



# Editorial

## The Future of Prosthodontics: From Replacement to Regeneration

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Prosthodontics stands at a defining moment in its history. For over a century, the specialty has refined the science of replacing tissue and structures compromised by disease, trauma, or aging. Today, however, technological advance and biologic insight demand a far larger vision—one in which the future stretches beyond prosthesis fabrication toward the orchestration of biologic repair and regeneration. This evolving paradigm does not diminish the craftsmanship of prosthodontics but expands its horizon and changes the specialty from a largely mechanical specialty to one deeply integrated with cellular biology, tissue engineering, and molecular medicine.<sup>1</sup>

Surface modification of dental implants marked the beginning of the transition. What was originally a passive titanium fixture has become an engineered biomaterial capable of influencing cellular adhesion, differentiation, and bone formation. Nano-modified and micro-roughened surfaces showed that implants could proactively interact with the surrounding biological milieu, expediting osseointegration and improving long-term stability. It is at this juncture that the realization that an implant can be biointeractive—not just biocompatible—represents a philosophical shift: it recasts the implant from being a structural

device into a biological catalyst, embedding the seeds for its regenerative identity within prosthodontics.<sup>2</sup>

Running parallel to surface engineering, the augmenting use of autologous biologics like PRF, I-PRF, and CGF has introduced a new dimension of biologically driven therapy. These concentrates enhance angiogenesis, stimulate fibroblasts, and support osteoblastic activity, providing a natural scaffold rich in growth factors. Simple as this may seem, the importance of such a development is therein: for the very first time, prosthodontists can enhance regenerative potential without external grafts or synthetic matrices, employing the intrinsic biology of the patient as the principal therapeutic tool. Thus, autologous biologics have become a link that connects conventional prosthodontic practice to regenerative medicine, allowing the clinician to influence not only the prosthesis itself but the healing environment.<sup>3</sup>

Yet growth factors alone do not drive regeneration. Scaffold engineering has become a transformative force in modern biomedical science. Bioresorbable scaffolds—made of hydrogels, collagen matrices, bioceramics, or three-dimensional-printed polymer networks—can provide conductive templates for bone formation, vascularization, and soft-tissue

architecture. In combination with stem cells, such scaffolds have demonstrated the ability to bioengineer segments of bone and soft-tissue constructs with remarkable predictability. The implications for prosthodontics are profound. Rather than depending solely on particulate grafts or ridge-augmentation techniques, the prosthodontist of the future may bioengineer alveolar bone with scaffolds engineered to mimic the biomechanical and cellular properties of native tissues. The prosthodontist will no longer merely restore a lost structure; he or she will participate in its regeneration.<sup>4</sup>

Advances in additive manufacturing continue to evolve toward four-dimensional printing-materials capable of dynamic responses to functional, thermal, or mechanical stimuli. Shape-memory polymers and smart ceramic composites enable prostheses that adapt to occlusal forces, preserve fit despite residual ridge changes, or optimize stress distribution over time. In this prospective scenario, the prosthesis becomes a living, responsive participant in the oral environment rather than a static replacement. The convergence of digital dentistry, smart materials, and biomechanics may ultimately yield prostheses that self-adjust in response to real-time functional demands.<sup>5</sup>

As biological and technological innovations continue to converge, the identity of prosthodontics will need to evolve. Future practitioners will be expected to have expertise in occlusion, aesthetics, biomechanics, tissue biology, immunomodulation, and biomaterials science. Education will have to expand to include molecular regeneration, scaffold design, biologic manipulation, and the integration of AI-driven diagnostic and predictive systems. The next generation of prosthodontists will work within a paradigm where distinctions among surgical, restorative, regenerative, and digital sciences blur into an integrated perspective. This evolution is not optional; it is necessary if scientific rigor is to

be maintained and clinical relevance is not to be sacrificed.<sup>6</sup>

With these strides come great ethics and regulatory considerations: widespread utilization of biologics and regenerative materials must be complemented by stringent standardization of preparation protocols, quality control, and clinical guidelines; safety regarding autologous tissues, scaffold degradation products, and long-term biologic interactions will have to be scrutinized in detail. There will be a need for cooperation among journals, academic councils, and regulatory agencies to ensure the rational development of regenerative prosthodontics within a framework of protection for patients while fostering responsible innovation.<sup>7</sup> However, the main challenge is conceptual. Prosthodontics needs to reconceptualize its purview. From a perspective of the discipline of "replacement," it must adopt a far more visionary narrative—that of restoring biology, function, and health at a more fundamental level. A regenerated ridge, a biologically stabilized peri-implant environment, an engineered soft-tissue interface, or a prosthesis designed to adapt to biological change defines the true evolution of the specialty. This requires vision, leadership, and a willingness to transcend tradition in pursuit of biologically driven excellence.<sup>1</sup> Prosthodontics must now define the next frontier of its identity. The specialty is ready to enable leadership at the interface between biomedical innovation and clinical artistry: biologically active implants, growth-factor-enhanced regeneration, scaffold-guided tissue engineering, and intelligent prosthetic systems. This evolution promises a better outcome but also redefines what rehabilitation means. The prosthodontist of the future will not simply replace what is missing but will become a participant in restoring life to tissues, function to movement, and vitality to oral ecosystems. The future of prosthodontics is regenerative, and it is within reach if pursued.<sup>2</sup>

## References

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