Review Article

PLASMA THERAPY IN DENTISTRY

Ramandeep Singh [1], Hemant Sawhney [2], Mun Bhawni Bagga [3], Garima Yeluri [4]
Reader[1,2,3,4]
1-Department of Oral Medicine, Diagnosis & Radiology,Dasmesh Institute of Research & Dental Sciences, Faridkot
2-Department of Oral Medicine, Diagnosis & Radiology, School of Dental Sciences, Sharda University, Greater Noida, UP
3-Department of Oral Medicine Diagnosis & Radiology, MN DAV Dental College and Hospital, Tatul, Solan (H P)
4-Department of Oral medicine and radiology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad

Abstract
Plasma is the fourth state of matter after solid, liquid and gas. Due to its antimicrobial property, non-inflammatory tissue modification and cell death properties on cells, it has gained its importance in dentistry. Types of plasma which exist are thermal and non-thermal or cold atmospheric plasma. Cold Atmospheric Plasma is less than 104°F at the point of application and is applicable in almost all branches of dentistry. In future plasma technology can become a valuable tool in dentistry. This article focuses an overview of biomedical and dental applications of Plasma therapy.
Keywords: Plasma, Cold atmospheric plasma, matter.

Introduction

Sir William Crookes, a British physicist found the fourth state of matter in 1879 and was termed "plasma" by Irving Langmuir in 1929. Plasma is a collection of stripped particles. When electrons are stripped from atoms and molecules, they become plasma. Plasmas are normally energetic because stripping of electrons takes continuous energy. If the energy profligates, the electrons reattach themselves and plasma particles gets converted into gaseous state.[1]

Physical plasma is a gas in which few of the particles are present in ionized form. This is achieved by heating a gas which breaks the molecular bonds and subsequently ionization of the free atoms. Thus, plasma is composed of positively and negatively charged ions and electrons as well as radicals, neutral and excited atoms and molecules.[2]

Mostly, plasma are not easy to test because they are extremely hot and difficult to manipulate. Among the two types of plasma: thermal and non-thermal or cold atmospheric plasma, thermal plasma has electrons and heavy particles (neutral and ions) at the same temperature. Cold Atmospheric Plasma (CAP) is called non-thermal because it has electron at a hotter temperature than the heavy particles that are at room temperature. CAP is a specific type of plasma that is less than 104°F at the point of application and holds promising results in Dentistry and Biomedicine.[3]

Plasma Therapy in Biomedicine

As far as the areas concerned about biomedical application the plasma therapy acts directly on the body tissues and participate in the discharge generation process. Plasma therapy plays an important role in wound sterilization, wound healing and cancer cells as follows:

Wound sterilization

Laroussi et al showed that after exposure to plasma E.coli bacterial cells undergo severe morphological changes like degeneration and lysis of cell organelles leading to cell death. They further hypothesized that damage to cell occurs by membrane rupture and charge build up on the cells by chemical attack of free radicals.[4]

Wound Healing

Low temperature Dilectric barrier discharge plasma significantly accelerates blood coagulation and leaves the adjacent tissue intact. It has been observed that during blood donation from a healthy donor the complete blood coagulation can be achieved in 1 minute with plasma therapy. Also in treatment of venous and arterial trophic ulcers plasma therapy helps in cleansing of ulcers by removing necrosis and granulation tissue which further aids in healing of ulcers. Therefore the duration of complete healing decreases by factor of 2.5 with use of plasma therapy.[4&5]

Cancer cells

Plasma therapy is very effective in treatment of melanoma cells. The low power Dilectric barrier discharge plasma does not cause direct cell destruction of the cancer cells, however it initiates apoptosis of cancer cells.[4] The melanoma cells were cultured in a culture media in petri dish. The solution was exposed to low power Dilectric barrier discharge of plasma for 5 seconds. After 72 hours, the amount of dead cells was 72.8 % and 3.2% respectively.Using the selectivity of the plasma treatment, one can find treatment conditions at which only cancerous cells will decay via apoptosis, whereas healthy will remain undamaged.[6]

Plasma Therapy in Dentistry

Sterilization: Plasma can treat and sterilize irregular surfaces; hence they are very suitable for decontaminating dental cavities without drilling. The mechanism of plasma sterilization is related to the amplitude of its reactive oxygen species, ions and electrons, and UV and EM fields.[7] Risk of prion transmission through surgical instruments is of public and professional concern. Prion diseases are those fatal diseases, which in humans include familial, sporadic and acquired Creutzfeldt- Jakob Disease (CJD), which is characterized by accumulation of an abnormal prion protein (PrPSc) in CNS. Use of gas plasma decontamination of surgical instruments reduces the absolute amount of proteinaceous materials that may be passed on to the patients when endodontic file are reused.[8] Yang Hong Li et al. stated that plasma sterilization, with the advantage of low temperature, fastness, safety, overcomes the deficiency of the traditional method of sterilization, and becomes a novel method for killing microbe.[9]

Lu et al., used a authentic and comprehensive plasma-jet device that could generate plasma inside the root canal. The plasma can be contacted by bare hands and placed manually into root canal for disinfection without causing any pain. When He/O2 (20%) is used as working gas, the spinning and vibrational temperatures are approximately 300 K and 2700 K, respectively. The peak discharge current is about 10 mA. Preperatory experiment results showed that it can effectively kill Enterococcus faecalis that causes failure of RCT in several minutes. Pan et al. investigated the reliability of using cold plasma for the treatment of a root canal infected with Enterococcus faecalis biofilms in-vitro and concluded that the cold plasma effectively disinfects dental root canal in vitro.[10]

Intraoral Diseases Oral candidiasis includes denture stomatitis, angular stomatitis, median rhomboid glossitis, and linear gingival erythema. Koban et al. and Yamazaki et al. reported the high efficiency of plasma in sterilization of Candida albicans and concluded that stomatitis caused by Candida albicans can be cured by plasma jets.[11]

Use of Plasma in Composite Restorations: Initially it was also shown that plasma treatment increases bonding strength at the dentin-composite interface approximately by 60%, and with that interface-bonding strength remarkably improves composite performance, durability, and longevity. Kong et al. investigated the plasma treatment effects on dental composite restoration to enhance interface properties and stated that atmospheric cold plasma brush (ACPB) treatment can improve the dentin surface increasing the dentin/adhesive interfacial bonding. The solution is to introduce bonds that depend on surface chemistry rather than surface porosity.[12]

Plasma In Tooth Bleaching

A non thermal, atmospheric pressure, helium plasma jet device was introduced to enhance the tooth bleaching effect of hydrogen peroxide. Combining plasma and has improved the bleaching efficacy by a factor of 3 as compared with using H 2O 2 solely. Tooth surface proteins were noticeably removed by plasma treatment. When a piece of tooth was added to H 2O 2 solution as a catalyst, production of OH after plasma treatment was 1.9 times greater than using H 2O 2 alone. It is suggested that the improvement in tooth bleaching induced by plasma is due to removal of tooth surface proteins and increased OH production.[13]

Advantages of Plasma Therapy [14-15]

1. Noiseless procedure
2. Dental procedures can be performed without shots and pain
3. Safe to use, as the flame is cool to touch without a feeling of warmth or touch.
4. Being superior to lasers, it operates at room temperature and does'nt cause bulk destruction of the tissue

Disadvantages of Plasma Therapy [16]

1. Highly sensitive
2. It does not work well where amalgam restoration is present in the oral cavity
3. Expenses for the equipment, marketing, maintenance and availability are also some of the drawbacks.
4. Plasma needle technology in the long run will prove its applicability in the days to come

Conclusion

Based on the above evidence, we can say that plasma therapy has a bright future in dentistry due to its antimicrobial properties and its cell death properties on cells. Studies showed promising results in tooth bleaching, deactivation of biofilms in teeth, instrument sterilization, and in composite restoration. Further studies are required to prove its efficacy and applicability in dentistry.

References

1. Raizer YP. Gas Discharge Physics. Springer, Berlin, Germany; 1997.
2. Conrads H, Schmidt M. Plasma generation and plasma sources. Plasma Sources Science and Technology. 2000;9:441-54.
3. Laroussi M. The biomedical application of plasma: Journal of Clinical and Diagnostic Research. 2014 Jun, Vol-8(6): ZE07-ZE10.
4. Vasilets VN, Gutsol A, Shekter AB, Fridman A. Preliminary reports from the 5th International symposium on Theoretical and applied plasma chemistry sep3rd 2008.
5. Laroussi M. Transactions on plasma. Science 2009;37:6-9.
6. Fridman G. Shereshevsky A. Jost M. Brooks A, Fridman A, Gutsol A. Plasma Chemistry.Plasma Process 2007;27:163.
7. Louroussi M (2005) Low Temperature Plasma-Based Sterilization: Overview and State-of-the-Art. Plasma Process Polym 2: 391-400.
8. Whittaker AG. Graham EM, Baxter RL Jones AC,Richardson PR, Meek G et al. Plasma cleaning of dental instruments. Journal of Hospital infection 2004;56:37-41.
9. YangHong L, Liu S, Hu T (2013) Application of low-temperature plasma in dental clinical sterilization. Foreign Med Sci Stomatol 40: 483-485.
10. Ohl A, Schröder K. Plasma assisted surface modification of biointerfaces. In: Hippler R, Kersten H, Schmidt M & Schoenbach KH. Low temperature plasma physics: Fundamental aspects and applications. Wiley-VCH, Weinheim, Germany; 2008.
11. Koban I, Matthes R, Hu¨bner NO, Welk A, Meisel P, et al. (2010) Treatment of Candida albicans biofilms with low-temperature plasma induced by dielectric barrier discharge and atmospheric pressure plasma jet. New J Phys 12: 073039.
12. Kong MG, Kroesen G, Morfill G, Nosenko T, Shimizu T. Plasma medicine: an introductory review. New J Phys. 2011;11:11-12.
13. Lee H W, Kim G J, Kim J M, Park J K, Lee J K and Kim G C, Tooth bleaching with nonthermal atmospheric pressure plasma. J Endod. 2009; 35:587–91.
14. Smitha T, Chaitanya Babu N. Plasma in Dentistry: An update. IJDA. 2010; 2:210-14.
15. Xinpei Lu, Yinguang Cao, Ping Yang, Qing Xiong, Zilan Xiong, Yubin Xian, et al. An RC plasma device for sterilization of root canal of teeth. Plasma Sci. 2009;37:668–7.
16. Somya Govil, Vishesh Gupta, Shobhit Pradhan. Plasma needle: The future of Dentistry. Indian Journal of Basic & Applied Medical Research. 2012;2:143-7.

Corresponding Author

Garima Yeluri
Reader
Department of Oral Medicine & Radiology
Teerthanker Mahaveer Dental College and Research Centre, Moradabad.
Email: garimay81@gmail.com

How to Cite this article: Singh R, Sawhney H, Bhawni M,Bagga,Yeluri G.Plasma Theraphy in Dentistry.TMU J Dent 2017;4:11-12.