Role of Micro Tensile Bond Strength Testing in Dental Composites

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Abstract- Due to their aesthetic qualities and capacity to connect with tooth structures, dental composites are a common choice for restorative purposes. The strength and resilience of the bond that forms between the composite and tooth substrate is a key factor in the success and endurance of composite restorations. A useful tool for assessing the adhesive qualities of dental composites is micro tensile bond strength testing. This article seeks to examine the benefits, drawbacks, and applicability of micro tensile bond strength testing in clinical practice in order to evaluate the bond strength and adhesion of dental composites.

INTRODUCTION

Dental composites have completely changed restorative dentistry thanks to their outstanding aesthetics and diverse range of clinical uses. Dental composite restorations' durability and clinical effectiveness depend on how well they adhere to tooth structures. Micro tensile bond strength testing provides a quantitative evaluation of the microscopic adhesion between the composite and tooth substrate. This testing approach makes it possible to compare different adhesive systems, surface treatments, and bonding procedures, improving therapeutic outcomes.

Procedure for Micro Tensile Bond Strength Testing

The Making of Samples

The preparation of samples, comprising the tooth substrate and the composite specimen, is the first stage in the micro tensile bond strength test (1). The tooth substrate should be thoroughly cleansed before obtaining flat areas of interest (dentin or enamel). The composite specimen is created with the aid of a mold or matrix with standardized dimensions. To guarantee optimal polymerization, the composite should be cured in accordance with the manufacturer's specifications.

Bonding Methodology

The administration of an adhesive system is required during the bonding phase in order to facilitate the binding between the composite and the tooth substrate (2). Based on the substrate (dentin or enamel), the adhesive system should be chosen, and it should be applied in accordance with the manufacturer's recommendations. Etching, priming, and the use of a bonding agent are frequently used for this. After making sure there is no surplus material, the composite specimen is next placed into the prepared tooth substrate. Using a suitable light-curing unit, the composite is light-cured while sticking to the advised light exposure and curing duration.

Preparation of Specimens and Mounting

The bonded specimen is safely fixed in a holder after bonding to maintain stability throughout the testing (3). The mounted specimen needs to be set up so that the bonded interface is parallel to the load direction. To create a well-defined rectangular or hourglass-shaped specimen that adheres to the dimensions stipulated by testing standards and guidelines, extra composite material around the bonded interface is cut away.

Data gathering and testing

Universal testing equipment with the proper grips is used to perform the micro tensile bond strength test (4). The mounted specimen is precisely set into the grips such that the load axis and the bonded interface are lined up. Then, at a predetermined crosshead speed, a regulated axial tensile load is supplied. The load and specimen deformation are tracked throughout the test until a bond failure happens. The failure load, which represents the micro tensile bond strength of the composite-tooth interface, is the highest load at which a bond can fail. By dividing the failure load by the bonded area, which can be computed using the specimen and bond interface's dimensions, the bond strength is obtained.

Failure mode investigation

The bonded interface is visually inspected to identify the mode of failure after the test (5). Cohesive failures occur within the composite or tooth structure, adhesive failures occur at the interface, and mixed failures consist of both cohesive and adhesive failures. This research offers important insights into the effectiveness and reliability of the bond.

Micro Tensile Bond Strength Testing Benefits

Quantitative Evaluation

The ability to produce precise measures of bond strength is one of the main benefits of micro tensile bond strength testing (6). Micro tensile testing provides objective and measurable information, in contrast to subjective assessments like a visual inspection. This testing method's accurate numerical values enable comparisons between various materials, bonding procedures, and surface treatments. It makes it possible for physicians and researchers to precisely assess the adhesive capabilities of dental materials.

Site-Specific Assessment

Micro tensile bond strength testing makes it possible to assess the bond strength within the tooth structure on a site-specific basis. It can, for instance, determine how well dental materials adhere to enamel, dentin, or the adhesive interface (7). Due to the fact that the binding strength can differ based on the substrate, this site-specific information is essential. Clinicians can choose materials and bonding methods with more knowledge if they are aware of the variances in bond strength at various spots.

Evaluation of Various Methods and Materials

The bond strength of various dental materials and adhesive systems can be evaluated using micro tensile bond strength testing (1,2). It can assess how well various composites, cement, adhesives, primers, and bonding agents perform. This benefit makes it possible for physicians and researchers to compare the adhesive qualities of various materials and choose the best ones for particular therapeutic settings. Additionally, it makes it easier to evaluate cutting-edge methods and materials, enabling improvements in dental restorative materials.

Studying and Developing

Testing the micro tensile bond strength is an essential part of dental research and development (6). It enables researchers to examine how various elements, including surface treatments, adhesive systems, and bonding techniques, affect the strength of a connection. Researchers can improve bonding methods, lengthen the life of restorations, and create novel adhesive systems by methodically altering these variables. Before using a material or technology in a clinical setting, it is important to screen and choose it using the micro tensile bond strength test.

Statistical Value

The clinical performance of dental restorations can be predicted with the use of micro tensile bond strength testing, which offers useful information. This testing approach provides information about potential weak points and weaknesses of the adhesive interface by measuring the binding strength at the microscopic level. Clinicians can increase the lifetime and durability of restorations by recognizing these problems. Additionally, the results of the failure mode analysis acquired from micro tensile testing offer important details on the mode of failure, assisting in the creation of better bonding procedures and materials.

Limitations

Accurate specimen preparation, which can be time-consuming and technique-dependent, is necessary for micro tensile testing (1,2). To achieve precise and repeatable findings, standardized methods should be followed. High-stress concentrations are produced at the bonded interface during micro-tensile bond strength testing. This stress concentration might not accurately reflect the intricate stress distribution that takes place during mastication in the oral environment. Variables that can affect the test findings include the crosshead speed, the size and shape of the specimen, the storage environment, and the operator method. To provide accurate and comparable results, these variables must be carefully controlled and standardized.

Clinical Relevance: Micro tensile bond strength testing offers clinicians useful data that they may use to make informed decisions about the best adhesive systems to use, improve bonding procedures, and assess the bond strength of dental composites in diverse clinical settings. It assists in determining how various surface treatments, like etching or bonding chemicals, affect the strength of bonds. Additionally, it makes it possible to spot weak spots in the bonding contact, which helps clinicians choose better clinical procedures and materials.

Upcoming directions

To improve and standardize micro tensile bond strength testing procedures, more research is required. Bond strength measures may be more accurate if new testing techniques, including fatigue testing, are developed that more closely mimic the oral environment. To develop better proof of its significance in restorative dentistry, it is also necessary to explore the relationship between micro tensile bond strength and clinical performance.

CONCLUSION

Testing the micro tensile bond strength is essential for determining how well dental composites adhere. In order to help with material selection, protocol optimization, and clinical decision-making, it provides quantitative assessment, site-specific evaluation, and microscopic investigation of the bond strength. Micro tensile bond strength testing, despite its drawbacks, is an important method in dental research because it offers pertinent data for optimizing the

performance and endurance of composite restorations in clinical settings.

References

1 Sano H, Chowdhury AFMA, Saikaew P, et al. The microtensile bond strength test: Its historical background and application to bond testing. Jpn Dent Sci Rev 2020;56:24–31.
2 Pashley DH, Carvalho RM, Sano H, et al. The microtensile bond test: a review. J Adhes Dent 1999;1:299–309.
3 Tao L, Pashley DH. Shear bond strengths to dentin: effects of surface treatments, depth and position. Dent Mater 1988;4:371–8.
4 Swartz ML, Phillips RW. A method of measuring the adhesive characteristics of dental cement. J Am Dent Assoc 1955;50:172–7.
5 Bowen RL. Adhesive bonding of various materials to hard tooth tissues. I. Method of determining bond strength. J Dent Res 1965;44:690–
6 Pashley DH, Sano H, Ciucchi B, Yoshiyama M, Carvalho RM. Adhesion testing of dentin bonding agents: a review. Dent Mater 1995;11:117–25.
7 El Mourad AM. Assessment of Bonding Effectiveness of Adhesive Materials to Tooth Structure using Bond Strength Test Methods: A Review of Literature. Open Dent J 2018;12:664–78.