A new perspective to push forward a stagnated dental world

Vitor C. M. Neves[1]

Key points

- Argues dentistry must embrace biology to move forward, just as medicine has done, or become a purely technical discipline.
- Discusses the path for a new era of dentistry that welcomes new, biologically-based approaches.
- Suggests students must be taught the importance of genetics, stem cells, regeneration, repair, transcriptomes, bioactive materials and bioengineering.

Abstract

Despite the major improvements in clinical dentistry, resulting from dental science efforts to shape current clinical dentistry, it has been almost forty years since a new therapy has reached dental practice. The focused scientific effort on evolving dental materials and equipment to facilitate their use has overshadowed the most important aim for developing new dental techniques: human biology. This opinion piece argues a new mindset in dentistry is crucial for the birthing of innovative treatments. It also discusses the path for a new era of dentistry that welcomes new biologically based approaches, including whole dental pulp and bioengineered tooth regeneration, currently being tested in cutting-edge laboratories around the world. Suggestions will be made to justify the reason clinicians must be educated in molecular biology and how universities and the General Dental Council need to prepare in-qualification or qualified dentists. A new biologically-based era of dentistry is around the corner and dentistry as we know it is changing forever.

Introduction

Ever since dentistry has become a recognised and regulated profession, new treatments for patients have appeared. The constant evolution in dental science has helped clinical dentistry to move from a mutilating profession that only extracted teeth with no anaesthesia (eighteenth century), to a multi-restorative profession using approaches that attempt to recover functionality and improve aesthetics (twentieth century).[1,2] Despite this evolution, dental treatments are not based on the biology of the human body and, in the past forty years, dentistry has evolved very little. The current approach of replacing lost organs and diseased tissues in the oral cavity for inert materials must shift to biologically-based approaches that aim to give back to the patients the same biological tissue or organ that was lost/damaged. Therefore, in order to continue evolving, clinical dentistry must fully embrace biology.

From antibiotics to composite resin, it is undeniable that dental treatments provided by dental professionals around the world today are of much better quality when compared to treatments provided in the mid-twentieth century.[2] However, even though recently developed technological tools, such as computers, have made the dentist's life easier, since Brånemark described osteointegration, a biological concept that was translated into dental organ replacement with titanium screws,[3] dentistry has stagnated in developing innovative ways to treat dental problems.

In the past forty years, dental science has mainly focused on improving the already developed materials and daily-use equipment for clinical dentistry. This is the principal reason for the stagnation of problem-solving innovation in dentistry. By doing so, dentistry left behind the understanding of the biology of the human body as the primary way to evolve the profession.

New mindset

Although dentistry has become a more evidence-based profession (not just empirically taught), the belief that it is nearly impossible to repair or regenerate a patient's own oral tissues or organs (enamel, dentine, dental pulp, periodontal ligament, salivary glands, gingiva etc) in the dental practice is still wide spread. One could argue that a regenerative mentality is in fact discouraged in the dental community.

In order to develop new treatments, the perspective of dentists must shift from a technician mindset (material/hand-ability, 'the craftsman'), to a cell and molecular biology mindset. One where the patient's body is more important than the inert materials inserted into it. This change in mentality is key for evolving dentistry past the stagnation that has kept our profession from innovating.

[1]Centre for Host and Microbiome Interactions, King's College London, London, UK.
Correspondence to: Vitor Neves
Email: drvitorneves@gmail.com

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New horizons

The human body is composed of approximately 50–100 trillion cells, of which the majority possess a nucleus filled with deoxyribonucleic acid, the molecule that carries our genetic code.[4] The dental organ is not just a lump of mineral stuck in the mandibular/maxillary bone. Teeth and the tissues surrounding them are dynamic and complex clusters of cells.[5] Therefore, moving from understanding materials to understanding the biological processes happening inside and around the dental organ is crucial for moving the profession forwards.

During my PhD, Professor Paul Sharpe and I thoroughly studied the molecular basis of dentine repair. We found that via the understanding of a signalling cascade called 'Wnt', we could manipulate dentine repair.[6] From the basic biological knowledge gained, we were able to translate this inner biological capacity into a novel treatment approach. We showed that by adding small molecules capable of activating this genetic cascade, we increased reparative and reactionary dentine secretion in the dental pulp, which has the potential to increase the vitality of teeth with large damaged areas.[7,8] This research helps to validate the claim that it is important to understand the biology of the cells of the dental organ in order to go beyond the classical, standardised paradigm that dentistry is operating within.

In addition to our research, which was a pre-clinical research performed in murine, Japanese researchers performed the first successful pilot clinical trial in humans, aiming for whole dental pulp regeneration by using stem cells collected from an unnecessary tooth's dental pulp in the patient's oral cavity. They managed to recover dental vitality in four out of five teeth, after a pulpectomy was performed, and saw new secreted dentine at the coronal part of the teeth.[9] This research has had a great impact in dentistry as it is the first time it was shown that human teeth with complete root formation were capable of regenerating the whole dental pulp via stem cell transplantation.

Moreover, periodontology has also been benefiting from the use of stem cells treatment. A Chinese group showed that by using stem cells from the apical papilla (SCAPs), defects caused by periodontitis in swine models were restored.[10] Meanwhile in Italy, human periodontal intrabody defects were repaired with significant change in probing depth and gain of clinical attachment level following dental pulp dissociated cells in collagen sponge were placed in the defect.[11]

Finally, the ultimate goal in dentistry would be to replace a lost dental organ with a bioengineered tooth instead of an inert tooth analogue. Since the early recombination experiments in the late 1960s, showing that a tooth germ could be transplanted into an adult mouse and developed into a complete tooth,[12] the aim to produce a whole bioengineered tooth to replace lost ones became feasible. In recent decades, researchers have been showing promising results in whole tooth bioengineering, suggesting this technique will be translated into a dental treatment in the next decades.[13] The technique of cell recombination to form whole bioengineered teeth in the laboratory has been well-established for years.[14,15] In addition, the transplantation of bioengineered teeth has also been achieved in several animals, proving it is possible and feasible to have an engineered tooth germ to develop into a vital, fully-formed tooth with periodontal ligament *in situ*.[16]

What now?

It is understandable that you could be reading this provocative piece of information and thinking that it will take ten to fifteen years until these techniques reach the dental practice; so at the moment, why should you think this is relevant for you as a clinician?

Technology has been reaching the market faster than the regulations and education can keep up with. A current example of how technology that was developed in the past decades are reaching the day-to-day dental practice is the accessible DNA analysis available in the market. The first human genome analysis took thirteen years and costed $2.7 million to complete (Human Genome Project).[17,18] Today, companies such as 23andMe offer genetic health analysis for £150, the same cost of a composite filling.[19] So far, no dental disease predisposition analysis tool has been developed. However, a patient can easily have his whole genome sequenced for $1,000 and ask you if you know genes that cause predisposition to, for example, periodontal disease.[20] The question is, would you be equipped to answer and counsel the patient?

Dentistry will never stop evolving and the knowledge needed to fully understand what a biologically-based product can cause in one's body goes beyond what the dental training currently has to offer. My experience transitioning from being a clinician to a researcher in molecular biology has shown me that current dental training does not prepare one to understand molecular biology nor capacitate dentists to perform biologically-based treatments either using cells or any other biological technique. Intuitively, I could suggest that dental undergrad training before mine also did not prepare dentists for this level of understanding.

During dentistry undergraduate training, it is common to see that biology and chemistry of the body are taught early on in the course, however soon after the clinics start the course and students focus on understanding hand skills and material properties. This gear-shift tattoos in the dentists' mindset that it is more relevant to focus their time and attention on technical abilities and the materials that will be placed in the patient, rather than understanding the biological intricacies of patients themselves. As a result, generations of dentists were trained to prioritise the quality of the material and how to use it in the dental practice, bluntly overlooking the molecular requirements of the patient's body for healing or regeneration to take place.

This must change urgently. The human body is complex and new knowledge is gained every day, connecting the various loose pieces of current scientific findings.

Because these new coming treatments will be fully based on biology, the sooner education can equip dentists with molecular biology applied to clinical dentistry, the more prepared the profession will be to offer patients these new techniques in the treatment plan.

An ideal scenario to start shifting this perspective would be to add biology and chemistry later in the undergraduate degree, linking these subjects to the clinical treatments the students have been experiencing. This way, the students would be able to understand and visualise the biological and chemical effects behind the treatments they performed during training. Whereas for the qualified dentists, it is now the General Dental Council's ethical obligation to the profession and population to require continued professional learning (CPD) in molecular biology applied to dentistry. Yet, in the scenario where dental practitioners in-qualification or already qualified do not want to learn molecular biology, an alternative option would be to limit the access of these new techniques to a new speciality. Dentists that want to perform cutting-edge molecular biology-based techniques would have to learn applied molecular biology in dentistry. In the UK, one example of a course that prepares

clinical-based dentists to understand this subject is the MSc in regenerative dentistry offered by King's College London.

This century's dentistry has great potential to evolve but evolution only happens when the *status quo* is challenged.[21] Any change requires exploration of the unknown:

'It is where the unpredictable emerges that the possibility for all new and useful information exists. It is during the process of exploration of the unpredictable or unexpected that all knowledge and wisdom is generated, all boundaries of adaptive competence extended, all foreign territory explored, mapped and mastered.'[22]

Conclusion

It is absolutely crucial that dentists around the world start opening their eyes to the biological future that is approaching. Together, as dentists who are focused on evolving dentistry, we can take another great step in pushing forward a profession that has been stagnating for decades. For that to happen, the teaching and philosophy of the profession must shift from looking at patients as receivers of a technical treatments to looking at patients as fully biological and chemical machines capable of biological wonders.

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