



EMERGING TECHNOLOGY AND NOVEL WAY OF RESTORING DENTAL IMPLANTS- NASA'S GLENN RESEARCH CENTER INNOVATION

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INTRODUCTION

Dental implants have been used to replace missing teeth for more than half a century. They are considered to be an important contribution to dentistry as they have revolutionized the way by which missing teeth are replaced with a high success rate. This success depends on the ability of the implant material to integrate with the surrounding tissue(1). Implant failure occurs because of patients systemic health, unskilled surgical hands and unsterilized implant surface(2). Atomic oxygen can be used to remove biologically active contaminants from surgical implants. Even with modern sterilization practices, it is difficult to remove all debris and bacterial cells from the implants. Atomic oxygen cleans the implant and removes all traces of organic materials, which greatly diminishes the risk of post-operative inflammation. This leads to better results for patients who require surgical implants.

Contamination Of Dental Implants

Dental implants can get contaminated due to the ecological system in the oral cavity with abundant microorganisms . Common elemental contamination from organic carbon and traces of elements including oxygen (O), nitrogen (N), calcium (Ca) and phosphorus (P) found on dental implant surfaces are potentially linked to failure in re-osseo integration when parts of an implant had lost its osseo integration .

It has been shown re-osseo integration occurs when there is a formation of a direct structural and functional union between an implant and bone, it has been shown that properly cleaned implants indeed may re-osseo integrate .

Currently, a growing amount of evidence suggests that the implant surface topography and chemistry has great influence on the osseo integration process by affecting protein signalling and cell migration or differentiation. Bone-implant contact area, mechanical interlocking and stress distribution are recognisably better in surfaces with a certain degree of roughness in comparison to smooth ones, favouring osteoblast-like cell colonisation . (3)

Inorganic metal oxide such as titanium oxide (TiO2) and its alloys are commonly used in dental implants due to its favourable biocompatibility and mechanical properties. The ability of the oxide layer of titanium (Ti) to withstand the corrosion in saline and acidic environment make it an excellent implant material increasing the chance of re-osseointegration .

However, after long term interaction with living tissue, the TiO2 will release small amounts of corrosion products and lead to dental implant contamination . Corrosion due to bodily fluids can cause changes in material structure and release of unwanted inflammatory by-products, and compromise implant's mechanical stability . Dental implants may also be contaminated when they are marketed, i.e. prior to any

contamination from the oral cavity. Therefore, there is a possibility that contaminations may also depend on other matters than biological in situ effects. Therefore, sterile packaged medical devices must be periodically reviewed and documented by the manufactures that the implants are free of surface impurities .

Another cause of dental implant contamination is galvanic corrosion. This is an electrochemical process that occurs when electrons can flow freely between two different materials with sufficiently different electrical potentials.

The key circumstances that could influence the initial healing phase of the implant site and the survival rate of dental implants are the surgical factors, the time of implant surgery, site of implant placement, type of implant osteotomy, implant design and implant stability.

These factors heavily influence the probability of exposure to contaminants. These contaminants may cause dental implants to fail in their function to restore missing teeth.

Methods Of Decontamination Of Dental Implants

The various methods of decontamination of infected implant surfaces—mechanical methods and chemical agents(4), as well as newer techniques such as photodynamic therapy (PDT) and laser and an novel approach using atomic oxygen.

Duarte et al (2009)	Titanium disks with smooth machined surfaces and SAE surfaces	1. Er:YAG laser 2. Metal curette 3. Plastic curette 4. Airborne particle-abrasion system (sodium bicarbonate)
Goncalves et al (2009)	Titanium implants with machined surfaces, surfaces sandblasted with titanium oxide (TiO2), and SAE surfaces	1. 980-nm GaAlAs laser 2. 1,064-nm Nd:YAG laser
Quaranta et al (2009)	Titanium implants with machined surfaces, TPS implants, and SAE implants	Er:YAG laser
Giannelli et al (2009)	Titanium disks cut from dental implants (Bicon)	Nd:YAG laser
Schwarz et al (2006)	SAE titanium disks worn as intraoral splints for 24 h	Er,Cr:YSGG laser
Park et al (2005)	Titanium surface (smooth) and coated with resorbable blast material	Nd:YAG and CO2 lasers

Schwarz et al (2005)	Acrylic resin splints with SAE titanium disks worn for 24 h	1. Er:YAG laser 2. Ultrasonic system 3. Plastic curettes and rinsing with chlorhexidine digluconate 4. Unworn titanium disks
Pereira da Silva et al (2005)	Machined titanium sheets and titanium sheets blasted with aluminum oxide	High-pressure sodium bicarbonate device (Dentsply Prophyjet)
Schwarz et al (2003)	Explanted titanium SAE implants	Er:YAG laser
Haas et al (1997)	Commercially pure titanium disks with machined surface, TPS surface, SAE, and HA-coated plasma-sprayed surface	Treated with a toluidine blue solution and irradiated with a diode soft laser with a wavelength of 905 nm for 1 min

Understanding Atomic Oxygen

Oxygen comes in several different forms. The oxygen that we breathe is called O₂ — that is, it's comprised of two tittles of oxygen. O₃ is ozone, similar as occurs in Earth's upper atmosphere, and O (one snippet), is infinitesimal oxygen.

infinitesimal oxygen does not live naturally for veritably long on the face of Earth, as it's veritably reactive. But in space, where there's plenitude of ultraviolet radiation, O₂ are more fluently broken piecemeal to produce infinitesimal oxygen. The atmosphere in low Earth route is comprised of about 96 infinitesimal oxygen. In the early days of NASA's space shuttle operations, the presence of infinitesimal oxygen caused problems.

Glenn Research Center was asked to probe the damage caused to NASA spacecraft by infinitesimal oxygen. The experimenters not only constructed styles to cover spacecraft from infinitesimal oxygen; they also discovered a way to harness the potentially destructive power of infinitesimal oxygen and use it to ameliorate life on Earth(5).

Helping Human Health



There are numerous biomedical operations of infinitesimal oxygen. It has been used to texture the face of polymers that may fuse with bone. The face of smooth polymers generally discourages adhesion with bone forming cells, but the infinitesimal oxygen creates a face where adhesion is enhanced. There are variety of ways this could be salutary to osteopathic health.

infinitesimal oxygen can also be used to remove biologically active pollutants from surgical implants. Indeed with ultramodern sterilization practices, it's delicate to remove all debris from bacterial cells(called endotoxins) from the implants. These endotoxins are organic but aren't living; thus, sterilization may not remove them. They can beget inflammation once implanted, and this inflammation is one of

the primary causes for pain and implicit loosening complications in cases who admit the implant.

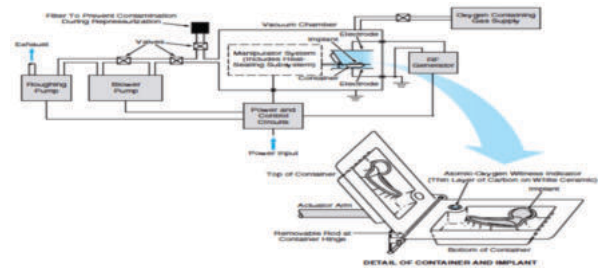
infinitesimal oxygen cleans the implant and removes all traces of organic accoutrements , which greatly diminishes the threat of post- operative inflammation. This leads to better results for cases who bear surgical implants.

Removing Bioactive Contaminants by Use of Atomic Oxygen

An Orthopedic Implant Is Decontaminated by exposure to monatomic oxygen from a radio-frequency plasma. The manipulator system positions the implant and container so that both the implant and the container surfaces adjacent to it are decontaminated, and seals the implant in the container once decontamination is complete. A major advantage of this method is that unlike in prior methods of decontaminating implants, there is no need to expose the implants to strong liquid chemical baths or high temperatures, both of which can degrade implant materials. Moreover, whereas the prior methods do not ensure complete removal of the contaminants, the present method ensures complete removal of the contaminants from all surfaces that receive sufficient exposure to monatomic oxygen.

The apparatus used to implement this method includes a vacuum chamber, a radio-frequency (RF) generator connected to electrodes in the chamber for generating a plasma, and a manipulator system. Included in the manipulator system are a special thermoplastic container for positioning one or more implants for exposure to monatomic oxygen from the plasma, an actuator arm for manipulating the container, and a subsystem for heat-sealing the implants in the container after treatment.

At the beginning , an implant to be decontaminated is placed in the special container and the container is positioned in the vacuum chamber to expose both the top surface of the implant and the inner surface of the top of the container to the plasma. The chamber is evacuated, then backfilled with oxygen at a pressure between 0.1 and 300 millitorr (between 0.013 and 40 Pa). The RF power is turned on to generate a plasma in the backfill gas. Volatile species formed by oxidation of contaminants become dispersed in the vacuum chamber and are simply removed by the vacuum-chamber pump system.



After the top surface of the implant and the inner surface of the top of the container have been exposed to the plasma long enough to ensure decontamination, the manipulator system, which closes the container and prevents uncontrolled rolling of the implant, withdraws the container into a chute, flips the container upside-down, pushes the container back out of the chute, and reopens the container; as a result, the former bottom surface of the implant and the former bottom inside surface of the container are now on top and are exposed to the plasma, while the decontaminated former top surface of the implant is now on the bottom, resting on the decontaminated inside surface of the former top of the container.

After sufficient exposure to the plasma to ensure decontamination, the manipulator system again closes the container and withdraws it into the chute. Then the RF power is turned off, and the implant, with its container, is either vacuum

sealed or the pumping system is turned off and ambient air, nitrogen, or inert gas is readmitted to the chamber through filters that prevent recontamination of the implant and container. The container with the implant inside is heat sealed by moving into the heat-sealing subsystem, where the top and bottom parts of the container are clamped at the perimeter and partially melted to seal the implant inside, where it is surrounded by, and in contact with, container surfaces that have been decontaminated. As thus packaged, the decontaminated implant can be stored, transported, and sterilized by exposure to gamma rays.(6)

CONCLUSION

Dental implant placement has become a common way to restore lost dentition by which a person regains his esthetics ,function and physical confidence. But it is mandatory for a dental professional to handle a dental implants with complete sterilization . Accidentally if a implant surface gets in contact with the objects other than the prepared site or meets with peri implantitis it becomes useless.

In near future the NASA's innovation provides to be a gold standard method in transforming an implant biocompatible which is previously unsterile can reduce the treatment cost and also increases the success rate of an retrieved implant also.

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