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Microfabricated biocatalytic fuel cells: A new approach to accelerating the orthodontic tooth movement

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Introduction: Orthodontic patients frequently complain about the long duration of their treatment. Increasing the speed of tooth movement can solve this dilemma. Many chemical and physical agents are useful as adjuncts to the mechanical forces in accelerating orthodontic tooth movement. One of potent tools that could accelerate orthodontic tooth movement is electricity. Animal experiments indicate that when 15–20 microamperes of low direct current (dc) is applied to the alveolar bone, modified the bioelectric potential, osteoblasts and periodontal ligament cells demonstrate increased concentrations of the second messengers cAMP and cGMP and consequently acceleration of orthodontic tooth movement. The main clinical problem with this concept is the source of electricity for intraoral use. Patients do not tolerate easily usual power sources, such as miniature mercury cells.

The hypothesis: This hypothesis tries to promote biotechnology to clinical dentistry. In recent years, there has been remarkable progress in research on implantable devices. An enzymatic micro-battery, which is placed on the gingiva near the alveolar bone, might be a possible electrical power source for accelerating orthodontic tooth movement. These devices use glucose as the fuel ($\text{Glucose} + \text{O}_2 \rightarrow \text{Gluconolactone} + \text{H}_2\text{O}/\text{H}_2\text{O}_2$). Implantable enzymatic micro-batteries are non-invasive, and are not osseointegrated. After application of low direct current in this fashion, the electric device can be easily removed. Due to the very small size of these devices, the procedure can be done with no tissue injury.

Evaluation of the hypothesis: Nowadays microfabricated enzyme batteries have recently been constructed, designed to function as a power supply for microsurgery robots or artificial organs and continuous glucose monitoring devices. However, in a critical point of view, there are several questions regarding this hypothesis. Is a micro fabricated enzyme battery tolerated by the oral tissues? Is there a risk of tissue damage? What is the effect of foods with different range of temperatures and pH on the output of the enzyme battery? Will Lifetime and power density of microfabricated enzyme batteries be enough for a long time orthodontic treatment?

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“Fifty years at the ‘Coal Face’ – facing the challenges and cherishing the rewards”

Paul Gratiaen

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Life is always full of challenges. Dentists are no exception. Challenges can make or break them. Challenges are opportunities in disguise, a great reservoir of learning, we should grasp them and ‘manipulate’ them to the advantage of both our clients/patients and ourselves.

The purpose of this talk is to:

- share my experiences (and the challenges I have faced) over the last 50 years, working in a number of developing countries (including in the Pacific), and in the latter part of my career, working regularly with old, ill and frail patients (including cancer patients with poor prognosis); and
- outline what I see as the challenges going forward for dental healthcare both in Australia, and in our Pacific neighbours.

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