Lasers : Redefining the Art & Science of Dentistry (Part I)

Vipul Srivastava[1], Shally Mahajan[2]

Professor[1], MDS
Endodontics & Conservative Dentistry, Advanced Proficiency in Laser Dentistry (ALD, USA)
Masters in Laser Dentistry (Vienna)
Vipul13@gmail.com
Private Practitioner, 32 Pearls Multispecialty Dental Clinic, Lucknow

Professor[2], Department of Dentistry, Dr. RMLIMS
drshally23@gmail.com

Access this article online

Website: *www.healtalk.in*

DOI: *10.6681/zenodo.72069966*

Quick Response Code:

Abstract

Lasers is a light that has specific properties which are useful in medical and dental field. Whenever we talk about any equipment or treatment in particular say braces or aligners, it is pertaining to orthodontic specialty, a scaler, it relates to periodontics BUT rarely do we ever come across an equipment that is having multidimensional implementation. This series of articles is an attempt to write a technology, that is LASERS which has applications in every stream of dentistry.

Keywords: Diode Lasers, Photo biomodulation, Dental phobia

INTRODUCTION

Throughout history, visiting a dentist has always been one of the most common and real fears. Many of our patients including us too, in spite of many technical advancements, still have the phobia of visiting a dentist. Though science and research have really made our lives easy like changes in the way we work, armamentarium we use, digital dentistry etc, but the sight of blood and fear of a dentist has always ruled the minds of a common man.

The term Laser is an acronym for 'Light Amplification by the Stimulated Emission of Radiation'.Laser is a device that amplifies or increases the intensity of light and produces highly directional light. Lasers have provided a cutting edge to modern dentistry. It is a technology that provides painless and minimum invasive dentistry achievable which is aspired by every dentist. One of the challenges for many new as well as experienced laser users is to acquire and maintain the knowledge to use their laser in a way to achieved best results. The current article will talk about the historical background of Lasers.

HISTORY

Light has always fascinated humans since the earliest of the days and their significance is deeply embedded in our history. The therapeutic use of light was a well-known fact amongst the in ancient civilizations. Many evidences are available where light has been used to cure. The Babylonians and Assyrians, for instance, encouraged sunbathing to aid in the healing process. Ancient Greece had a city, Helipolis which meant "City of the Sun. The first sentence of the Hippocratic oath recognizes Apollo, the god of light, and Hippocrates himself was the first to document the therapeutic nature of sunlight.

In1880, light therapy was being used to relieve people suffering from mental health disorders, as well as a forerunner for the cure of tuberculosis and certain skin conditions. Ancient Egyptians, Chinese, and Indians used light to treat rickets, psoriasis, skin cancer, and even psychosis.[1] Going to the historical review, Albert Einstein in the year 1917, who for the first time postulated the theory of Stimulated Emission. This theory laid the foundation of Lasers and soon after there were many researches carried for the efficient use of this technology in medical and dental field. In 1940, Russian physicist Valentin A. Fabrikant suggested that stimulated emission in a gas discharge might amplify light under suitable conditions but somehow he could not continue with the study.[2]

After World War II, Willis Lamb, Jr., and R. C. Retherford realized that nuclear magnetic resonance could produce population inversions.[3]

How to cite this article: Srivastava et al.: Lasers : Redefining the Art & Science of Dentistry (Part I) , HTAJOCD.2023;Jan-Feb(3):32-34

In 1951, Charles H. Townes took the next conceptual step, suggesting that stimulated emission at microwave frequencies could oscillate in a resonant cavity, producing coherent output. In 1954, Townes and his student James Gordon demonstrated the first microwave maser,

Theodore H Maiman, an American engineer and Physicistbegan investigating ruby at Hughes Research Laboratories on its applications on teeth. And in the year 1960, he announced his invention, the first Laser, a synthetic ruby laser to the world **(Fig 1)**. It was a very simple device which was by slipping a small ruby rod inside the coil of a photographic flashlamp, and enclosing the assembly in a reflective cylinder, and intense pump light was focused into the ruby rod.

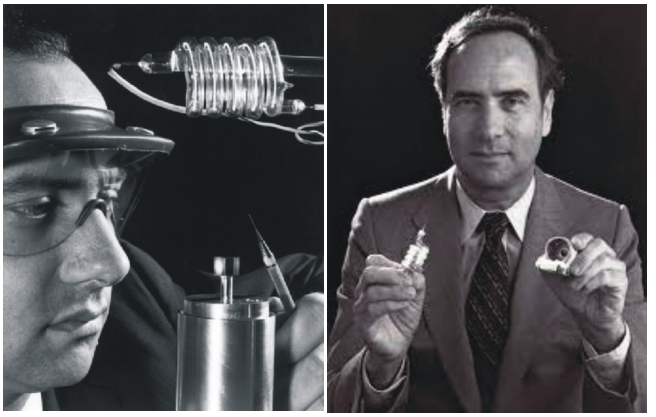

Figure 1: Theodore Maiman with Ruby Laser

The invention of Ruby lasers inspired many companies both old and new were quick to get into the laser market and many investigators for doing contract research and development

Many notable works were published like in 1964, Ralph Stern and Reidar Sognnaes, used the ruby laser to vaporise enamel and dentine. They reported glass like fusion and catering of enamel when subjected to 500- 200J/cm2 of laser energy along with charring of dentine[4]

In 1965 Goldmana physician at the University of Cincinnati, along with his colleagues conducted an invitro use of ruby laser where for the first time he subjected a vital tooth to laser energy. He observed, thepatient experienced no pain and had only minor, superficial damage to the crown of the tooth.But ruby lasers soon lost its popularity as it needed very high energy therefore the heat generated was reported to cause severe thermal damage to the pulp and collateral damage to the adjacent tissues due to scattered radiation. So, the ruby was abandoned by the end of the decade.[5]

Patel in the same year developed the CO2 lasers at Bell Laboratories whichhad the ability to be absorbed by water. This laser was perhaps the first laser that truly had both hard tissue and soft tissue applications. In 1969 Leon Goldman used the laser clinically on enamel and dentine.However these gas based lasers could not be delivered through optic fiber due to its large wave length that did not fit into the crystalline molecules of the conducting glass and has to be conducted either by a hollow wave guide or an articulate arm delivery system.

In 1962, Robert N. Hall demonstrated the firstlaser diode laser, which was made of gallium arsenide and emitted in the near infra red band of the spectrum at 850 nm. Later that year, Nick Holonyak, Jr. demonstrated the first semiconductor laser with a visible emission.

The Nd:YAG laser was developed in 1964 by Bell Telephone Laboratories for soft tissue procedure as well as inhibition of caries. Though Nd:YAG Lasers where discovered a year before CO2 lasers, it was largely overshadowed for a long time by the ruby laser and later by various other inventions going on at that time. It was not until 1990 that Nd:YAG laser was available for dental use.[6]

By the early 1980s, research on hard-tissue applications for the dental laser started, with research focused mainly on soft-tissue oral surgery.

The work of Myers and Myers in the mid-1980s spurred interest in hard-tissue applications of the Nd:YAG; by the early 1990s, this wavelength (1064 nm) was found to be useful for minor hard-tissue removal. The search continued to find a wavelength that was well-absorbed in hydroxyapatite, without penetration or damage to pulpal tissue.[7]

In 1988, Paghdiwala were the first to describe in detail the effect of the Er:YAG laser on dental hard tissues. Tests demonstrated that successful "drilling" of holes in enamel and dentin, without water, did not produce cracking, charring, or significant temperature rise in the pulp.[8]

However it was in the year 1997, the Er:YAG laser obtained clearance for marketing for use on enamel and dentin by the Food and Drug Administration. And since then there has been no looking back on the various applications of lasers in dental practice for several oral uses, including removal of caries, enamel, dentin, cement, composite, and glass ionomer. Hibst and Keller assessed the Er:YAG laser for selective ablation of caries with negligible effects on adjacent hard and soft tissues.[9,10]

This technology is becoming the standard of care for many dental cavity preparations and the treatment of choice by many patients.

Figure 2: Co2 Laser

Nowadays, diode lasers are extensively used in the field of dentistry for doing soft tissue procedures. They are compact, portable, self contained and allows operator to adjust multiple soft tissue procedure settings.

While the high power surgical lasers such as CO2 **(Fig 2)**, Nd:YAG and Er:YAG lasers **(Fig 3)** have an accepted place in the armamentarium of dental practice, diode lasers **(Fig 4)** with different wavelengths and parameters arealso having a global impact on the scope as well as the outcome of treatments being provided.

Figure 3: Er:Yag Laser with Nd:Yag laser

Figure 4: Diode Laser

Another category of therapeutic lasers generally operate in the visible and the infrared spectrum are known as "Low level lasers". They are also called as biomodulation or biostimulation as they tcan not only stimulate, but also suppress biological processes.

REFERENCES

1. Daniell MD, Hill JS: A history of photodynamic therapy, Aust NZ J Surg 61(5):340–348, 1991.
2. A. Fabrikant, "Emission mechanism of a gas discharge," Trudy VEL 41, 236 1940; reprinted in English in V. A. Fabrikant, Selected Works p. 133, privately printed, Moscow 2007.
3. W. E. Lamb Jr. and R. C. Retherford, "Fine structure of the hydrogen atom, part I," Phys. Rev. 79, 549–572 1950.
4. Stern RH, Sognnaes RF. Laser beam effect on dental hard tissues. J Dent Res 1964;43:873
5. Goldman L, Gray JA, Goldman J, Goldman B, Meyer R. Effect of laser beam impacts on teeth. . J Am Dent Assoc 1965;70:601-606
6. Yamamoto H, Sato K. Prevention of dental caries by acousto-optically Q-switched Nd: YAG laser irradiation. J Dent Res 1980;59(2):137.
7. Myers TD, Myers WD: In vivo caries removal utilizing the Nd:YAG laser. J Mich Dent Assoc 1985; 67:66-69.
8. Paghdiwala AF: Application of the Erbium: YAG laser in hard dental tissues: Measurement of the temperature changes and depths of cut. In: Profio AE (ed): Laser Research in Medicine, Dentistry and Surgery, ICALEO'88. Santa Clara, CA, Laser Institute of America 1988; 192-201.
9. Keller U, Hibst R: Tooth pulp reaction following Er:YAG laser application. In: O'Brien SJ, Dederich DN, Wigdor H. et al (eds): Lasers in Orthopedic, Dental, and Veterinary Medicine. Los Angeles, Proceedings of the International Society for Optical Engineering (SPIE) held in Bellingham, WA 1991; 127-133.
10. Wigdor H, Abt E, Ashrafi S, et al: The effect of lasers in dental hard tissues. J Am Dent Assoc 1993; 124:65-70.