Simone Deliperi interviews Jack L. Ferracane

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Department of Restorative Dentistry, Oregon Health & Science University, Portland, Oregon, 97239, USA

Jack L. Ferracane Curriculum Vitae

His current position is Professor and Chair of Restorative Dentistry, and Division Director of Biomaterials and Biomechanics at Oregon Health & Science University. Dr. Ferracane received a B.S. in Biology from the University of Illinois, and an M.S. and PhD. in Biological Materials from Northwestern University. He is a founding fellow and past-President of the Academy of Dental Materials. He is a past-President of the Dental Materials Group of the International Association for Dental Research. He serves on the editorial board of ten journals, and is Associate Editor of the Journal of Dental Research and Odontology. He has authored a textbook entitled "Materials in Dentistry. Principles and Applications," now in its second edition. He has published and lectured extensively on dental materials, including dental composites, adhesives and dental amalgam. His current research interests are in dental composites and the use of bioactive glasses in resin-based dental materials. He also is actively involved in the establishment of networks designed to conduct clinical research in the private practice setting. His research is funded by the NIH/NIDCR as well as private industry. He has provided continuing education at annual meetings of the ADA, British Dental Association, California Dental Association, Chicago Midwinter, Midwest Dental Conference, Oregon Dental Conference, Pacific NW Dental Conference, Southwest Dental Conference, Yankee Dental Congress, and to other professional dental organizations

Resin composite: formulation, properties, clinical considerations and future development

I had the pleasure of personally meeting Dr Jack Ferracane at differing IADR meetings.
A common friend of ours, Barbara Nordquist was our matchmaker. She introduced both Jack Ferracane and Tom Hilton to me at a dinner she organized in Dallas in 2008. We had a great time that night; since then I had the great privilege of being a friend of both Tom and Jack.
Jack has being conducting several relevant research projects at Oregon Health & Science University for many years. His research works are known all over the world. He has made very important contributions to the development of resin composites.
I have being reading Jack's publication since I was a student at the dental school. He has been and still is like either a basketball or soccer superstar for me. My Stress-Reduced Direct Composite clinical technique is also based on the laboratory research works Jack and his co-workers have conducted at Oregon Health & Science University.
It is my pleasure sharing with you, both friends and colleagues, this interview I have just completed with Jack. Please, enjoy!

Dr Deliperi's question #1
Since their introduction in the 80s, composite resins underwent a continuous improvement. One of the first introduced composite resins was a "microfill". Microfill composites were based on nano-fillers instead of micro-fillers, actually. Hybrid and micro-hybrid composites progressively replaced "microfill" over the years due to better physical and mechanical properties. Interestingly, "nanofill" composites based on nano particles are considered the most recent innovation in composite technology. Dr Ferracane, do you think composites underwent a true evolution over the last three decades?

"Composite has undergone an evolution in the sense that current materials have reached a high level of esthetics and polishability while maintaining a relatively high level of physical properties. The reduction in particle size through enhanced filler production, and the innovative use of nanofillers, has resulted in materials with true universal use characteristics. Thirty years ago the profession was presented with very strong materials of limited esthetics based on their inability to be polished to a high luster, or more importantly to maintain luster, due to the large size of the fillers. This led to the development of the microfill composites, which as you point out were truly nanocomposites, which satisfied the polishability, but by compromising on mechanical properties. Today's materials are vastly superior to both of their predecessors in terms of their overall utility to dentists."

Dr Deliperi's question #2
Dr. Ferracane, you recently authored a paper in the journal of Operative Dentistry entitled " Placing dental composites: a stressful experience" referring to the stress generated on composites during the polymerization process. Based on the research performed in your lab at OHSU in the last 25 years, could you recommend any clinical protocol/strategy to reduce this stress?

"I believe that there is significant in vitro evidence that stress can be reduced to a great extent by using several different placement/curing techniques, including pulse-delay light curing when the initial pulse is of very low irradiance, long curing protocols with continuous but low irradiance exposure, the use of a large number of small, individually cured increments to build the restoration, and the use of materials of low elastic modulus to line or partially fill the cavity before placing the composite. The clinical practicality of each of these methods is often questioned. Other methods include modifications to the formulation of composites, including the development of monomers of lower overall shrinkage via enhanced size or altered chemistry, reducing the curing rate of the composite, including dimensionally stable stress absorbing additives to the composite, and others.

To date, however, there is little published clinical evidence that any of the modifications to the formulation or placement method truly results in enhanced performance or longevity of dental composite restorations."

Dr Deliperi's question #3
Could the placement of composite in medium and large cavities of either anterior and posterior teeth become soon a "less stressful experience" for clinicians?

"The development of new dental composites is the key to answering this question. There are two critical factors directly related to the composite that will enable dentists to place the materials with less stress, or at least less concern. New materials with different resin formulations that result in reduced polymerization contraction stress, not simply reduced shrinkage, but reduced stress on the interfacial bonds with the cavity wall, is one key advance. Such a material would eliminate the need to layer composite or place it in small or thin increments to minimize the effects of curing stress. This material would, by virtue of its lower stress production, reduce the need for an adhesive capable of producing extremely high bond strengths. But this alone is only a partial solution. The second important advance will be the ability to place composites in large increments that can be exposed to a single, relatively short illumination from a curing light without fear of leaving material undercured far from the exposed surface. I think these two advances would significantly ease the placement of composites. Finally, if the material and the adhesive combination were unaffected by water, blood, and saliva contamination, things would really become simple."

Dr Deliperi's question # 4
What are the most important formulation enhancements expected in dental composites in the next couple of years? How might these changes eventually improve the clinical performance of composites?

"Part of the answer to this question is found in the answer to the preceding question. Additional enhancements will likely be made in the following areas. The ideal composite would have an inherent antibacterial quality, either through the addition of a permanently bound compound (eliminating concerns over potential toxicity from its own release) that prevents bacterial adhesion and proliferation, or a slowly released, non-toxic molecule that has an anti-bacterial or at least bacteriostatic effect. In addition, the material would contain compounds that release calcium and phosphorous ions when challenged by a low pH environment produced by local surviving bacterial biofilms. Finally, the material would have a self-healing mechanism allowing it to repair defects such as small cracks and delaminations that might otherwise eventually lead to failure by chipping, fracture or wear."

Dr Deliperi's question #5
Could the improvement of both strength and fracture toughness of composites contribute to expand their clinical application until progressively replace ceramic crowns.

"Any change in formulation that enhances the fracture toughness of the material would also be important, as this would allow the material to be used in more high stress situations, such as the replacement of surfaces exposed to high bruxing, or clenching forces, without concern that it would fracture. The viscoelastic nature of composites, as well as their lower elastic modulus, make them an excellent choice for certain restorations, such as implant coverage, as the material provides some damping of biting and chewing energy as compared to ceramics, which essentially demonstrate totally elastic behavior that transfers all stresses to the implant structure and ultimately the bone. I believe that there is a critical fracture strength for dental materials, which would essentially guarantee that they would not fracture under even the most severe oral conditions. Metals have very high toughness, and do not fail by fracture. Some of the new high strength ceramics, such as alumina and zirconia, while perhaps only 1/10 or 1/5 as tough as metals, are virtually free of bulk fracture under most conditions. However, composites, porcelains and amalgams, with much lower fracture toughness, do fail by fracture. Perhaps the target fracture toughness that would provide an almost insignificant amount of fractures in the mouth may be approximately 5 $MPa \cdot m^{1/2}$. I think fracture toughness is the more critical property. Strength is important, but two materials with the same inherent strength may fail at very different load levels simply because they have different populations of surface flaws created by the placement technique. Thus, fracture toughness is more of an inherent material property than strength."

Thank you very much for sharing your science with us, Jack. It has been a great pleasure. I really appreciate your time and friendship. I'll see you in Portland in 10 days! Ciao