كلية طب الاسنان | جامعة القادسية
University of Al-Qadisiyah
College Of Dentistry

# LASERs and its applications in dentistry

*A Research Submitted to college of Dentistry,University of AL-Qadisiyah in partial Fulfillment of the Requirements For the Degree of Bachelor in dental and Oral Surgery (B.D.S)*

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***Supervised by :***

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**2020 – 2021**

بسم الله الرحمن الرحيم


وقل ربي زدني علمًا

صدق الله العلي العظيم

سورة طه : الآية 114

# SUPERVISOR CERTIFICATION

*I certify that this project entitled :*
*" laser and its application in dentistry " prepared by*
*( Tabarak abdullah waheed ,* Batool abd-al jasim , Husam salman ,Jaefar hamza Baneen saeed , *Ban azeem)* *under my supervision at Al-Qadisiyah University, College of dentistry in partial fulfillment of the requirements for the degree of Bachelor in dental and oral surgery (B.D.S)*

***signature :***

***Name :*** *Dr. Raheem Abd - jabr*

***Date :*** *2021/ /*

# *DEDICACTION*

*We would like to dedicate this research to our dear fathers ,who have been a wonderful supporters until our research was completed, and to our beloved mothers, who have been encouraging our always*
*and we would like to dedicate our research also to all the professors and doctors who bore the trouble of us teaching from the first moment we entered the Faculty of Dentistry and to this moment as we present our graduation thesis, thanking them for their tremendous efforts, headed by the Dean of the Faculty of Dentistry, Dr. Professor Ali Hassan Murad and all the respected teaching staff and of course*

*our friends in class 5 in our college and to all people who have worked hard to help us complete this research.*

# ***ACKNOWLEDGEMENT***

*Primarily we would thank God for being able to complete this research with success.*
*Then we would like to thank our Doctor Dr. Raheem abd-jabr whose valuable guidance has been the ones that helped our patch this research and make it full proof success , his suggestions and his instructions has served as the major contributor towards the completion of the research*

*Then we would like to thank our parents and friends who have helped our with their valuable suggestions and guidance has been helpful in various phases of the completion of the research*

*Last but not the least we would like to thank our classmates*

*who have helped our to complete our research .*

*Thank you for all.*

# ABSTRACT

*As we know the light is beneficial and may lead to cure does not belong exclusively to our time; Greek and Ancient Egyptian doctors practiced cures by exposure to sunlight.*

*However, it was in the past century that one of the great technological advancements was made: the development of laser appliances for use in fields ranging from CDs and DVDs to performing surgeries and treating diseases.*

*We live in a fast-paced world. The practice of dentistry is constantly evolving and there are mainly two main reasons we change: one is that we want to strive to deliver the optimum treatment available for our patients; the other is that we want to keep abreast with the latest and best method to achieve that.*

*Since the laser has occupied multiple fields, the medical field has taken its share of this exciting invention, including dentistry. In this research, we discussed the subject of laser within three chapters, where the first part of the first chapter talks about terms in the world of laser, for example, the definition and methods of its interaction with living tissues, its types and uses in general.*

*While the second chapter, it included the areas, procedures, or operations in which laser technology can be used in dentistry to improve the quality of performance, for example, in the evaluation. And surgery, fillings, etc., and the most famous types used with their benefits and harms.*

*In the last chapter, we discussed one of the most important fields in which laser is used in dentistry, which is soft tissue surgery We also included for you the sources from which the search content was selected We hope that our research will be at your best, successful and useful to all*

Chapter 1

# SECTION 1 LASERS AND ITS APPLICATIONS

1.1 INTRODUCTION
1.2 Basic laser science
1.3 Types of laser light delivery
1.4 LASER and tissue interactions
1.5 Applications of LASERS.
1.6 LASER classification

## SECTION 2:Masters(MSC) in laser dentistry

# Section 1 :

## *A contemporary Apprise on LASERS* and its applications in dentistry

### Introduction :

A laser, an acronym for light amplification by stimulated emission of radiation, is a device for generating a high-intensity, ostensibly parallel beam of monochromatic (single wavelength) electromagnetic radiation.

The possibility of stimulated emission was predicted by Einstein in I9I7; based on the work of Gordon in 1955 and Schawlow and Townes in 1958, Maiman created the first operational laser in 1960, a ruby laser emitting a brilliant red beam of light.
This was followed within 3 years by the development of the argon, carbon dioxide (C0 2), and neodymium:yttrium-alu- minum-garnet (Nd:YAG) lasers, which remain the most widely used lasers in medicine.

In 1963 the ruby laser was employed in the treatment of pigmented dermatologic lesions and for photocoagulation of the retina. Early applications of lasers in oral and max- illofacial surgery began to appear in the mid- to late 1970s. Potential advantages of surgical lasers were clear from the beginning, but the cost, unreliability, and operational com- plexity of the early machines greatly limited the actual use of lasers, except in the fields of ophthalmology and derma- tology, until the past 15 to 18 years. In recent years im- proved understanding of lighttissue interactions and, of greatest importance to the surgeon, new technologies for delivering laser light to (he tissue, has transformed lasers into versatile and valuable surgical instruments.

### Basic LASER science

The word of LASER is an acronym for Light Amplification by Stimulated Emission of Radiation .
A study of each words offers an understanding of the basic principle of how laser operates.

| S.No | Ordinary light | Laser beams |
|---|---|---|
| 1 | In ordinary light the angular spread is more. | In laser beam the angular spread is less. |
| 2 | They are not directional. | They are highly directional. |
| 3 | It is less intense | It is highly intense |
| 4 | It is not a coherent beam and is not in phase. | It is a coherent beam and is in phase |
| 5 | The radiation are polychromatic | The radiations are monochromatic |
| 6 | Example: Sun light, Mercury vapor lamp | He- Ne Laser, $Co_2$ laser |

Comparison between ordinary and laser light

### Basic Laser Components:

❶ Optical resonator / tube containing the active medium
❷ Active medium(Lasing medium) solid, liquid or gas
❸ Pumping mechanism
❹ Controller
❺LASER delivery system.

### Types of LASER light delivery:

Lasers in :Fiber optic delivery system

- the visible (445 and 532 nm) and near infrared (from 810 to 1,064 nm) range use optic strands, by and large made of quartz, to convey the laser vitality to the tissue, specifically or by means of terminal hand piece, with straight and precise tips

***Disadvantage:*** gets worn with time

## Why is Fiber optic important?

- Light weight  Easy to approach
- Easy sterilization
- Tactile sensation

Hollow Fiber Er: YAG and CO 2 lasers

- utilize a hollow tube with reflective internal walls which transmit laser energy along its internal axis.

***Disadvantage:*** loss of energy over time with lack of control over variability of energy due to internal reflection.

This Articulated arm delivery system

- delivery system utilizes a progression of verbalized mirrors (generally 7) associated one to each other, prompting transmission of vitality.

requires a precise system

***Disadvantage***: for alignment of mirrors

## Handpiece two types :

***Close  contact handpiece ;*** Works by way of tips of diverse size,shape,length and angle.
Intended for specific interaction with improved kinds of tissues and laser beam close or indirect contact to tissue that allow expansion to work site.

***Non- contact handpiece:*** These are also called tip-less use a sapphire lens,located in the final part of the hand piece.and that put in specific distance from tissue (5 to 10 mm) according to type of tissue

## Laser and tissue interactions :

The light energy from a laser can have four different interactions with the target tissue, and these interactions depend on the optical properties of that tissue and wave length used.

***1- Transmission:*** Transmission of laser vitality specifically through the tissue ,with no impact on an objective tissue ,Water is generally straightforward to Nd:YAG while tissue liquids promptly retain carbon dioxide.

***2- Absorption :*** This impact is the typical alluring impact, and the measure of vitality that is consumed by the tissue relies upon the tissue qualities, for example, pigmentation and water content, and on the laser wavelength and discharge mode.
Diode and Nd : YAG has a high fondness for  melanin and less communication with hemoglobin.  Longer wavelength is more intelligent with water and hydroxyapatite as  Erbium, carbon dioxide laser. And Short wave lengths, from around 5001000nm are consumed promptly in pigmented tissue.

3- ***Diffusion or Scattering :***
Scattering of the laser light causes debilitating the vitality and conceivably delivering no helpful biologic impact

***4- Reflection :***
Laser beam becomes more divergent as the distance from hand-piece increases that make it dangerous

## Types of tissue interactions :

- ***Photochemical ;*** effects that lasers make to arouse chemical reactions, such as curing of the composite resin.

They can also origin a breakdown in chemical bonds, such as in the process of photodynamic therapy .

- ***Photo ablation :*** When a laser is absorbed, it elevates the temperature and produces photochemical effects depending on the water content of the tissues. When a temperature of 100°C is extended, vaporization of the water within the tissue occurs, a process called Ablation.Removal of tissue by vaporization and super heating of tissue fluids, coagulation, and hemostasis.

❖ ***Tissue fluorescence :*** used as a diagnostic method to detect the light reactive substance in tissue.
Eg. Diagnodent for caries detection

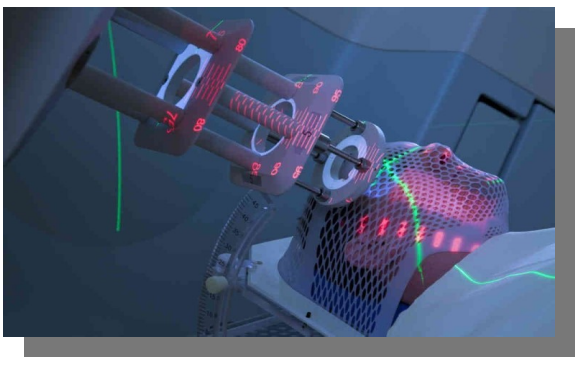
❖ **Vaporization & Carbonization :** at temperatures below 100°C, but above almost 60°C, proteins begin to denature, without vaporization of the underlying tissue. On the other hand, at temperatures above 200°C, the tissue is dehydrated and then burned, resulting in an undesirable effect called Carbonization

## Applications of LASERS :

**Laser-aided Manufacturing :**

Lasers are widely used for laser material processing
In manufacturing, e.g. for cutting, drilling, welding,
cladding, soldering (brazing), hardening, surface treatment, marking, engraving, micromachining, pulsed laser deposition, lithography, etc. In many cases, relatively high optical intensities are applied
to a small spot, leading to intense heating, possibly
evaporation and plasma generation. Essential aspect are the high spatial coherence of laser light,
allowing for strong focusing, and often also the potential for generating intense pulses. Laser processing methods have many advantages, compared with mechanical approaches,they allow the fabrication of very fine structures with high quality, avoiding mechanical stress such as caused by mechanical drills and blades.

A laser beam with high beam quality can be used to
drill very fine and deep holes, e.g. for injection nozzles. A high processing speed is often achieved,
e.g. in the fabrication of filter sieves. Further, the lifetime limitation of mechanical tools is removed. It can also be advantageous to process materials without touching them.The requirements on optical
power and beam quality apart from the wavelength
depend very much on the application and the involved materials. For example, laser marking on plastics can be done with fairly low power levels, whereas cutting welding or drilling on metals requires much more often multiple kilowatts. Soldering applications may require a high power but only a moderate beam quality, whereas particularly remote welding (i.e., welding with a substantial distance between laser head and welded parts) depends on a high beam quality . Laser-aided manufacturing often allows one to produce the essentially same parts with higher quality and/or lower cost. Also, it is often possible to realize entirely new part designs or the use of new materials. For example, automobile parts are increasingly made of light materials such aluminum, which require tentatively more laser joining operations. Weight reductions are possible not only by the user of lighter materials, but also e.g. by producing them with shorter flanges due to higher precision than is feasible with conventional production methods.
Lasers are also widely used for alignment purposes. Alignment lasers may simply emit a Gaussian laser beam, forming a circular spot on a workpiece, a line, a cross, or some other pattern. They are important for many manufacturing processes



***Medical Applications :*** There is a wide range of medical applications. Often these relate to the outer parts of the human body, which are easily reached with light; examples are eye surgery and vision correction (LASIK), dentistry, dermatology (e.g. photodynamic therapy of cancer), and various kinds of cosmetic treatment such as tattoo removal and hair removal.

Lasers are also used for surgery (e.g. of the prostate), exploiting the possibility to cut tissues while causing minimal bleeding. Some operations can be done with endoscopic means; an endoscope may contain an optical fiber for delivering light to the operation scene and another fiber for imaging, apart from additional channels for mechanical instruments. Medical lasers are not always used for therapy.
Some of them rather assist the diagnosis, e.g. via methods of ocular imaging, laser microscopy or lasers spectroscopy.

***Metrology :*** Lasers are widely used in optical metrology, e.g. for extremely precise position measurements and optical surface profiling with interferometers, for long-distance range finding and navigation

**Lasers classification :**
1.based on active medium
a. gas
b. liquid
c. solid
2. based on wavelength:
a. short wavelength.
b. long wavelength.

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# Section 2 :

## New Masters (MSc) Degree in Laser Dentistry at the University of Genoa (Genoa, February 2013 - November 2014)

The use of lasers in dentistry has now become a part of everyday clinical practice.

Rapid development of technology has led to instruments with ever-improving performance; teamed with traditional methods, such laser-based instruments offer value-added benefits to primary dental treatment. Any advanced technological aids, i.e. operating microscope, piezoelectric devices, and laser require adequate knowhow with a progressive learning curve.

In 1999 at the University of Genoa, Prof. Alberico Benedicenti, pioneer researcher in this field established the first Proficiency Course in Italy in the use of laser photonic energy in adjunctive use in treatment of appropriate head and neck conditions. Responding to the needs of clinicians for adequate theoretical and clinical instruction, the course was set up following the foundation of the first university "Laser Therapy Center" department, within the Faculty of Medicine. Having reached its 12th year, the proficiency course

expanded in 2011 to an International Masters in Laser Dentistry (MSc) degree course. The second MSc degree course will commence in February 2013.
The Masters Programme will be a 2 year course. In the first year, students will follow a course equivalent to the Proficiency Certification. Those who decide to complete the second year will prepare and present a thesis on one of the topics dealt with in the course, after which they will be eligible to receive the Masters degree.
In addition to offering personal post-graduate Professional enrichment, the new University Masters Programme will enable the student, under the supervision of a tutor to learn directly and also practice laser techniques which are Internationally accepted as "state-of-the-art".

## Educational objectives

λ To provide postgraduate students with the confidence and ability to enhance their current clinical practice by incorporating the latest advances in technology and research in the use of lasers in dentistry.
λ To provide an innovative programme which enhances current knowledge and clinical skills in laser use in dentistry
λ To present sound academic theory and high quality practical training by world class mentors
λ To deliver learning using the latest technology enabling students to access the course, whilst maintaining their commitment to their clinical practice. Through lessons on theory and hands-on participation activities the Masters course aims to help the student acquire specific proficiency and clinical experience in laser wavelengths principally used in dentistry. The clinical experience activities will be held in the new department of laser therapy and surgery, with live operations on patients performed by participants under the guidance and supervision of teachers. The course is International in character with affiliations with European and American universities. The courses will be conducted in English.

## Classroom and distance learning

In addition to a traditional classroom learning situation, there will be audio/video recordings of the lessons available for online access. The hands-on learning activities will be held within the Department.

Admission Criteria
λ Applicants must be able to satisfy the general admissions criteria of the university.
λ Applicants must provide evidence of their primary dental qualification from a recognised institution.
λ Applicants will have completed a preliminary course of instruction in the use of lasers in dentistry.
λ Applicants will own or have access to and routinely use a laser for application in clinical dentistry.
λ Applicants will make payment as required of course fees as applied by the University of Genoa

## Location:

University of Genoa – DI.S.C. - Department of Surgical and Diagnostic Sciences, , San Martino Hospital pavilion 4, Largo R. Benzi 10, Genoa, Italy

**Cost:** The cost of each academic year is 4,500 Euros. Total 9,000 Euros.

### CME Credits:

CME credits are accrued during the course and are equivalent to National verifyable hours of continuing education.

**Information:** E-mail: g.servadei@rosadeventi.com E-mail: benedicenti@unige.it
Maximum number of participants: 30 Students
Registration deadline: December 2012

### Course program and dates

Proposals for 2013 – 2014
λ The MSc course will be conducted with English as the spoken language.

λ The course shall continue as a mixture of on-campus lectures and practical sessions (San Martino Hospital, Pavillion 4, Genoa, Italy) and personal student study conducted at home and on-line.

λ The on-campus meetings shall be conducted as three individual weeks, each week running from Monday afternoon (start 14.00) to Saturday lunchtime (13.00) inclusive.

λ Students shall be liable for hotel and flight expenses. The number of meetings will impact favourably on the cost of airfares. Hotel accommodation shall be at AC Hotel, Corso Europa, Genova. 2013 Dates for in-campus attendance. Each day shall run from 09.00 -17.00. Detailed programmes for each period of lectures and practical session shall be made public in advance.

λ February 2013 Mon 11th – Sat 16th
λ June 2013 Mon 10th – Sat 15th
λ October 2013 Mon 7th – Sat 12th

## Syllabus Overview

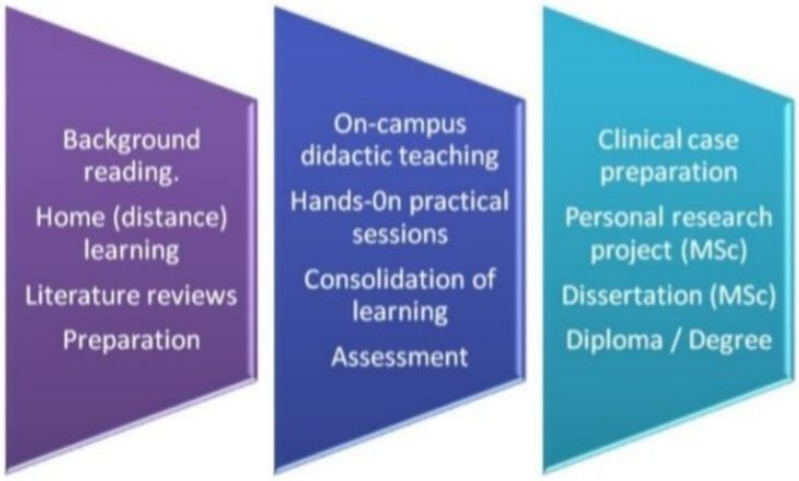
The two-year Master of Science (MSc) in Laser Dentistry is a composite structure to allow maximum flexibility for the student and integration into existing General Dental Practice.

Three essential areas of activity are recognised for qualification:

λ Home study: Background study, preparation and literature review.

λ On-campus: Commitment to receive didactic learning, hands-on learning and practice, clinical techniques teaching and evaluation, together with opportunity for consolidation of learning with faculty and mentors.

λ Individual projects: Clinical case preparation and presentation. Dissertation and thesis preparation and presentation, together with personal research project.




*Areas of teaching and learning for MSc programmes.*

Syllabus Overview
Syllabus - areas of study
λ The syllabus will be underpinned by a thorough knowledge and understanding of laser physics and laser – tissue interaction.

λ Additional core areas shall explore the phenomena of ablative and non-ablative uses and application of laser photonic energy.

λ With such basics, the wider applications of laser use in dentistry shall be considered.

λ At all times, the application of laser photonic energy shall be based on evidence and published research and considerable emphasis shall be placed on review of selected literature.

λ Students shall be expected to demonstrate clinical skills commensurate with the appropriate level of post-graduate study. Clinical case presentations shall form a core example of these skills.

λ The award of the MSc degree shall be based on the following:
(i) Attendance at each of the in-campus sessions throughout the period of the course.

(ii) Compilation and presentation of five clinical case studies of the student's choice, to display understanding and suitable use of laser photonic energy within a clinical setting.

(iii) Successful completion of a multiple-choice written examination at the end of the course.

(iv) Presentation of a personal thesis to reflect the student's understanding and research into a subject allied to laser use in dentistry.

The areas of activity are covered during year one to a level of detail and application consistent with a post-graduate diploma. These areas are covered in greater detail and reference during year two of the MSc course, together with additional areas such as research project and thesis.

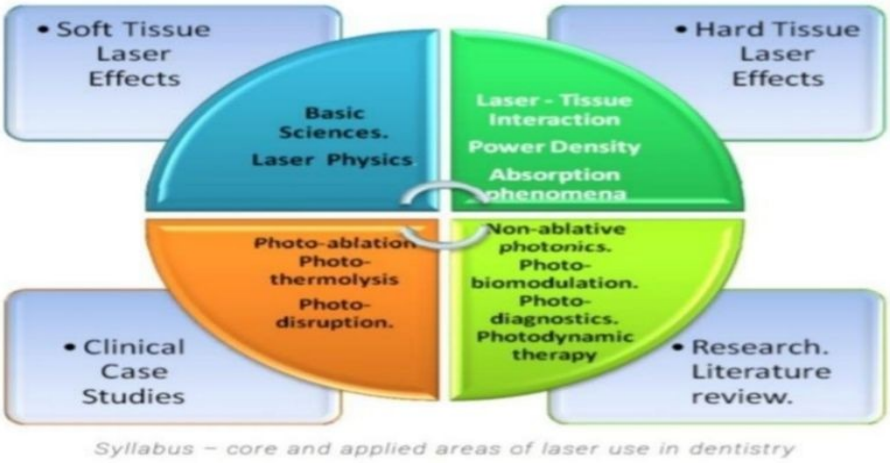
Syllabus Overview

Methods of Study
λ Part-time distance learning: The majority of the learning resources will be online. The programme will combine interactive distance learning, webinars, live learning and print to create an integrated learning programme, using the best of new media and technology. Addition requirements will be met through the presentation of oncampus course elements provided at the University of Genoa.

λ Ownership: The programme is designed to encourage the student to take responsibility for his/her own learning. The emphasis of the MSc degree is on a selfdirected approach to learning.

λ Resources: Students will have access to The University of Genoa's online library.

λ Methods of Assessment: Multiple choice questions administered after live/distance and interactive lectures and course elements are designed to appraise a level of learning consistent with expected outcomes. Documentation and pictures submitted for assessment for case studies shall be judged against the formatted assessment guidelines.



Syllabus – core and applied areas of laser use in dentistry

Foundations of Lasers in Medicine and Dentistry

Aim: This unit will provide a basis of theoretical knowledge of photonics, the electromagnetic spectrum and relationship between photon energy, wavelength and frequency.The development of theory into the production of machines capable of producing coherent laser photonic energy, together with examples of current laser use in dentistry.

Laser safety Aim: This unit provides a comprehensive review of regulatory and practical aspects of laser safety, reflecting both IEC and ANSI (USA) regulations.

Laser tissue interaction

Aim: This unit covers all aspects of interaction between a chosen laser wavelength and a target tissue element. The influence of emission modes and power density factors, together with parameters governing thermal change within the tissue will be demonstrated. Benefits and complications of laser-tissue interaction.

Low level laser use Aim: This unit provides knowledge of sub-ablative (non-surgical) laser photonic energy and its interaction with target tissue elements. The concept of photobiomodulation is explored and clinical use of low-level laser devices is demonstrated. Additionally, the use of non- ablative laser radiation in diagnostics is described, together with laser use in photodynamic therapy

Laser use with soft tissue

Aim: A comprehensive exploration of all laser wavelengths with target oral soft tissue elements. Emphasis to be placed on the benefits and drawbacks of laser use verses other surgical treatment modalities. Examples of clinical techniques, comparisons of wavelengths and expected outcomes of surgical procedures on para-dontal (fixed – ketartinised) soft tissue structures and non- dental, non-keratinised soft tissue structures in the oral cavity.

Laser use in periodontology

Aim: Overview of pathogenesis of periodontal disease. The use of surgical and nonsurgical lasers in the treatment of periodontal pathologies. Emphasis to be placed on the adjunctive role of lasers within accepted treatment modalities.

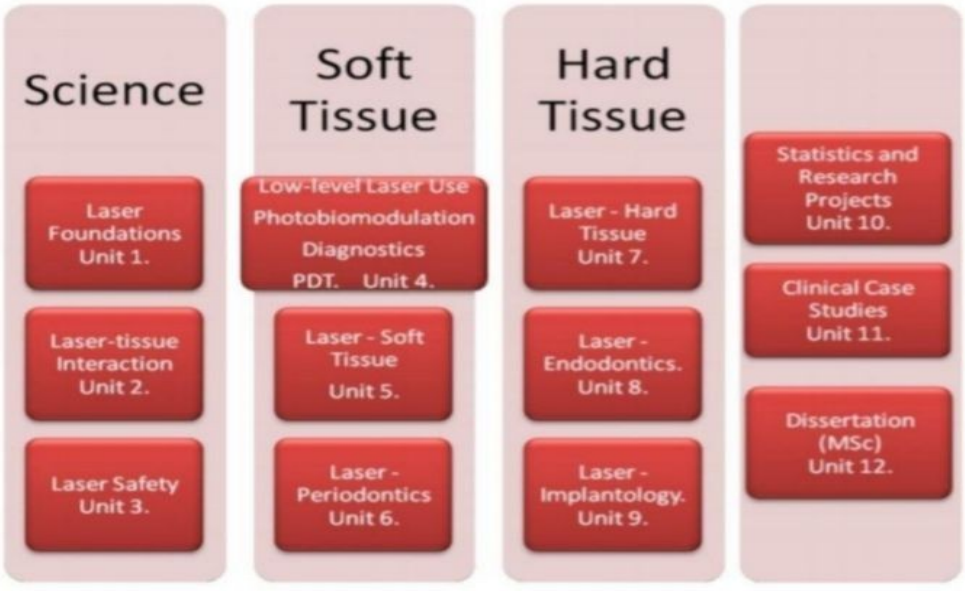
Laser use in endodontics

Aim: An overview of the pathogenesis of dentine hypersensitivity, pulpal pathology and peri-apical infection associated with the consequences of pulp death. The use of lasers in pulp flowmetry. The use of laser photonic energy in the physical preparation of the root canal, elimination of bacterial contamination and obturation techniques in endodontics. Emphasis to be given to the adjunctive use of laser radiation within accepted therapeutic protocols. The use of lasers in the treatment of apical pathology and open-flap peri-apical surgery.

Laser use with hard
tissue Aim: A comprehensive exploration of all laser wavelengths with target dental hard tissue and alveolar bone elements. Emphasis to be placed on the benefits and drawbacks of laser use verses other surgical treatment modalities.
Examples throughout of clinical techniques, comparisons of wavelengths and expected outcomes of surgical procedures. Exploration of integration of current restorative materials technology with adjunctive laser use in cavity preparation and restoration.

Laser use in implantology
Aim: An overview to be provided on the development and practical protocols associated with the placement of root-form osseointegrated dental implants. Consideration given as to the adjunctive use of lasers in the preparation of the osteotomy site and exposure of 2nd-stage implant recovery techniques. Pathogenesis of peri-implantitis and the possible use of surgical and low-level laser radiation in treatment modalities. Additional adjunctive use of in low-level photodynamic anti-bacterial chemotherapy in the treatment of peri-implantitis

Statistics Aim: This unit will aim to provide the student with a basic appreciation of statistical analysis and how it can be integrated into research techniques. An overview will be provided of current statistical methods and how they can be applied with mathematical examples. Students will be encouraged to complete example computations of analysis.




*Syllabus – core and applied areas of laser use in dentistry*

## Laser Dentistry MSc

A professional qualification for dentists, hygienists, and dental therapists designed to allow dental professionals to acquire evidence-based knowledge and application of lasers for use in clinical dental therapy.
This course is subject to final validation in February 2021

Entry criteria
A 2:2 honours degree or equivalent in a relevant subject area. Relevant degrees include but are not confined to a degree in Clinical Dentistry.

Applications are welcomed from mature candidates and those with relevant work experience and evidence of prior learning who do not meet the minimum entry requirements can apply and each application will be judged on an individual basis.

Applicants should demonstrate a clear interest in the course with explanation and evidence in the personal statement with a strong commitment to working in the field of Laser Dentistry.

## The course is structured through six modules:

Module #1 Laser Science Foundation. This module will address the development of theory into the production of machines capable of producing coherent laser photonic energy, together with examples of current laser use in dentistry. The module will provide a basis of theoretical knowledge of photonics, the electromagnetic spectrum and relationship between photon energy, wavelength and frequency.

Module #2 Lasers and Oral Soft Tissue Application. This module focuses upon laser use in oral soft tissue management and periodontology. Sub-ablative applications of lasers will include aspects of photobiomodulation (PBM), its effects with target tissue elements, and the adjunctive role of lasers in diagnostic techniques in clinical dentistry. Additionally, the use of non-ablative laser radiation in photodynamic therapy is explored. Emphasis to be placed on the benefits and drawbacks of laser use verses other surgical treatment modalities.

Module #3 Lasers and Oral Hard Tissue Application. This module will focus upon the use of lasers in oral hard tissue management, within endodontics and laser use in implantology. The module will provide a comprehensive exploration of all laser wavelengths with target dental hard tissue and alveolar bone elements. The module will explore the integration of current restorative materials technology with adjunctive laser use in cavity preparation and restoration.

An overview of the pathogenesis of dentine hypersensitivity, pulpal pathology and peri-apical infection associated with the consequences of pulp death will be examined

Module #4 Research Methods, Techniques and Statistics. Enhance student appreciation and skills of research methodologies, statistical analysis and how these are integrated into scientific research.

Module #5 Clinical Case Studies in Laser Dentistry. This module will bridge the gap between theoretical and practical aspects of laser dentistry. Students will be required to provide documentary evidence of clinical cases involving the adjunctive use of appropriate lasers in delivering dental treatment carried out in their day-to-day practice. Cases varying in degrees of complexity are to be presented. Cases will include details of patient assessment, diagnosis, and treatment plan, including details of the laser(s) used and treatment sequence, indications, contra-indications and precautions, including post treatment strategies and assessment of outcome and prognosis.

Module #6 Research Project: Lasers in Dentistry. Provides students with the opportunity to design, execute and report upon an original research problem in an area of laser dentistry. Students will work closely with a supervisor to formulate and design their research project. The project will develop the students' ability to relate research concepts to clinical settings.

## Programme Goals:

To teach the delegates how to put scientifically proven cutting-edge Laser techniques into practice to deliver great results.
Give the delegates confidence to take on simple and complex cases.
Help ease the delegate's transition into private practice.

## Programme Benefits:

Upon graduation, you will:

-Increase your income: up-skill now and give yourself the opportunity to generate more income. Performing just one extra treatment a month could mean that the course pays for itself!

-Improve your job prospects: secure a better, more varied job. Gain the confidence to open your own private practice and stop referring to high-value work elsewhere.

-Boost your confidence: our lecturers will teach you proven techniques to improve the quality of your results, reduce your failure rate and, increase your confidence to take on more complex work.

-Update your skills: keep up to date with cutting-edge techniques and advancements and become accustomed to new materials

# MASTERSHIP Diploma Lasers in Dentistry with Germany's RWTH Aachen University & Laser Center

INTRODUCTION

Lasers have been used in dentistry for diagnostic and therapeutic purposes for more than 30 years, and are an indispensable instrument in any modern dental surgery. The use of lasers enables new treatment methods to be employed and lasers can meaningfully supplement more traditional therapies.

The use of lasers is associated with minimal contact, reduced vibration and pain, as well as a reduction in bleeding, leading to a more comfortable overall experience for the patient and a cleaner, meticulous technique for the dental practitioner.

Lasers are highly versatile tools that can be successfully used in a wide range of applications in the treatment of mucous membranes, hard tooth structures and bones.
Additionally, the specific properties of lasers allow the development of radically new treatments and surgical techniques, and improvements in treatment success rates have been observed when lasers are applied.
Modern facilities and increased customer satisfaction help ensure the long-term financial success of any dental practice and, for these reasons, you should not miss the opportunity to expand and improve your range of treatments.

Lasers are primarily used in the following fields:

Diagnosis: Caries detection
Cariology: Caries removal, cavity preparation
Endodontics: Reduction of germs in root canal dentine
Implantology: Implant exposure, peri-implantitis therapy
Surgery: Soft tissue and bone surgery
Periodontology: Cleaning of the hard tissue surface and periodontal pockets
Cosmetic treatments: Bleaching Photobiomulation & Pain Therapy: Low Level Laser Therapy

PROGRAMME/S OF STUDY
Today, the use of lasers in dentistry has become a sought after new standard, part of daily clinical practice. The Mastership course by Aachen Dental Laser Center (AALZ) is a one-year career-accompanying clinical specialisation course in selected wavelengths in laser dentistry. The course addresses practicing and approbated dental professionals choosing to increase their knowledge to be highly qualified specialists in laser supported therapies in dentistry, and be abreast with the latest and most advanced technology in dentistry. Successful completion of the Mastership course can be combined with the full MSc. Degree in Aachen, Germany. The Mastership is available in South Africa, and now also Mauritius through SciVision to support their clientele (dental professionals) and is open to a limited number of local and international participants.

MASTERSHIP WAVELENGTHS
The following wavelengths are taught:
Er,Cr:YSGG and Er:YAG Lasers
Diode Lasers and Photodynamic Therapy (PDT)

COURSE STRUCTURE
The course is divided into four modules requiring 10-12 days of attendance over a one year period.

MODULE I
Laser Physics & Laser Safety including the Laser Safety Officer certification (in addition to the Mastership Certificate/Diploma)
Laser structure, function and handling: hands-on laser-tissue interactions

MODULE II
Er:YAG and Er,Cr:YSGG Lasers
Theoretical background, clinical indications, skill training and demo treatments
Biophysical background (absorption and transmission in various types of tissue)
Clinically important for e.g. periodontics, implantology, endodontics, hard and softtissue surgery, cavity preparation and cariology

MODULE III
Diode Lasers and Photodynamic Therapy (PDT)
Theoretical background, clinical indications, skill training and demo treatments
Communication and application of suitable indications
Clinically important for e.g. periodontics, implantology, endodontics and soft-tissue surgery

MODULE IV
Written examination
Presentation of five clinical treatment cases

FURTHER STUDY OPTIONS
Completion of the Mastership course may be credited towards modules three and five of the M.Sc. programme.

FURTHER DETAILS
The certificate/diploma "Mastership Laser Therapy in Dentistry" is taught, examined and awarded by the university of excellence, RWTH Aachen University, Aachen of Germany.

This programme with its specialty lecturers from Germany, including world-renowned Exec. Director of the World Federation of Laser Dentistry is brought to South Africa and Mauritius by SciVision Medical for the benefit of local and international dental practitioners and specialists, including lecturers from various universities globally, seeking to advance their curriculum. The course is strictly open to a limited number of delegates.

During the course, independent access is available to a modern e-learning environment, supported by scientific staff
The MSc. and Mastership Programs' Course Director, Prof. Dr. Norbert Gutknecht will conduct the Mastership lectures personally in South Africa alongside Physicist, Dr. rer. medic. Rene Franzen. Together, they take participants on a fascinating laser learning journey that will revolutionise their daily practice with the adjunct of lasers.

Completion of the Mastership course may be credited towards modules three (Erbium Lasers) and five (Diode Lasers, Photodynamic Therapy) of the full "Master of Science Lasers in Dentistry Degree" with RWTH Aachen University's Aachen Laser Centre (AALZ). The Mastership graduate may apply to upgrade to the 2-year module based MSc. Degree. Achievements will be recognised and the fellowship fees for the recognised modules will be deducted from the total MSc. fees. The program is internationally recognised, accredited in Germany and the European Union, as well all countries that are signatories of the "Washington Accord." View Course Brochure

Laser units can be available and loaned to participants without access to lasers to present the five clinical cases by the host, BIOLASE / SciVision in South Africa and Mauritius by special arrangement.

The course will have a total amount of 390 hours workload and 96 presence hours.

As a participant or graduate of a Mastership / MSc. Lasers in Dentistry programme, you may request to attend the exclusive graduation ceremony and dinner at the culmination of each class (South Africa / Mauritius) as a guest or alumni of the RWTH Aachen University. Please refer such enquiries to SciVision directly. Enquire

The prestigious Mastership course was first brought to South Africa in collaboration with the RWTH Aachen University in 2017, following by popular demand in 2018 and 2019. The course is scheduled to take place in Mauritius for the first time in October 2019 as another option for local and international dental practitioners.

Participation numbers are limited to 20 to preserve the standard of excellence of the programme. Participation in the course is confirmed with the registration fee of Euro 950 upon acceptance for a limited time on a first come, first served basis. Once the course is full, no more participants will be allowed, even in the case of receiving acceptance and failing to register in time. The registration fee is non-refundable and forms part of the total course fees for the year applied for.

-Use of different laser systems from leading manufacturers with all offered wavelengths during skill training and practical exercises
-Practical instructions on laser handling and subsequent practical use
-Live operations directly on a patient or via direct monitor transfer
-Provision of all necessary organic materials and suitable laser safety goggles for independent practice with lasers
-Carefully documented working material serves as a sound reference work for everyday practice
-Distribution of specialist literature allows immersion in the subject and supplements your personal technical library
-Training as a certified Laser Safety Officer is a part of the course
-Issuing of certificates with ECTS credit points for each successfully finished module
-Convenient learning environment due to own state-of-the-art seminar rooms
-Link-up to the scientific community: Participants attend international scientific congresses and are encouraged to issue in scientific publications
-Legalization (Apostille) of the Master Degree certificates for application abroad

Chapter 2

# LASERS IN DENTISTRY

2-1 introduction
2-2 types of dental LASERs
2-3 commonly used LASERs in dentistry
2-4 LASERs uses in various dental specialists.
2-5 advantages of LASERs
2-6 disadvantages of LASERs

# INTRODUCTION :

Lasers have provided a new cutting-edge technology to the dental world.
Incorporating lasers into conventional therapies helps in better prognosis and treatment outcomes.

Lasers began as alternatives for soft tissue oral surgery and have expanded into all aspects of dentistry: orthodontics, endodontics, oral and maxillofacial surgery, periodontics, aesthetic dentistry, restorative dentistry, prosthodontics, dental implantology, and pediatric dentistry. In addition, low level lasers can be used as adjuncts to treat chronic pathologies and within photodynamic therapy to treat infectious diseases

A dental laser can help you provide a higher level of care.
➢ In restorative dental procedures, management of soft tissue is simplifed because the tedious and painful placement of retraction cord can be eliminated.
Better impressions are possible for indirect restorations such as crowns and bridges, and clearer margins near the gingiva are revealed for optical scanning.
Class V carious lesions can be prepared at or near the subgingival level with excellent hemostasis

➢ Endodontic therapy can be aided by both laser debridement and pathogen reduction.
Examples of laser soft tissue excisions are numerous: a removal of fbrous tissue in an irritation fbroma and epulis in the soft tissues of patients wearing removable prosthodontic appliances, operculectomy treatment of an unerupted tooth, a frenectomy to prevent further adult periodontal problems, releasing a tongue tie in infants, and revising the frenum in a child's diastema to aid proper tooth positioning.

➢ Oral surgical procedures such as oral submucositis fbrosis, lichen planus, and leukoplakia can also be performed.

Lasers can also be used for aesthetic enhancement of the patient’s smile by minor recontouring of gingival tissue, laser tooth whitening, and removal of depigmentation in the soft tissues.

Osseous crown lengthening for treatment of altered passive eruption or to obtain adequate tooth structure for a restoration can proceed with the all-tissue lasers. During the initial alignment phase of orthodontic treatment, lowlevel laser therapy (LLLT) can be given to patient as it has shown to accelerate the tooth movement and also to relieve the discomfort that occurred during the initial arch-wire changes

same effect, also known as photobiomodulation, can be used in patients with bruxism, temporomandibular joint disease, acute abscess areas, and many more applications
One of the biggest hurdles while taking diagnostic records, impression making, or intraoral radiographs is gag reflex, which can be particularly strong in some patients.
Low-level lasers are a boon in such cases; using lower doses of laser energy helps in minimizing the reflex

## TYPES DENTAL LASERS :

***Non surgical***

• DIAGNOSTIC CARIES DETECTION LASER
• DOPPLER FLOWMETRY
• LOW LEVEL LASER THERAPY
• MISCELLANEOUS
• PAD (PHOTOACTIVATED DISINFECTION) LASER CURING LIGHT

***SURGICAL***

• HARDTISSUE Er:YAG Er,Cr:YSGG CO2
• SOFTTISSUE DIODE Nd:YAG CO2

## COMMONLY USED LASER IN DENTISTRY

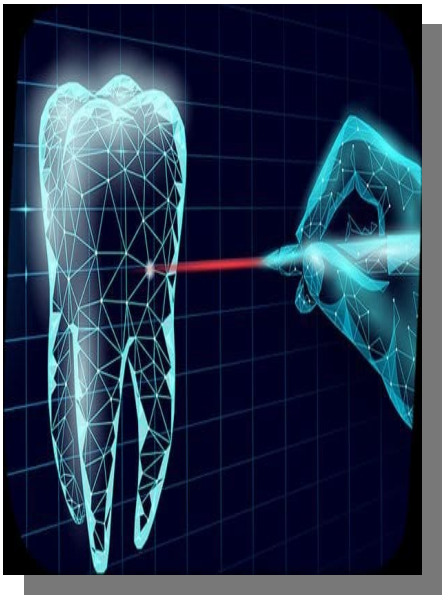
1. Carbon dioxide Lasers :Gas Lasers

***Advantages***

• Have high affinity for water, rapid soft tissue removal.
• Rapid hemostasis with shallow penetration.
• Generally used in surgical procedures both major and minor.
• Improves mechanical retention of sealant

***Disadvantages***

• Have the highest absorbance of any laser
• Large size, high cost
• Greater hard tissue destruction



2. Neodymium- Yttrium Aluminum Garnet Laser (Ne: YAG) : Solid state Lasers

***Advantages***

• Highly absorbed by pigmented tissues.
• Effective for cutting and coagulating dental soft tissues
• Good hemostasis
• Used in non-surgical sulcular debridement

***Disadvantages***

• High cost and size.

3. Erbium Laser: Solid state Lasers

***Advantages***

• Erbium wavelengths have a high affinity for hydroxyapatite and the highest absorption of water.
• Used for both soft and hard tissues

***Disadvantages***

• High cost.
• Marginally prolonged treatment time but better results.

4. Diode Lasers : Solid state Lasers

***Advantages***

• Engrossed primarily by tissue pigment (melanin) and hemoglobin.
• Used for soft tissue applications

***Disadvantages***

• Poorly absorbed by the hydroxyapatite and water present in the enamel

5. Argon Laser

• Yield high intensity visible blue light
• Curing of dental restorations
• It also changes the surface chemistry of both enamel and root surfaces dentine, which reduces the probability of recurrent caries.
• Removes extrinsic and intrinsic stains
• Bleaching of teeth.

6. Erbium: Chromium: Yttrium Scandium Gallium Garnet Laser (Er:Cr:YSGG)

• Etches enamel surface
• Removal smear layer

7. Erbium: Yttrium Aluminium Garnet Laser (Er:YAG)
• Removes dislodged GIC and Composite
• Remove caries in enamel and dentin
• Desensitize the hypersensitivity dentin

## LASERS USES IN VARIOUS DENTAL SPECIALISTS

### *A. Oral Surgery*

1. Surgery (major & minor)

2. Treatment of abscess
3. Aphthous ulcer
4. Hemostasis
5. Curettage
6. Epulis
7. Irritation fibroma
8. Gingivectomy prior to impression
9. Granuloma
10. Haemangioma
11. Removal of hyper plastic tissue
12. Bacterial reduction
13. Operculectomy
14. Flap surgery
15. Excisional biopsy
16. Retention cyst
17. Exposure of impacted teeth
18. Seeping haemorrhage
19. Sulcus preparation
20. Vestibuloplasty
21. Root end resection
22. Ankyloglossia

### *B. Periodontics*

1. Flap surgery
2. Frenectomy
3. Gingival contouring/ Gingivectomy
4. Pocket treatment
5. Bacterial reduction
6. Curettage
7. Pocket reduction
8. Operculectomy
9. Decontaminate membrane
10. Internal bevel incision

### *C.Orthodontics*

1. Bracket curing
2. Post orthodontic removal of residual cement
3. Exposure of impacted tooth

### *D. Paedodontics*

1. Removal of caries in deciduous teeth
2. Pulpotomy and Pulpectomy procedure

### *E. Endodontics*

1. Bleaching
2. Caries removal
3. Canal irrigation
4. Curing of cement
5. Removal of fractured restorations
6. Etching of the tooth
7. Root resection (Apexectomoy)
8. Smile design

### *F. Prosthodontics*

1. Sulcus deepening
2. Vestibuloplasty
3. Crown contouring
4. Crown lengthening
5. Smile design

## ADVANTAGES OF LASER

• No anesthesia, no drill
• Less blood loss, less pain hemostatic, analgesic effect.
• Reduce post –operative edema • Less post-op scarring.

## DISADVANTAGES OF LASER

• Laser beam could harm the patient or operator by direct beam or reflected light, causing retinal burns
• Laser  more expensive
• Need qualified personal
• Lasers can't be used
  - ➢ remove defective crowns or silver filling
    fill cavities located between teeth
  - ➢ prepare teeth for bridges

*Chapter 3*

# LASERS IN SOFT TISSUES SURGERIES

**3-1 Introduction**
**3-2 Frenectomy**
**3-3 Internal insertion**
**3-4 Labial frenum**
**3-5 Lingual frenum**
**3-6 Ulectomy/ulotomy**

# Introduction :

One of the first lasers to be used for soft tissue surgery in medi- cine was the CO2 laser.
Since 1970, this laser has also been used for oral tissue surgery and was approved for this purpose by the US Food and Drug Administration (FDA) in 1976.

The CO2 laser emits light of wavelength 10600 nm and may operate in the pulsed or continuous mode. It is highly absorbed by the water in oral tissues, which results in precise and local- ized tissue removal. It is used in various soft tissue treatments: crown augmentation, treatment of ulcers (aphthas), frenectomy and gingivectomy, and re-epithelialization of gingival tissue during periodontal treatment.

The characteristics of the CO2 laser allow good hemostasis, rapid and efficient tissue removal, and good healin
The Nd:YAG laser emits light in the near-infrared range (1064 nm) and operates in the pulsed mode.
It acts on tissue by coagulation and vaporization and has various applications in dentistry: endodontics, periodontics, preventive dentistry, and surgery.

The Nd:YAG laser makes it possible to use a minimally invasive technique in dentistry and in procedures involving soft tissues.
It is capable of penetrating deeply into the target tissue.
As is the case with the Nd:YAG laser, the Argon laser has great coagulation and vaporization capacity for tissues rich in hemo- globin and melanin, and emits in the range between 457 and 502 nm in pulsed or continuous mode. However, it has superficial cutting capacity, reducing its use in oral surgery.
In dentistry, its use is related to dental bleaching and resin polymerization.

The diode laser (high power) is a semiconductor that emits light between 805 and 980 nm.
It may be used in continuous or pulsed mode, and in contact or not in contact with tissue.
The wavelength of the diode laser (high power) is highly absorbed by pigmented tissues (melanin) and little absorbed by hydroxyapa- tite and bone.
Various studies with the diode laser (high power) have demonstrated good efficiency in soft tissue surgeries, such as frenectomies, hyperplasias, and gingivectomies.

# Frenectomy

In dentistry, the labial frenum becomes a problem if it is inserted very close to the gingival margin.
The tension on the frenum in this region may cause traction on the gingival margin and retract it, leading to exposure of the tooth root.

This condition may increase biofilm accumulation and make it difficult to clean in the cervical region. In this case, surgical removal must be performed if there is gingival retraction, in order to prevent periodontal problems, and when the frenum causes diastemas, making it difficult to perform orthodontic, phonoaudiological, prosthetic, and esthetic treatments.

It is important to evaluate the radiographic exam, in order to eliminate the possibility of the presence of supernumerary teeth, or absence of union of the maxillary processes, which are contraindications to frenectomy Frenums may be classified according to their insertion:
- Mucosal insertion: situated on the mucogingival line (causes no problems);
- Gingival insertion: situated on the inserted gingiva;
- Papillary insertion: when there is traction, this causes ischemia in the papillary region.

During the procedure, the papilla must be preserved

## *Interdental insertion*

The attachment of the frenum passes right up to the papilla, inserting in attached gingiva.
This is the cause of severe ischemia.
Frenectomy or frenulectomy basically consists of the complete removal of the frenum insertion, which is very fibrous and close to the gingival margin, resulting in traction and retraction of this margin, which may lead to progressive localized recession.

The insertion of a prominent frenum is associated with a narrow zone of attached gingiva.
Another technique used is frenotomy or frenulotomy, with the purpose of partial removal of the frenum in order to move its insertion more into the apical direction, without inter- fering with the papilla, so that the final result is more esthetic.

## *Labial frenum*

One technique used for removal of the labial frenum is the con- ventional type the precursor of all the other techniques.
This is performed with a scalpel handle and blade, and the labial frenum is removed by means of an incision.
This is the most commonly used technique, followed by the technique using an electric scalpel or electric cautery, which cuts tissue by means of electrically heating the bladeshaped tip of the appliance. The use of high power laser in soft tissue surgeries has demonstrated favorable results and is well accepted because of its efficiency, incisive power, ablation, and good clinical and biological responses, and it has been used for labial frenum removal

## *Lingual frenum*

The frenum of the tongue is made up of conjunctive tissue rich in collagen and elastic fibers, fatty cells, some muscle fibers, and blood vessels.
These tissues are covered by stratified pavimentous epithelial tissue.
Ankyloglossia is a developmental anomaly characterized by a short, thick lingual frenum, which limits movements of the tongue. In patients with a normal frenum, it has been observed that orofacial functions and the mobility of the tongue are better if the frenum insertion is


short or anteriorized. It has also been observed that when it is short, the tip of the tongue is elevated and in general, this elevation raises the floor of the mouth or the mandible.
In addition, short frenums are thicker than other types.
In a phonoaudiological evaluation, a partially or completely united lingual frenum will determine the treatment: surgical frenuloplasty for the partial or complete removal of the frenum from the tongue.

# ***Ulectomy/ulotomy***

The periods of tooth eruption, in general, differ among populations and geographical areas, as they may be influenced by several factors, such as environmental conditions, socioeconomic level, race, gender, and local disturbances, such as gingival fibrosis and eruption cysts.

Gingival fibrosis is caused by friction of foods during mastication, and occurs more frequently on the maxillary central incisor due to premature exfoliation or early loss of primary teeth.

The dentist may perform an ulectomy, which consists of excision of the tissues that line the incisal or occlusal face of the tooth crown of an unerupted primary or permanent tooth.
The aim of this procedure is to facilitate the eruption of the tooth.

For a precise indication of the surgical technique, meticulous clinical and radiographic examination of the region is required.
Once ulectomy has been indicated, it must be performed immediately, because postponement of the surgery may lead to closure of the space, due to inclination of the neighboring teeth, which will prevent later orthodontic treatment to recover the lost space .

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AT THE UNIVERSITY OF GENOA (GENOA, FEBRUARY 2013 - NOVEMBER 2014)

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