Introduction to Dental Lasers

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V Karic[1], G Melman[2], R Mulder[3]

It was Albert Einstein who in 1917 defined the theory of the Stimulated Emission of Radiation, developing and expanding on the work of Niels Bohr, who in 1913 had formulated the Spontaneous Emission theory. Einstein described the electrons of molecules being excited by a source of energy, usually heat, and directed in a specific way.[1] The excited electron releases a spontaneously emitted photon which interacts with a molecule of the active medium, causing those electrons to move to a less stable, higher energy state and producing further photons. This process exponentially increases the number of identical photons which are focused by mirrors at either end of the laser tube and emitted into the delivery system.[2] The acronym "LASER" represents "light amplification by stimulated emission of radiation".

Theodore Maiman (1960) developed the first working laser.[3] The active mediums contain a homogeneous population of atoms that characterize each type of laser, allowing photons to be produced and absorb energy of certain wavelengths. The active mediums can be a gas such as carbon dioxide (CO_2), or solid crystal such as yttrium-aluminium garnet (YAG) or a neodymium-doped yttrium aluminium garnet (Nd) YAG. Diode lasers are solid state semi-conductors. In dentistry lasers can be classified according to their active mediums which determine the wavelengths of the laser and which in turn dictate the tissue interaction, intra-oral uses and the scope of practice (Table 1).[4]

A synopsis of lasers in use in Dentistry

The Carbon Dioxide Laser (CO_2) provides rapid soft tissue removal and haemostasis with a very shallow depth of penetration. It provides a very dry operating field with reduced swelling of soft tissue. The main chromophore target for this wavelength (10,600nm) is water. The exposed tissue undergoes a rapid evaporation of both intracellular and extracellular fluids and the photo-destruction of the rest of the cell.

The Neodymium (Nd) Yttrium Aluminum Garnet Laser: YAG wavelength (1,064nm) is highly absorbed by haemoglobin and melanin. The energy emitted from this laser is predominantly diffused in the targeted tissues in the form of heat, making it a very effective surgical laser for cutting and coagulating dental soft tissues, with good haemostasis. In addition to its surgical applications, there has been research on using the Nd:YAG laser and various diode lasers for non-surgical sulcular debridement in periodontal disease control and the Laser Assisted New Attachment Procedure (LANAP).

1. **Vesna Karic:** *BDS(Bgd, EU), MSc(Dent)(Wits).* Senior Lecturer, Division of Operative Dentistry, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg.
2. **Geoffrey Melman:** *BDS(Wits), MSc(Dent)(Wits),* Specialist in Paediatric Dentistry (UK). Department of Orthodontics and Paediatric Dentistry, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg.
3. **Riaan Mulder:** *BChD (UWC), MSc(Dent)(UWC).* Lecturer, Department of Orthodontics and Paediatric Dentistry. University of the Western Cape, Tygerberg, Cape Town.

Corresponding author

Vesna Karic:
Division of Operative Dentistry, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg.
E-mail: Vesna.Karic@wits.ac.za

ACRONYMS

KTP: potassium titanyl phosphate
Nd:YAG: neodinium-doped yttrium aluminium garnet
Nd:YAP: neodinium-doped yttrium aluminum perovskite
CO_2: carbon dioxide
Er,Cr:YSGG: erbium-chromium-doped yttrium scandium gallium garnet
LANAP: Laser Assisted New Attachment Procedure

Table 1: Classification of dental lasers in accordance with dental use.

Soft tissue lasers	
Argon	514 nm
KTP	532 nm
Diode	803, 810, 940, 980, 1064 nm
Nd:YAG	1064 nm
Nd:YAP	1340 nm
CO_2	10600 nm
Hard and soft tissue lasers	
Er,Cr:YSGG	2780 nm
Er:YAG	2940 nm
Low-level lasers	
Helium neon	635 nm
Diode	635, 810, 980 nm
Photopolymerization lasers	
Argon	488 nm
Tooth whitening lasers	
KTP	532 nm
Diode	803, 810-980 nm
Caries detection lasers	
Diode	655 nm
Dentine desensitization	
Er:YAG	2940nm
Er,Cr:YSGG	2780 nm
CO_2	10600 nm

Erbium Laser: There are two distinct wavelengths, namely the Er,Cr:YSGG lasers (2780nm) and Er:YAG lasers (2940nm). The erbium wavelengths have a high affinity for hydroxyapatite and the highest absorption of water of any laser wavelengths. Consequently, it is the laser of choice for treatment of dental hard tissues in operative dentistry. It has been shown that there is a 3°C rise in pulpal temperatures during cavity preparation on extracted teeth with the Er:YAG laser, well below the 5.5°C that is deemed safe to prevent an acute pulpitis.[4] In addition to hard tissue procedures, an erbium laser can also be used for soft tissue ablation due to its high affinity for water.

Diode Laser: The diode laser is a solid state semiconductor that can be made of aluminum, gallium, arsenide and occasionally indium. All diode laser wavelengths (803 to 1,064nm) are absorbed primarily by tissue pigment (melanin) and haemoglobin. The emitted laser energy is scattered in the target tissues and later converted to heat. Conversely, the energy is poorly absorbed by the hydroxyapatite and by water present in the enamel. Specific procedures appropriate to their use include aesthetic gingival re-contouring, soft tissue crown lengthening, and removal of inflamed and hypertrophic tissue. The diode laser has become popular for use in frenectomies and for photostimulation of apthous / herpetic lesions.

Lasers offer a wide application in Dentistry with considerable benefits and advantages. However, there is a basic requirement that clinicians and associated staff ensure that laser use is carried out in a safe environment and with consent from the patient. Lasers can damage oral tissue, the skin, and eyes. Safety considerations are proportional to established and recognized risk. Safety glasses must be worn by the dental team and the patient at all times. The operator must have a thorough understanding of laser physics and of the device being used. Strict adherence to national and international regulations for dental lasers is essential.

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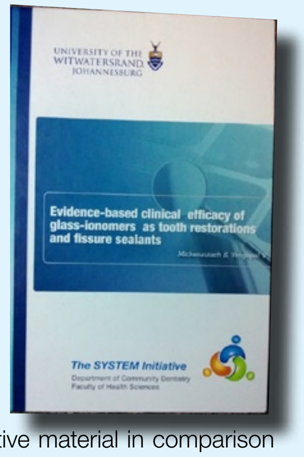
Evidence based clinical efficacy of glass -ionomers as tooth restorations and fissure sealants



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ISBN number 978-0-620-68083-7
Authors: S Mickenautsch and V Yengopal.
Seven Chapters and 211 pages.

This is an innovative book, intriguing in concept and challenging in content. The authors have assembled nine of their papers into a coherent presentation which comprehensively explores the clinical efficacy of glass ionomer restorations. The papers reflect the most thorough analysis of the literature dealing with glass ionomer as a restorative material in comparison with the traditional amalgam and gold standards.

The papers emanate from a unit based in the Department of Community Dentistry of the University of the Witwatersrand, Johannesburg. The System Initiative is the shortened version of the complete title of the unit….. Systematic Review Initiative for Evidence-based Minimum Intervention in Dentistry. The three main objectives are:

- To develop the basis for evidence-based teaching concerning Minimum Intervention-related topics
- To generate evidence-based practice guidelines for clinical service delivery
- To provide recommendations for further research.

SYSTEM has adopted the use of systematic reviews in seeking to achieve these objectives.

The collection of essays reflects that approach, for the papers are based on meta analyses of the related and cogent literature.

Comprehensive and meticulous literature searches characterise the determination and selection of those publications which meet the criteria and robust statistical methods are applied to extract the most reliable evidence on which clinical decisions may be based. The search conducted for one paper involved an original data base of 1359 articles. The stringency of selection may be gauged when only 20 trials were accepted for further review and data extraction.

And the evidence of the analyses challenges the widely held concepts of the relative clinical inferiority of high viscosity glass ionomers in comparison with the current gold standard of amalgam. Further that the efficacy of glass ionomers as pit and fissure sealants has not been shown to be inferior to other methods.

The nine papers are organised into sections useful to the reader who may seek information in a particular topic. The two main divisions present papers on Glass Ionomers as Tooth Restorations and Glass Ionomers as Fissure Sealants. Included in the first are papers dealing with:

A critique of the laboratory evidence
A critique of the evidence from uncontrolled clinical trials
Evidence from controlled clinical trials
Evidence synthesis.

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