

# Dentistry

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The specialty of Dental Surgery has progressed from the “blood and acrylic” of the early seventies. Dentistry has undergone a quantum leap over the past twenty-five years, with improvements in both technique and technology, bringing us the sophisticated procedures used in today’s practice.

## Restorative Dentistry – Endodontics

The technique of root canal preparation has evolved from the step-back technique to the balanced force technique. This has been supported by the development of nickel-titanium instruments such as the K3 rotary file system. The main feature is the preparation of the root canal with coronal flaring produced by greater taper instruments and the avoidance of procedural accidents by the more flexible nickel titanium. The changes in canal shape necessitated further developments in canal obturation and the use of thermoplasticized gutta-percha techniques with the more recent obturators. Retrograde root canal preparation has seen developments in the use of ultrasonic instruments rather than burs to prepare the apical root end while root-end obturation utilizes the mineral trioxide aggregate.

Ongoing research is being carried out in various centers on Mineral Trioxide Aggregate.<sup>1</sup> This biocompatible material is essentially Portland cement with bismuth oxide added for radio-opacity and is used primarily for retrograde filling. There is collaboration between the Department of Building and Civil Engineering, University of Malta and GKT Dental Institute in London on the material to make it more suitable for more applications in dentistry.

Advances have been made in understanding the microbiology of the root canal. The microbial population of the root canal changes during and after root canal treatment is performed. Instrumentation of the root canal reduces bacterial counts considerably but re-colonization of the root canal occurs in between visits.<sup>2</sup> Bacteria colonise not only the root canal but also within dentinal tubules as far as the cementum. *Enterococcus faecalis*, a facultative anaerobe, has been implicated in cases of failed root canal treatment. This microorganism is very resistant to treatment, surviving starvation and local medicament therapy.

The use of camphorated monochlorophenol (CMCP) and tricresol and formalin (TCF) as an inter-visit root canal dressing has been abolished. The accepted medicament within the root canal is non-setting calcium hydroxide and sterile saline slurry. This limits, but does not totally prevent regrowth of endodontic bacteria.<sup>3</sup> The antimicrobial treatment of calcium hydroxide in combination with either erythromycin or tetracycline has a significant effect on enterococci, but the overall antimicrobial effect is relatively weak. Other medicaments used in combination with calcium hydroxide treatment are chlorhexidine digluconate and iodine potassium iodide. The antibacterial activity of these medicaments however seems to be inhibited by different components of dentin.

The debate whether to remove the smear layer prior to root canal obturation remains unresolved. Removal allows better debridement of the root canal as the smear layer may harbour micro-organisms and improves access of irrigants and medicaments, sealers and other obturating material to the dentinal tubules. However removal of the smear layer allows faster and deeper penetration of bacteria within the root canal system. A new solution, MTAD (mixture of tetracycline isomer, acid, and a detergent) has been introduced which, used in combination with sodium hypochlorite, seems to be effective in removing the smear layer and does not significantly change the structure of the dentinal tubules.<sup>4</sup>

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## Radiology and imaging

Direct digital acquisition of the radiographic image provides many advantages over conventional film-based systems. Although film based imaging has not yet been abandoned completely, nothing will affect the clinical practice of dentistry in this decade as greatly as electronic dental imaging.

Digital systems require no chemical processing system. This eliminates the inconvenience and common errors associated with film processing. Immediate viewing of the image is also possible and since the images are in digital format, image-processing techniques can be used to enhance or analyse the image information,<sup>5</sup> while the cost and time of storing and retrieving digital images is considerably decreased. Finally, the higher efficiency of electronic sensors in comparison to film should make possible a substantial reduction of x-ray dose to the patient.

Currently dentists can choose between the two types of receptors for direct digital image acquisition: the charge-coupled device-based sensor (CCD) and the storage phosphor image plate (photostimulable phosphor or PSP). In CCD systems, a wire connects the sensor and the computer monitor after exposure of the sensor. In PSP systems a plate is exposed to x-irradiation, and a latent image is created. The information contained in the plate is emitted when stimulated by light of a particular wavelength and captured in a laser scanner.

The future of digital imaging should continue to see increased adoption of sensor technology as well as improvements in equipment throughout this decade and beyond.

Computed tomography has several applications in dentistry; it can be used to identify and delineate pathologic processes, display trauma and assess the sites for pre-surgical implant planning.<sup>6</sup> CT combines thin-section imaging with electronic image acquisition and computerized image generation. There have been dramatic changes over these last few years with the introduction of helical and spiral scan CT.

A possible disadvantage of CT is that it has always been considered a high radiation dose technique. Several parameters affect the patient dose, including the area being imaged, the number of slices, the thickness of the slice and the kilovolt peak: as with plain film radiography, the use of a higher kilovolt peak decreases the patient dose.

Magnetic resonance imaging (MRI) provides a new and not yet fully utilised method of evaluating head and neck pathology. One of the principal advantages of MRI is that no radiation is involved and no biologic damage has been reported so far.<sup>7</sup> With new scanner designs and newer pulse sequences, MR imaging should increase.

Accompanying advances in digital diagnostic imaging and its clinical applications, several new opportunities have been introduced. Teleradiology is the electronic transmission of radiologic images from one location to another for the purpose

of interpretation, consultation, dental insurance authorization and continuing education.<sup>8</sup> While digital imaging systems provide high quality images, they may not provide an acceptable level of exchange capabilities. Proprietary formats may limit the opportunities for sharing digital images. The digital imaging and communications in medicine or DICOM standard was created to develop a common format for exchanging images and information with the ultimate goal of total interconnectivity among medical and dental imaging devices.

## Periodontal disease

Periodontal disease comprises a group of inflammatory conditions of the supporting tissues of the teeth caused by dental microbial plaque. Although treatment still relies mainly on removing calculus deposits on affected teeth by scaling, root planing and surgery, tremendous advancements have been made in this field.

The bacteria making up dental biofilms at the gingival crevice provokes a state of chronic inflammation which persists if overwhelming numbers are allowed to remain. The clinical outcome varies greatly despite similar quantitative and qualitative levels of bacteria. A Gram-negative shift in the flora populating the periodontal pocket alone is not sufficient to induce the periodontal disease initiation and progression. It is the host immune response that decides the rate of deterioration of the periodontium. This is influenced by environmental, acquired and genetic factors.

Modulation of the host response will minimize tissue destruction. Promising pathways are the inhibition of matrix metalloproteinases (MMPs) with antiproteinases e.g. subantimicrobial doses of doxycycline; inhibiting activation of osteoclasts with bone-sparing agents e.g. bisphosphonate and promoting faster inflammatory resolution through stimulation of endogenous lipid mediators.<sup>9</sup>

There is reawakening interest in the focal infection theory and the link of periodontal disease with medicine. Bacteria causing periodontal disease can stimulate the release of proinflammatory cytokines or acute phase proteins at distant sites such as the liver, pancreas, skeleton and arteries. These products may initiate or intensify such a disease process as in atherosclerosis and diabetes,<sup>10</sup> and they have also been associated with certain adverse pregnancy outcomes. Bacteria may also travel from oral sites to other mucosal surfaces to cause inflammation and infection.

The control of pathogens still remains the singular effective means of management and the development of locally delivered antiseptics or antibiotics, having sustained-release vehicles, have boosted the arsenal.<sup>11</sup> They bring high concentrations where needed, combined agents can be prepared, they offer less side effects in comparison to systemic antibiotics, and professional application ensures compliance.

A better understanding of the cellular and molecular

mechanisms which regulate the development and the healing of tissues have permitted the reversal of a once irreversible disease.

The Guided Tissue Regeneration (GTR) technique involves interposition of a membrane between the gingiva and the root, delaying apical migration of gingival epithelium. Progenitor cells from the periodontal ligament and osseous tissues then repopulate the tented space adjacent to the denuded root surface.

Periodontal tissue engineering utilizing growth and amelogenin-like factors is a recent development. These factors, absent in mature tissue, carry information needed to regulate the cellular activity responsible for tissue formation. They are placed in the bony defect promoting the recolonization of the root surface by cementoblasts which in turn stimulate regeneration of the periodontal ligament and alveolar bone.<sup>12</sup>

A wide range of bone replacement grafts have been used successfully in conjunction with GTR to increase clinical attachment levels. These concepts have been extended to produce alveolar ridge augmentation for placing implants.

### **Paediatric dentistry**

The goals of creating a generation free of cavities and anxiety are attainable with the acceptance of fluoride, sealants and early dental education. New technology, such as air abrasion, makes possible painless, conservative caries removal when decay is diagnosed early.<sup>13</sup>

Sedation for paediatric patients is an essential tool in anxiety management and is used as an adjunct to behaviour management. Nitrous oxide/oxygen sedation is routinely used as an alternative to general anaesthesia. This may be administered easily and safely to children in general dental practice to obtain an adequate plane of relative analgesia.<sup>14</sup>

There is growing evidence that consumption of potentially erosive foodstuffs and soft drinks is associated with a high level of erosion and exposed dentine in a significant number of teenagers. Children with asthma seem to be more prone to dental erosion than healthy controls. Fluoride is known to reduce enamel solubility during the caries process and investigations are being carried out to determine whether fluoride preparations affect erosion attributed to citric acid-based soft drinks. An *in vitro* study has shown that fluoride applied to enamel either in acidic solutions or as a pre-treatment, reduces enamel erosion. However more *in vivo* studies are required.<sup>15</sup>

The improvements in adhesives and composite technology have made resin-based composite resins and polyacid-modified resin-based composites (compomers) very popular as materials to restore primary and permanent anterior and posterior teeth. More conservative preparations can be performed, maintaining more tooth structure due to the adhesive properties of the bonding agents used with composites and compomers. Meticulous care in the placement of adhesives and

subsequently, resin-based composites and compomers, is necessary to produce long-term satisfactory results.<sup>16</sup>

### **Oral Medicine and Pathology**

One of the more important topics that confront oral medicine and pathology is diagnosis and correct evaluation of pre-malignant lesions. Recent research is concentrating on the molecular biologic changes and possible identification of specific markers suggesting premalignancy or definite malignant change.<sup>17</sup>

The future of detection and possibly treatment of these lesions is through specific molecular biologic tools. Much progress has been made but is fair to say that, in spite of these advances, histopathologic evaluation of the severity of the epithelial dysplasia are, so far, the most reliable diagnostic features. Another aspect is the identification of biologic features which may relate to the prognosis of the squamous cell carcinoma. Recent studies have accentuated the importance of studying changes of the advancing front of the malignant lesion.<sup>18</sup>

The management of erosive lichen planus is mainly through local or systemic steroids but a range of other immune suppressant drugs have been utilised. The latest to be studied is tacrolimus or some of its variants which have worked in recalcitrant cases.<sup>19</sup> As in all immunosuppressant medication they must be used with care.

### **Orthodontics and oral surgery**

By far the greatest breakthrough affecting orthodontics within the past few years has been the development of osseointegrated implants.<sup>20</sup>

Titanium is the accepted ideal material, but other materials have been described.

There is however, a lack of consensus on implant design. The incorporation of a thread aids loading of surrounding bone in compression; a smooth cylindrical design increases implant support when shear forces are exerted on bone. Both designs show a more uniform stress distribution compared to other designs.

These are used in orthodontic treatment to prevent unwanted tooth movement and the principle of osseointegration is used to gain a stationary intra-oral anchorage site.

The use of implants purposely designed for orthodontic use have led to a variety of designs and they can be placed subperiosteally, transosseously or endosseously with the latter as the most common approach.

A disc-shaped implant called "onplant" has been described for use when insufficient bone is available for endosseous implant placement. The hydroxyapatite-coated disc is placed subperiosteally using a "tunnelling" surgical procedure. The structure is subsequently connected to orthodontic bands by a transpalatal arch.

The Straumann Orthosystem implant is an endosseous

implant up to 6mm in height placed at the anterior midpalatal region and connected to a transpalatal arch.

Orthodontic implants can be used also for active distal tooth movement through the use of a distal-jet device.<sup>21</sup>

Recent advances in molecular biology have started to clarify basic concepts of orofacial development.<sup>22</sup> The homeobox-containing genes are now seen as responsible for early polarity in the first branchial arch and establishing the molecular foundations for patterning of the skeletal elements and the teeth. Interactions between the ectoderm and ectomesenchyme control the odontogenic developmental programme, from early patterning of the future dental axis to the initiation of tooth development at specific sites within the ectoderm.

Distraction osteogenesis is a technique used to gradually lengthen bone through the application of a gradual external force over a corticotomised site. The continual minaturisation of distraction devices has greatly increased the scope of their use. Devices can be sited intra-orally or subcutaneously and can be applied in growing children with skeletal anomalies.<sup>23</sup> The technique has been used to treat such facial deformities as mandibular hypoplasia, hemifacial microsomia, Treacher-Collins', Pierre-Robin and Nager's syndromes. It has also been used to advance the maxilla following Le Fort I osteotomy. Reports suggest reduced nerve paraesthesia and shorter in-hospital stays compared with conventional osteotomies as well as increased stability. Bone lengthening will occur in the same plane as that at which the distractor is placed and positioning of the distractor is of paramount importance in order to obtain good three-dimensional control.

## Conclusion

Research and innovation have broadened the scope of Dental Surgery so that it no longer solely involves dealing with the aftermath of dental caries. Modern practice is to take a comprehensive multidisciplinary approach to the care of the stomatognathic system, and the quality of life of the patient as a whole.

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