

# Impact of argon plasma treatment on microbiological surface receptivity of titanium implants: An *in vitro* study

Marco Annunziata,<sup>a</sup> Pablo Galindo Moreno,<sup>b</sup>  
Giovanna Donnarumma,<sup>c</sup> Pina Caputo,<sup>c</sup>  
Livia Nastri<sup>a</sup> & Luigi Guida<sup>a</sup>

<sup>a</sup> Multidisciplinary Department of Medical-Surgical and Dental Specialties, Second University of Naples, Naples, Italy

<sup>b</sup> Department of Oral Surgery and Implant Dentistry, School of Dentistry, University of Granada, Granada, Spain

<sup>c</sup> Department of Experimental Medicine, Microbiology Section, Second University of Naples, Naples, Italy

## Corresponding author:

### Dr. Marco Annunziata

Multidisciplinary Department of Medical-Surgical and Dental Specialties, Second University of Naples  
Via L. De Crecchio 6  
80138 Naples  
Italy

T + 39 081566 5514  
marco.annunziata@unina2.it

## How to cite this article:

Annunziata M, Galindo Moreno P, Donnarumma G, Caputo P, Nastri L, Guida L. Impact of argon plasma treatment on microbiological surface receptivity of titanium implants: an *in vitro* study. *J Oral Science Rehabilitation*. 2016 Sep;2(3):16–8.

## Abstract

### Objective

Pretreatment of dental implants by argon plasma has been suggested to increase their surface energy and enhance integration of both hard and soft periimplant tissue. However, no data are available on the risk of implant sterility loss after this process. This study aimed to test whether the treatment of implant fixtures by argon plasma in conditions compatible with clinical use produced an increased risk of microbiological contamination.

### Materials and methods

Thirty (15 control and 15 test) sterile Grade 4 titanium implants were used. Test implants were removed from their original packages, pretreated in an argon plasma chamber for 12 min, and then immersed in a bacterial culture medium (Luria-Bertani broth) at 37°C for 72 h. Control implants were directly transferred to Luria-Bertani broth.

### Results

When the culture broths were examined after the 72 h incubation, no traces of bacterial contamination were found for either controls or test implants.

### Conclusion

Within the limits of this study, the data reported suggest that argon plasma technology could be used to pretreat implant fixtures immediately before their surgical placement without increasing the risk of microbiological contamination.

### Keywords

Argon plasma, dental implant, microbiological contamination.

## Introduction

Argon plasma is widely employed as the final step of the manufacturing process of titanium implant fixtures before their sterilization by gamma rays. With this treatment, a spray of argon under pressure at room temperature is used to clean implants and remove microbiological and organic contaminants from the metal surface. At the same time, however, the atomic bombardment to which the titanium surface is subjected, causes its activation, that is, a state of excitation of the electronic mantle and the modification of its physicochemical and biological features.<sup>1</sup>

The activation obtained during the manufacturing phase is temporary and will have ceased once the implant fixture is used clinically. It has been suggested that the reactivation of the titanium surface by argon plasma immediately before the implant positioning in the oral cavity could be advantageous in terms of the integration of both hard and soft periimplant tissue.

*In vitro* and animal studies performed in sterile environments have shown an increased surface energy and an enhanced early biomechanical fixation of dental implants pretreated by argon plasma.<sup>2-4</sup> Furthermore, preliminary results have suggested that treatment of titanium abutments by argon plasma may enhance cell adhesion at the early stage of periimplant soft-tissue healing<sup>5</sup> and marginal bone preservation over time.<sup>6</sup> However, no data are available about the possible effect of this treatment on the implant surface receptivity toward environmental bacteria and on the risk of sterility

loss of the fixture just before its surgical placement. The aim of the present study was to test whether the treatment of implant fixtures by argon plasma in conditions compatible with clinical use produced an increased risk of microbiological contamination.

## Materials and methods

Thirty (15 control and 15 test) sterile Grade 4 titanium implant fixtures with a sandblasted and acid-etched surface (ZirTi, average surface roughness of 1.3  $\mu\text{m}$ ; Sweden & Martina, Due Carrare, Padua, Italy) were used for this study. Control implants were directly transferred with sterile tweezers from their original packaging into test tubes containing 5 ml of Luria-Bertani broth (Oxoid, Basingstoke, UK) and incubated at 37 °C for 72 h. Test implants were inserted into a metallic holder (**Fig. 1**) and pretreated in an argon plasma chamber (Plasma R, Diener electronic, Ebhausen, Germany) for 12 min at room temperature and then transferred to culture broth. In order to simulate the clinical practice and environment, the time between the removal of each fixture from its sterile package, or from the argon plasma chamber, and its immersion in the culture broth was standardized at 60 s and the transfer was performed in a nonprotective environment. Three independent experiments were carried out under the same conditions.

Fig. 1

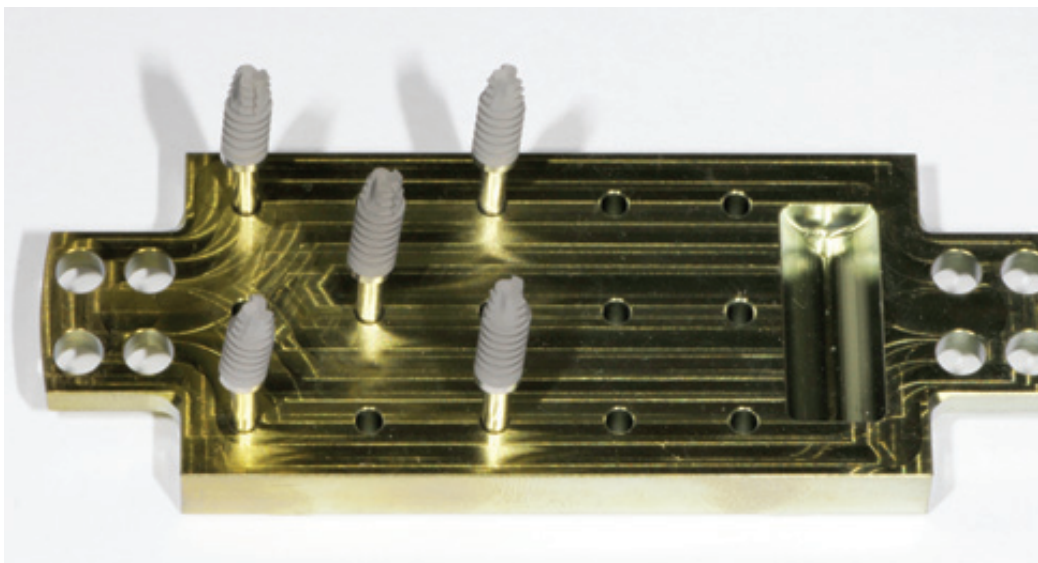


Fig. 1

Test implants inserted into a metallic holder before pretreatment in the argon plasma chamber.

**Fig. 2**

Culture broths examined after the 72 h incubation. No traces of bacterial contamination were found for either controls or test implants.



Fig. 2

## Results

When the culture broths were examined after the 72 h incubation, no traces of bacterial contamination were found for either controls or test implants (Fig. 2).

## Competing interests

The authors declare that they have no competing interests.

## Conclusion

Within the limits of this study, the data reported suggest that argon plasma technology could be used to pretreat implant fixtures immediately before their surgical placement without increasing the risk of microbiological contamination. However, additional microbiological and preclinical studies should be performed to test the clinical applicability of this procedure.

## References

1. Aronsson BO, Lausmaa J, Kasemo B. Glow discharge plasma treatment for surface cleaning and modification of metallic biomaterials. → *J Biomed Mater Res.* 1997 Apr;35(1):49–73.
2. Coelho PG, Giro G, Teixeira HS, Marin C, Witek L, Thompson VP, Tovar N, Silva NR. Argon-based atmospheric pressure plasma enhances early bone response to rough titanium surfaces. → *J Biomed Mater Res A.* 2012 Jul;100A(7):1901–6.
3. Giro G, Tovar N, Witek L, Marin C, Silva NR, Bonfante EA, Coelho PG. Osseointegration assessment of chairside argon-based nonthermal plasma-treated Ca-P coated dental implants. → *J Biomed Mater Res A.* 2013 Jan;101A(1):98–103.
4. Teixeira HS, Marin C, Witek L, Freitas A Jr, Silva NR, Lilin T, Tovar N, Janal MN, Coelho PG. Assessment of a chair-side argon-based non-thermal plasma treatment on the surface characteristics and integration of dental implants with textured surfaces. → *J Mech Behav Biomed Mater.* 2012 May;9:45–9.
5. Canullo L, Peñarrocha-Oltra D, Marchionni S, Bagán L, Peñarrocha-Diago MA, Micarelli C. Soft tissue cell adhesion to titanium abutments after different cleaning procedures: preliminary results of a randomized clinical trial. → *Med Oral Patol Oral Cir Bucal.* 2014 Mar;19(2):e177–83.
6. Canullo L, Peñarrocha D, Clementini M, Iannello G, Micarelli C. Impact of plasma of argon cleaning treatment on implant abutments in patients with a history of periodontal disease and thin biotype: radiographic results at 24-month follow-up of a RCT. → *Clin Oral Implants Res.* 2015 Jan;26(1):8–14.