The VALUE and remaining NEED of bond-strength testing

Bond strength testing and its clinical relevance remain issues of high and repeated debate within the research community that focuses on dental adhesive technology. Common comments made are that bond strength data are rubbish, only make noise in scientific literature, are not clinically relevant, etc. Measuring bond strength to wisdom teeth is even claimed to be useless, as in clinical practice we hardly bond to pristine dentin.

There are many diverse bond strength tests, ranging from the most simple and popular shear-bond strength approach to more complicated and labor-intensive microtensile bond strength test methods. Some claim that a static bond strength does not reflect the dynamic loading of adhesive interfaces intraorally. In other words, adhesive-tooth bonds should rather be cyclically fatigued. More complicated fracture-toughness approaches are also frequently recommended to replace ordinary bond strength tests.

There is a recurrent demand for standardized methodology protocols enabling comparison of bond strength data gathered at different research institutes.

But should bond strength testing be regarded as such a black-and-white issue?

With the major focus of the *Journal of Adhesive Dentistry* being adhesion to tooth structure, we believe that bond strength remains THE primary property that should be measured in one way or the other.

Each bond strength test provides some information on bonding performance, even the simplest shear bond strength test. However, the outcome should definitely be interpreted in the correct context and certainly not be overinterpreted by translating the findings directly to clinical outcome. Yet at the same time, it is also incorrect to state that bond strength data have no value at all in predicting clinical performance. Every now and then, some (self-) adhesive materials are marketed despite having actually failed in basic bond-strength testing. When clinical trials were nevertheless initiated, they needed to be discontinued because of unacceptably high early failure rates. Such products that do not meet the primary property of bonding to tooth tissue and – to top it all off – are marketed with false claims regarding additional bioactive potential should not be allowed to be "dropped" onto the market.

Our patients aren't guinea pigs!

Isn't it time that ISO standards become more stringent and products meet higher standards to become commercially available?

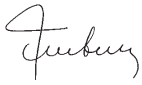
It is simply impossible to define a standard bond strength test, as there will always be methodological details that differ among tests done at different centers and may lead to different bond strengths. Too often the absolute MPa value is still considered a parameter for comparison, while the actual MPa is of no importance; solely the mutual (statistical) ranking of adhesives according to their bond strength within one study is relevant. Proper (gold-standard) controls/references should always be added, which is not always done even in recent studies. Immediate bond strength data should be measured as reference data but should always be complemented with aged bond strength data; the latter obviously should not follow current ISO standards with short aging regimes but should involve long-term water storage and/or a high number of thermocycles (at least 25,000).

Unfortunately, the high variance in bond strength data should frequently be ascribed to insufficient methodological accuracy. Conducting a bond strength test in an accurate and controlled way is not easy! Researchers should always take care that the methodology employed is sufficiently accurate and standardized.

Simple bond strength tests, eg, the shear bond strength test, give some initial indication of bonding performance, but should definitely be complemented not only by multiple tests done at (independent) research institutes, but also by different complementary test protocols that are more discriminative than they are. Noteworthy is that alternative test protocols using different approaches – be they microtensile, microshear, static or dynamic fatigue tests, fracture toughness approaches, etc – do not necessarily reveal different data, but most often provide similar equivalent bonding-effectiveness outcomes (rankings) as obtained with more conventional bond strength protocols. New adhesives should be subjected to a broad battery of different (non-linked) test protocols, even including adhesive-tooth interfacial characterizations that also indirectly provide information on bonding performance, this with regard to hybrid layer quality and simply based on specimen survival during rather severe specimen preparation

and processing, like for instance diamond-knife ultramicrotomy for TEM.

JAD remains the perfect forum to report your bond strength data when (1) the test was conducted accurately, (2) immediate reference bond strength data were complemented by long-term aged bond strength data, and (3) proper gold-standard multistep adhesives were included in the test setup. Otherwise, do not be experimentally too ambitious and strive to limit experimental groups to the research question(s) to be answered. This is for the direct benefit of reaching sufficient statistically discriminative power and satisfactory methodological accuracy. Reviewers of manuscripts should also be able to judge test accuracy, meaning that authors should include visual evidence (digital images, micrographs, …) which prove that specimen preparation and actual testing was conducted accurately enough. Schematics are useful to illustrate the experimental workflow but should be complemented by photographic documentation.



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