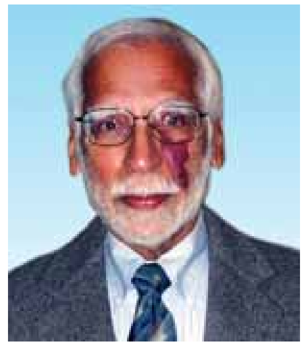
Guest Editorial

RESEARCH IN DENTAL BIOMATERIALS



Oral care has been in existence in one form or the other throughout the last few millennia of human existence. Along with that, there is sufficient scriptural and archeological evidence indicating that some type of research, rudimentary as it may have been, was precursor to the development of restorative materials and artificial teeth. It is said that the systematic records of research became readily available to general dentists and scientists when the world's first dental journal, the American Journal of Dental Science, came into existence in the mid-nineteenth century. Since then, research in dental biomaterials, along with technology, has seen a continuous progression with a few periods of hiatus. The following are only a few examples of how research on dental biomaterials has arrived at its present form.

Historically, the most notable documentation of research on a commonly used restorative material, dental silver amalgam, started with the endeavors of Dr GV Black, the so-called father of modern dentistry. Because of the desirable mechanical properties and relatively inexpensive nature of amalgam, it gradually diminished the popularity of direct filling gold (goldfoil) as a primary restorative material. The volume of research on amalgam has resulted in an understanding of its setting reactions, identification of various metallic phases in its microstructure and their relationship with the material's clinical behavior leading to variations in its modern formulations.

The advent of the polymethylmethacrylate type of restorative materials soon after World War II gradually displaced the traditional silicate cement as the main esthetic, direct filling restorative material. The addition of fillers, a variety of formulations for the resin matrix including what is now a common polymer, Bis-GMA, and the recognition of the importance of various optical properties, including fluorescence, have resulted in resin composites being the materials of choice for cost effective, highly esthetic restoratives. The fillers have evolved not only in a variety of chemistries of ceramic and glass particles but also in their size. From the initial macro sized particles, they have progressed through microsized to the present day nanoparticles. The manipulation of refractive indices of fillers and the matrix resins has led to the availability of a full palette of shades and vivid translucence for the dentist to match existing teeth. Bis-GMA and Polyurethanes are also the main resins for the pit and fissure sealants which have played an important role along with fluoridation of water supply in preventing caries. Various types of resins are integral parts of adhesive systems that are now so commonly used in restorative procedures.

Gold containing alloys remained the main materials for cast restorations for a century or more. The quest for more esthetic and natural looking restorations led to porcelain fused to metal (PFM) crowns, and the sudden spike in the gold prices led to the development of alloys containing noble metals other than gold as well as non noble or base metals. As the advances in ceramic technology progressed, the need for more resilient backing for the ceramic structures obtained from metals gradually declined and continues to decline. Currently, crowns made entirely from zirconia type, high strength, low elastic modulus, ceramic materials appear to be well on their way to dominating esthetic restorations for anterior as well as mechanically more demanding posterior dentition.

While the use of alloys for all metal fixed prostheses has declined over the years, it has remained vital for removable partial dentures (RPDs), although the research related to alloys for this purpose is probably at a low ebb. However, the strides taken in developing alloys for oral implants have been quite substantial as the demand for biologically conducive properties has increased. For implant materials, it is not only necessary to be biocompatible but also to be able to promote the growth of biological structures.

The research in metallurgy involved with endodontic files and orthodontic wires has produced landmark advances in the two important properties of nickel-titanium (Ni-Ti) alloys, namely superelasticity and temperature-related shape memory. Superelasticity of Ni-Ti wires has allowed the endodontists to effectively prepare root canals without the excessive changes in their shapes. Orthodontists have benefited with this property by being able to generate low level forces for extended periods of time, thus obviating the need for more frequent patient visits.

In addition to the restorative materials, an emerging group of chemicals is making its presence known and of great interest to dentists and scientists. These chemicals are used for reduction of dentin sensitivity and the remineralization of tooth structure decalcified as a result of the carious process. The very nature of the materials of this type and the research related to them requires not only investigating their chemistries but also performing complex clinical trials.

Scientists continue to investigate standard mechanical properties, like strength, hardness and fracture toughness as well as physical properties, such as water sorption, thermal behavior corrosion and color. And, it has become increasingly necessary to investigate properties, such as those related to material surfaces and particle size, in the context of implants and adhesive dentistry to name a few.

Impression materials have been improved in their properties of flow, hydrophilicity and detail reproduction with clever use of different monomers and nanosized filler particles. Currently available modern cements are readily characterized by their ability to release fluoride or show physicochemical adhesion to tooth structure as initiated by the glass ionomer and related materials.

The phenomenal development of dental biomaterials has been possible partly because of research leading to the ever increasing body of knowledge about the microstructure and molecular make-up of oral tissues, including the bone, various components of the tooth and periodontal tissue. Advances in technology have made it possible for such research. A multitude of analytical instruments, such as scanning and transmission electron microscopes, atomic force microscopes and various types of spectroscopes with the capabilities of detecting elements and measuring their diminishingly small amounts, have enabled us not only to view the microstructures but also to quantify structural elements at the molecular and atomic levels.

CONCLUSION

Just a cursory look at the plethora of scientific literature will show clear evidence that research related to biomaterials has progressed from its humble beginnings to a highly urbane level along with the continued sophistication of technology in analytical instrumentation and manufacturing. It is safe to conjecture that the future of biomaterials research looks very bright with the resulting availability of biomaterials capable of arresting decay, reducing pain and producing long lasting, lifelike esthetic restorations.

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