Subjective Interpretation Pitfalls With Paper Markings

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Upon successful completion of this CE activity, 1 CE credit hour may be awarded.
The participants were asked to select the single most forceful and the single least forceful contact present in 6 clinical pictures by employing subjective interpretation in the same way they would use subjective interpretation in their daily practice of occlusion (Figure 1). To determine how well the participants did at selecting the most and least forceful contacts, each clinical picture was matched to Tekscan's T-Scan relative occlusal force data that was recorded from the same teeth, immediately after the paper mark photograph was obtained (T-Scan 8 [Tekscan]) (Figure 2).

The T-Scan system is a digital occlusal force and timing analyzer that illustrates graphically in video format 256 varying...
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levels of relative occlusal force, excursive movement occlusal interference timing sequences, and occlusion and disclusion timing (Figure 3).2 The T-Scan HD recording sensor (Figure 3a) has been shown to accurately measure differing relative occlusal force levels3-6 with 95% force reproduction capability.4

Subjective Interpretation Leads to Incorrect Contact Selection

The inaccuracy of subjective interpretation is related to the fact that paper mark size and color depth do not describe differing occlusal force levels,1-7 despite this idea being incorrectly taught in dental schools, being perpetuated in some continuing education programs, and having been described in many textbooks on occlusion.13-19 Paper mark color depth, size, shape, and distribution have been suggested to indicate occlusal contact force content and contact time simultaneity;13-19 however, to date, no published studies in the literature exist that support the long-advocated paper mark dogma.

Examples of how incorrect the principles of subjective interpretation can be are shown in Figures 4 and 5, which contain articulating paper markings compared to T-Scan force data of the same marked teeth. In Figure 4, there is a very light and small paper mark present on the mesiolingual aspect of tooth No. 11, while there is a much larger mark visible on the mesiolingual marginal ridge of tooth No. 9. The T-Scan occlusal force measurement of No. 11 mesiolingual shows 2 very high-level force contacts present there (pink columns), while No. 9 mesiolingual contains a low-level force contact (blue column), despite a large ink mark resting there. Without the T-Scan technology measuring each contact’s occlusal force profile, No. 11 mesiolingual could be misinterpreted as light force and No. 9 mesiolingual misinterpreted as high force by a clinician who bases the contact selection on the incorrect principles of paper mark size subjective interpretation.

Figure 5 illustrates another very clear example of how misleading subjective interpretation principles can be when choosing forceful versus nonforceful contacts for treatment. Tooth No. 3 has 3 large red contact marks and healthy tooth structure under the 3 marks on its palatal-occlusal aspect. Tooth No. 2 has significant exposed dentin mesio-occlusally (Figure 5a), where the enamel has been eroded and very little red ink is present. The lost tooth structure is surrounded by very faint light red markings, but no ink is present on the exposed dentin. Subjective interpretation principles would choose No. 3 as
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being under high force, and No. 2 as having light force, which clearly would be incorrect when one sees the true extremely high force profile that the T-Scan detected on the mesial of No. 2. With the passage of time, this extreme force has destroyed the enamel, allowing dentin to become the contacting occlusal tooth structure.

The opposing tooth counterpart picture (Figure 5b) shows tooth No. 31 also with lost enamel disto-occlusally and, in addition, where no paper marks exist. Yet there is healthy tooth structure visible on tooth No. 31 mesio-occlusal and tooth No. 30 disto-occlusal, where 3 dark black ink marks exist.

The question becomes this: Why is there so much ink where there is healthy tooth structure and no ink where there is severely worn tooth structure when subjective interpretation states high force should exist where there is a lot of visible ink?

The answer is that the carbon paper and its ink cannot survive the severe applied force where the enamel has been systematically eroded through with time by repetitive high force application. The paper and ink are crushed into bits of nothingness right where the enamel is eroded. In the same way, the applied high forces destroyed the enamel on tooth No. 2; the same high forces physically destroyed the ink and the paper matrix. As a result, no ink is capable of marking No. 2 except when peripheral to the severe occlusal forces. Alternatively, the paper and ink remains thick and intact when there are low force occlusal contacts that do not crush it into little bits. Look at how healthy the tooth structure is on Nos. 3 and 30, where there is a lot of red/black ink, compared to Nos. 2 and 31, where there is almost no red/black ink present (Figure 5).

Comparatively, the T-Scan sensor matrix holds up well under tooth-tooth interocclusal compression, as it is not destroyed by high force and it can reliably isolate that Nos. 2 and 31 are under excessive load that has worn away the occlusal enamel.3-4,20 The T-Scan objective occlusal analysis method predictably improves how occlusal force excess can be clinically managed through the proper detection of high force on natural teeth, dental restorations, and dental implants. This is especially important during occlusal adjustment procedures where subjective interpretation inaccuracy will lead to contact selection force interpretation errors and incorrect parts of teeth being adjusted, while high forces are left unadjusted to harm teeth and restorations through cyclic overloading.

Consequences of Selecting Incorrect Contacts

When occlusal contact force diagnostic errors are made by a clinician looking at paper marked ink spots, it will directly lead that clinician to select incorrect tooth contacts for occlusal adjustment treatment, resulting in a number of potential untoward complications, as follows:20

- Excessive tooth structure removal from areas of teeth that do not need occlusal force reduction, thus weakening and thinning enamel
- The thinning out and weakening of occlusal dental materials present on differing prostheses, which could lead to early material failure and shorten the lifespan of the prosthesis
- Potentially destabilizing a patient’s occlusal comfort level, leading to the appearance of occlusally activated tooth pain, and/or the sudden onset of previously absent temporomandibular disorder symptoms
- The potential for the clinician to not treat the true areas of occlusal force excess because the paper marks do not appear to the clinician to be “forceful-looking.” This will result in the ongoing existence of localized high occlusal force being applied repetitively on some tooth contacts. Long-standing high force can cause fractures, occlusal wear, tooth mobility, abfraction formation, gingival recession, periodontal bone loss, and peri-implant bone loss.

CLOSING COMMENTS

Because subjective interpretation is so prone to improper contact selections, it represents a maximally invasive treatment approach when compared to a minimally invasive measured approach using the T-Scan technology.1 This clinical reality suggests that, for the well-being of dental patients, subjective
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interpretation should be replaced with a measurement-driven occlusal force detection method. The T-Scan system has been shown to be capable of repeatedly measuring relative occlusal contact force, thereby eliminating the need for subjective interpretation. The T-Scan technology replaces this inaccurate and error prone method with an objective process that reliably determines where occlusal force excess exists so it can be targeted accurately.21-24

References

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1. The findings of the 2013 study published in the Journal of Craniomandibular and Sleep Practice confirm that dentists can accurately detect occlusal force levels by looking at the size, shape, and color depth of articulating paper markings.
   a. True        b. False

2. The T-Scan HD (Tekscan) recording sensor has been shown to accurately measure differing relative occlusal force levels with 85% force reproduction capability.
   a. True        b. False

3. According to this article, carbon paper and its ink cannot survive the severe applied force where the enamel has been systematically eroded within time by repetitive high force application.
   a. True        b. False

4. The T-Scan objective occlusal analysis method predictably improves how occlusal force excess can be clinically managed through the proper detection of high force on natural teeth, dental restorations, and dental implants.
   a. True        b. False

5. The T-Scan system, although helpful, has never been shown in any study to be capable of repeatedly measuring relative occlusal contact force, eliminating the need for subjective interpretation.
   a. True        b. False
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