Patient

This is a freshly developed idea in which the patient's dentition cast data is scanned to create a three-dimensional dental model. This offers quantifiable data that can help determine the occlusal interferences and evaluate his chewing performance. Furthermore, the dentist can determine how the patient's occlusion has changed over time by sequentially comparing these occlusal contacts.[34]

Discussion

Halperin et al. (1982) suggested that the optimal occlusal registration strip should be no thicker than 21 microns, based on the average proprioception of patients with normal dentition. This finding is important for both researchers and practitioners. Clinically, materials of different thicknesses have been shown to produce varying occlusal surface markings, which may affect the ability to detect and assess premature contacts and interferences. This is significant because the ultimate goal of any dental restoration is to be created, placed, and adjusted to achieve harmonious contact with the opposing dentition. The size of the markings these materials produce can influence the adjustments that a clinician or laboratory technician must make.

Some researches claim that the most effective way to register occlusal interactions is by silk articulation. [24, 25] Some writers claim that because occlusal contacts are subjectively assessed and it is impossible to pinpoint the exact timing and intensity of their occurrence,

the markings produced from the articulation paper cannot be accurately interpreted. [18–21] There is no scientific correlation between the depth of color and the surface area, force, or amount of the mark, which limits articulating papers' ability to detect occlusal load.[23] While some studies suggest that stain intensity can indicate contact strength, a key limitation of quality occlusal indicators is their inability to assess the sequence and strength of contacts. Some researchers argue that the intensity of the mark is not a reliable measure for evaluating the strength of occlusal interactions.[18, 35] Sharma et al. state that articulation foil, being the thinnest occlusal indicator, more accurately records occlusal interactions between teeth compared to paper and silk.[24] Additionally, the Shimstock foil can be used to confirm whether there is contact between the opposing teeth. [17] Because the T-Scan technology measures both contact duration and occlusal forces, it provides a dependable way to record occlusion. [36]

Conclusion

We have talked about the several occlusal registration indications that are accessible. Their traits and level of sensitivity distinguish how they should be used in various contexts.

1. The location and quantity of contacts can be determined using qualitative recording materials. The main reasons these materials are favored are their affordability and simplicity of use.
2. Any qualitative recording medium's ability to be marked is adversely affected by saliva; therefore, it is advised that when using intraorally, the teeth be dried before testing and that the medium be used only once.
3. Since the T-Scan technology measures the force and timing features of occlusal contacts, utilizing it to produce bilateral simultaneous occlusal contacts that are genuine and measurable is a therapeutically feasible goal.

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