Missing the Mark:
Accurate Observation of Occlusal Forces

Robert B. Kerstein, DMD*

Articulating paper, foils, and ribbons have been used in clinical practice primarily as occlusal indicators.[1] Their clinical implementation requires operator subjective interpretation to decide which contacts are acceptable and which are forceful. Despite the fact that, to date, there are no scientific studies to support that articulating paper mark appearance describes occlusal forces, textbooks have declared marking appearance characteristics to be descriptive of the occlusal load that created the mark. Large, dark marks have been advocated to indicate heavy occlusal load, and smaller, lighter marks have been advocated to indicate lesser loads.[2-7] Lastly, similar-sized marks on neighboring teeth are purported to indicate equal occlusal contact intensity, evenness, and time simultaneity.[2,3] These unsubstantiated paper mark appearance misperceptions have guided practitioners in making occlusal adjustments for well over 100 years, despite the fact that there are no published, scientifically-based, articulating paper proper-use guidelines available for the clinician to employ.[1]

In 2007, a study of 600 paper markings made at varying human occlusal loads on epoxy dental casts determined that articulating paper mark size can vary so greatly at a given human occlusal load that an operator would be unable to determine which marks are forceful and which are not from visual inspection alone.[8] This study illustrated that a mark of any size could represent a range of loads (from 0N to 500N) and that equal-sized marks on neighboring teeth did not represent equal loads.[8] Seventy-nine percent of the marks studied did not describe the applied load that imprinted the marks to the casts.[8]

What this means to the clinician is that, in a given pattern of marks spread out over neighboring teeth, any size mark could contain any load (Figure 1). Because of this, using mark size as a guide to select forceful teeth to adjust will result in poor occlusal force applications, which could shorten the life of any restoration or result in post-insertion patient discomfort. As an alternative to operator subjective interpretation of articulating paper marks, computerized occlusal analysis can be employed (T-Scan III Computerized Occlusal Analysis System, Tekscan, Inc, Boston, MA) to determine the amount of occlusal force being applied to the teeth.

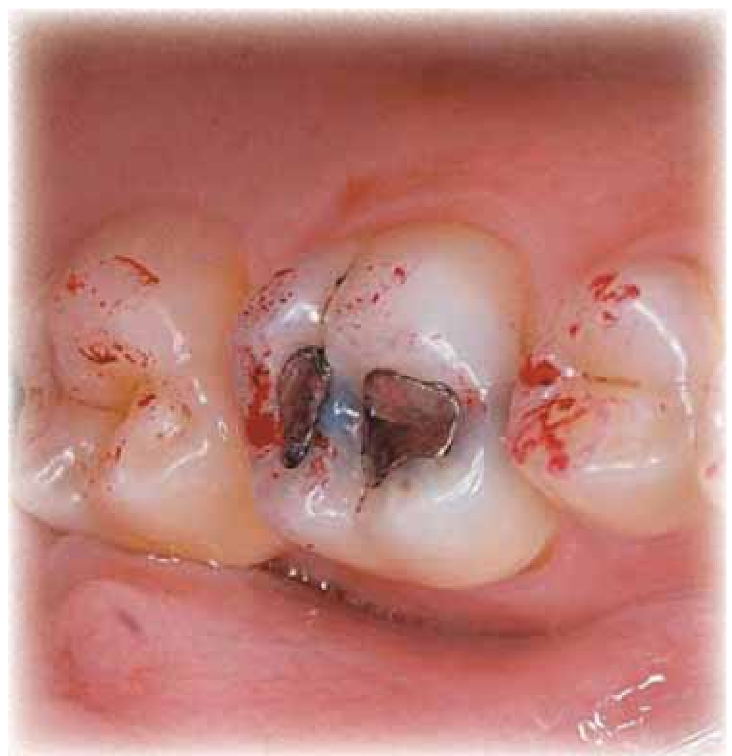

Figure 1. Articulating paper markings spread across numerous teeth. Recent research has shown that any mark could contain any occlusal load, despite size and appearance.

Computerized Occlusal Analysis System Attributes

The T-Scan III Computerized Occlusal Analysis System (Figure 2) is a Windows-based, USB plug-in technology, which

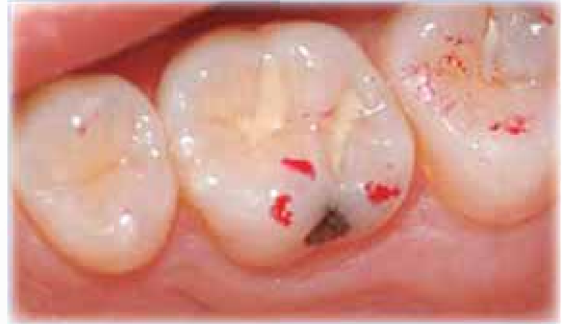

Figure 3. Posterior right maxillary Accufilm markings on teeth #2(17) and #3(16).

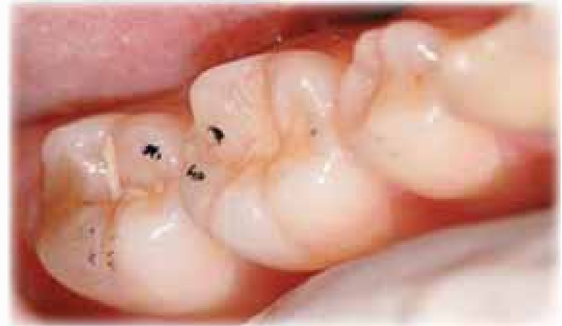

Figure 4. Posterior right mandibular Accufilm markings on teeth #2(17) and #3(16).

Figure 2. USB recording handle connected to a computer workstation (laptop).

can be used to diagnose occlusal problems, identify occlusal force aberrances, locate prematurities, and guide natural tooth and prosthetic installation occlusal adjustments.[9-13] Because it accurately isolates forceful and time premature contacts, the operator can perform targeted occlusal adjustments resulting in predictable occlusal endpoints.[14,15] Within the literature, there are published proper-use guidelines described for the clinician to use to predictably employ the technology.[16-21]

Paper Mark Misperception Clinical Example

Paper mark misperception can occur when intercuspated articulating paper marks are made (Accufilm, Parkell Inc, Farmingdale, NY) (Figure 3). Incorrect interpretation occurs when one assumes the large, dark, palatal occlusal marks are forceful, and pinpoint markings represent light occlusal force (Figures 3 through 5). Computerized occlusal analysis measurements of the contacts reveal that the small pinpoint markings on tooth #2(17) represent the high occlusal force and the large markings on tooth #3(16) are actually low-force contacts (Figure 5). Had corrective occlusal adjustments

been performed using *paper mark size* as the guide, the wrong contacts would have been adjusted and the excessive forces present already on #2(17) and #31(47) would have worsened instead of improved.

Conclusion

Articulating paper mark size is non-descriptive of occlusal load, as many different sized marks can represent the same load, and equal sized marks do not represent similar loads.[8] Computerized occlusal analysis removes any operator subjectivity from the clinical decision-making process of isolating problem occlusal loads when observing paper markings of various configurations. Mark size, mark color, and "donut-shaped" markings become "contact locators" only, as operator subjective paper mark misperceptions are replaced with force and contact location knowledge for proper contact isolation.

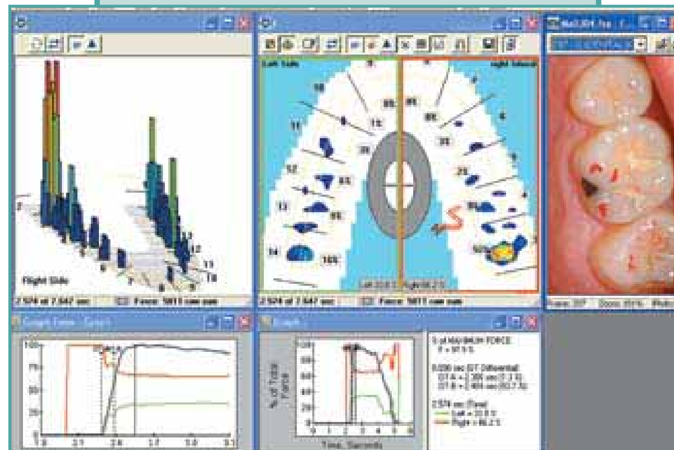

Figure 5.

Computerized occlusal analysis determined that the high force is actually on teeth #2 (17) and #31(47), where small paper markings appeared, and not #3 (16) and #30(46) as the large paper markings suggest.

Disclaimer:

Dr. Kerstein is a Clinical Consultant to the Tekscan Corporation, Boston, Massachusetts. He will receive no direct compensation for the publication of this manuscript.

References

1. Millstein, P. Know your indicator. J Mass Dental Soc 2008;56(4):30-31.
2. Glickman I. Clinical Periodontics. 5th ed. Philadelphia: Saunders and Co; 1979, 951.
3. McNeil C. Science and Practice of Occlusion. Carol Stream: Quintessence Publishing; 1997:421.
4. Harper KA, Setchell DJ. The use of shimstock to assess occlusal contacts; a laboratory study. Int J Prosthodont 2002;15(4):347-352.
5. Okeson J. Management of Temporomandibular Disorders and occlusion. 5th ed. St. Louis, MO: CV Mosby and Co; 2003:416,418,605.
6. Kleinberg I. Occlusion Practice and Assessment. Oxford, England: Knight Publishing; 1991:128.
7. Smukler H. Equilibration in the Natural and Restored Dentition. Chicago, IL: Quintessence Publishing; 1991:110.
8. Carey JP, Craig M, Kerstein RB, Radke J. Determining a relationship between applied occlusal load and articulating paper mark area. The Open Dent J 2007:(1);1-7.
9. Kerstein RB. Computerized occlusal management of a fixed/detachable implant prosthesis. Pract Proced Aesthet Dent 1999;11(9):1093-1102.
10. Kerstein RB, Montgomery M. Mapping occlusal forces on rebuilt anterior guidance. Cont Esthetics; 2000;14(4): 68-73.
11. Kerstein RB. Current applications of computerized occlusal analysis in dental medicine. Gen Dent 2001;49(5):521-530.
12. Kerstein RB, Grundset K. Obtaining bilateral simultaneous occlusal contacts with computer analyzed and guided occlusal adjustments. Quint Int 2001;32(1):7-18.
13. Kerstein RB, Wilkerson D. Locating the centric relation prematurity with a computerized occlusal analysis system. Compend Contin Educ Dent 2001;22(6): 525-528, 530,532.
14. Kerstein RB. Disocclusion time-reduction therapy with immediate complete anterior guidance development to treat chronic myofascial pain-dysfunction syndrome. Quint Int 1992;23(11):735-747.
15. Kerstein RB. Nonsimultaneous tooth contact in combined implant and natural tooth occlusal schemes. Pract Proced Aesthet Dent 2001;13(9);751-755.
16. Kerstein RB. Wright NR. Electromyographic and computer analyses of patients suffering from chronic my fascial pain-dysfunction syndrome; Before and after treatment with immediate complete anterior guidance development. J Prosthet Dent 1991;66(5):677-686.
17. Kerstein RB. Chapman R, Klein M. A comparison of ICAGD (Immediate complete anterior guidance development) to mock ICAGD for symptom reductions in chronic myofascial pain dysfunction patients. Cranio 1997;15(1):21-37.
18. Kerstein RB. Disclusion time measurement studies: Stability of disclusion time—A 1 year follow-up study. J Prosthet Dent 1994;72(2):164-168.
19. Kerstein RB. Disclusion time measurement studies; Part 2: A comparison of disclusion time length of 49 chronic myofascial pain dysfunction syndrome patients to 40 non-patients. A population analysis. J Prosthet Dent, 1994;72(5);473-480.
20. Kerstein RB, Lowe M, Harty M, Radke J. A force reproduction analysis of two recording sensors of a computerized occlusal analysis system. Cranio 2006: 24(1);15-24.
21. Kerstein RB, Radke J. The effect of disclusion time reduction on maximal clench muscle activity levels. Cranio 2006:24(3);156-165.

**Former Assistant Clinical Professor, Department of Restorative Dentistry, Tufts University School of Dental Medicine, Boston, Massachusetts; private practice, Boston, Massachusetts.*