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Review Article

TAG-New generation of implants design

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Abstract: It is an obvious fact that the number of dental implantation procedures is constantly growing and is more and more in use for dental restoration procedures. Growing demand for the implantation procedures requires it's continuous improvement, to make it more affordable, more predictable and with fewer side effects as possible. Among other issues, the issue of time to restoration became highly influential as an accompanying factor for long term success of the dental implants. In fact the importance of the issue is so high, that it became a stimulating factor for many companies operating in the field of implant dentistry to conduct a wide scale studies concerning the geometry and surface of the implants to improve the overall results of the procedure. The following article is meant to introduce the results of one such study, performed by T.A.G dental, which is an active player in the market of dental implants.
Keywords: geometry and surface, biocompatibility, healing period, osseointegration.

INTRODUCTION

Overall duration of implantation procedure is a factor of high importance and is very relevant for decision concerning the process character. Generally, the implantation process duration, is a derivative of implant osseointegration, which is the so called healing time/period. Not a while ago, the methodology of implantation called for a period of three to six month healing time post the implantation for complete implant osseointigration[6]. Today, restoration prior to full osseointegration is a common practice. Timing of the restorative phase, in both cases will depend on the implantation site condition and on the physicians - judgment and professional experience. The difference is an outcome of two different implant stability mechanisms:

Factor of implant stability is among the variables, which determine conditionssuitable for restoration. Implant stability that allows for restoration is commonly identified at two post implementation periods – immediately or in close proximity to implantation process and the three to month six after implantation. The two periods, are derivatives of two separate stability mechanisms and both can be achieved and controlled by the specific implant design.

The first stability mechanism, which allows immediate or early loading procedures, relies on the implant stability even before the accomplishment of the osseointigration. Mechanical stability of the implant is an outcome of the implant geometry and surface in relation to osteotomy site[7].

The second stability mechanism, which is osseointegration, relies on the bone growth. Subject to site conditions, the new bone, will "envelope" the implant. The implant incorporated into the jaw, will allow the required stability for restoration. Osseointegration is an outcome of implant geometry and surface roughness, best suited for the bone growth[2].

Both methodologies are commonly exploited these days. Therefore, the implant design ought to incorporate geometric and surface features to comply with both methods, this to maximize the mechanical stability of the implant and reduce the time for osseointigration, to improve and secure the long – term procedure result.

These previous statements are gaining wide support from relevant field researches and provide strong evidence that implant concept such as Macro design geometry and micro surface quality will determine tissue reaction and influence the long term clinical dental implant success.

Since the surface is the first part of the implant to encounter the bone, it is natural that surface engineering has requested more carefulness and become an area of extensive investigation. The composition, the topography and the roughness influence the surface energy and have an influential impact on the overall procedure result.

SURFACE AND GEOMETRY

Being the implants in continuous contact with tissue, posing a stringent and strict demands on the raw materials from which the implants are made of. Metallic materials, includes Stainless Steel (SST) and Vitallium has a long history of use in various medical applications in general and dental applications in particular [5].

Titanium (Ti), which is light, high strength and corrosion resistant metallic element, is widely in use for production of implants, due to it previously mentioned advantages. Its excellent biocompatibility and osseointigration is related not only to material properties, but, also to it suitability for various surface treatments, which provides the required characteristics for it implementation in dentistry applications. Titanium, allows the formation of a dense, highly resistant passive oxide film that protects the underlying material from oxidation and corrosion[8].

T.A.G implants are designed to significantly decrease the amount of bone loss, by creating a distance between the connection points of the implant with the bone. This consequently maintains the bone and archives maximum biological response.

MACRO GEOMETRY

The macrogeometry principle, on which the basic concept of the T.A.G dental implants is established, increases the overall functional surface area of the implant. The declared goal is to achieve the reduction of stress peak in the bone, this beside the increment of the functional surface and promotion of the bearable compressive load on the implant because of a favorable force distribution. In other words the aim is to create a strong platform on top of which a durable, stress sustaining construction can be build.

Surface quality and its characteristics is an additional factor in overall macro geometry of the implant. The macro porous surface of the T.A.G dental implants (-40µmm), plays an important role in stability of the implant and its long term fixation. The importance of surface topography is scientifically evident for implant osseointegration and the overall acceptability of the implantation process [3, 4].

In addition to it, parameters like; thread form, helix angle, width, depth, pitch and the body shape, are crucial parameters for consideration in case of immediate load. The multiplication of variables, just emphasize the complexity of product macro geometry and empowers its significance.

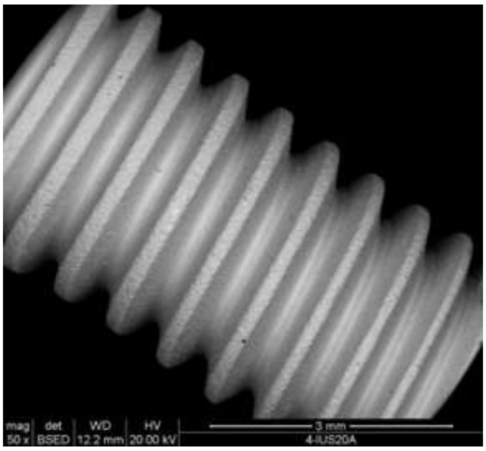

Fig-1: T.A.G implant thread sample.

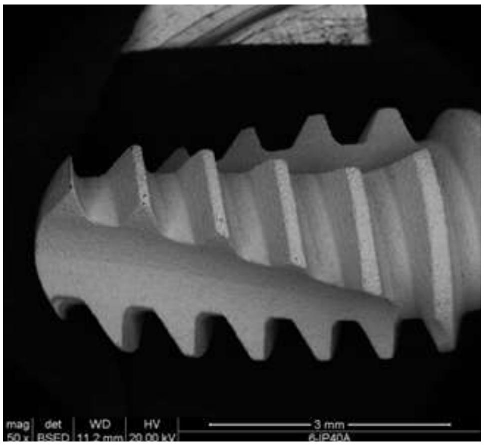

Fig-2: T.A.G implant thread shape

ROUGHNESS

The roughness of implant is an important factor mainly for determinationof response between the tissue and the implant. In other words, the factor of roughness is capable to influence upon the bone healing and implant fixation [9].

Macro topographic profiles of dental implants have a variable surface roughness range and are directly correlated with implant geometry. There are several methods to create controlled roughness on the implant surface. Generally those methods can be classified as – mechanical and chemical[1].

Mechanical treatments– is a removal of surface material and deformation of the surface by particles blasting technology. Such a method may create surface topographies and surfaces compositions, which are relatively rough and still suitable for the needs.

Chemical treatments–assortment of active techniques(solvent cleaning, acid etching and passivation treatments) meant to modify the implant surface. Here as well the aim is to change the topography of the surface material and modify it to make it better suited for the process and improve its interaction with the tissue.

T.A.G dental, is producing the implants from biocompatible Titanium (Ti 6AL 4V ELI), with accordance to ASTM F136. The quality of surface is monitored by X-ray spectroscopy method and scanning microscopic analysis.

The surface of the implant is processed mechanically and chemically – by particles blasting and acid etching, with roughness from 1.8µ up to 2.2µ and morphology of the cavities from 2µ to 40µ.

MICRO SURFACE

Since the implant surface is the first component to interact with the host, surface modifications have been extensively investigated in an attempt to increase the rate of bone healing and thereby allowing practitioners immediate/early loading of dental implants. Increasing the surface biocompatibility and osseoconductive properties may promote enhanced bone healing and apposition that lead to rapid biological fixation of implants to bone. Significant increase in total area does necessarily represent an effective increase in osseointegration area, since spaces greater than 50µ m are typically required for bone formation and subsequent maintenance.

Rough surfaces such as those obtained through particles blasting with subsequent acid-etching procedure have demonstrated higher torque values at earlier implantation times when compared to only machined surfaces.

It should be noted that mechanical testing by means of torque-out, pull-out, or push-out show that micro roughness 10 µ - 1µ improve the interlocking between mineralized bone and implant surface.

T.A.G dental implant surface treatment is a result of a long experience in the aim to obtain the best biological response.

The micro surface morphology roughness (40 µ - 1µ) achieved by blasting followed by acid etching increases bone to implant contact resulting in improvement of mechanical anchorage for a better primary stability that favorites the cellular adhesion.

Modification of the surface energy at the nano level to an osteoconductive and hydrophilic surface promotes an active ion interaction with the blood plasma for faster osseointegration and BIC distribution.

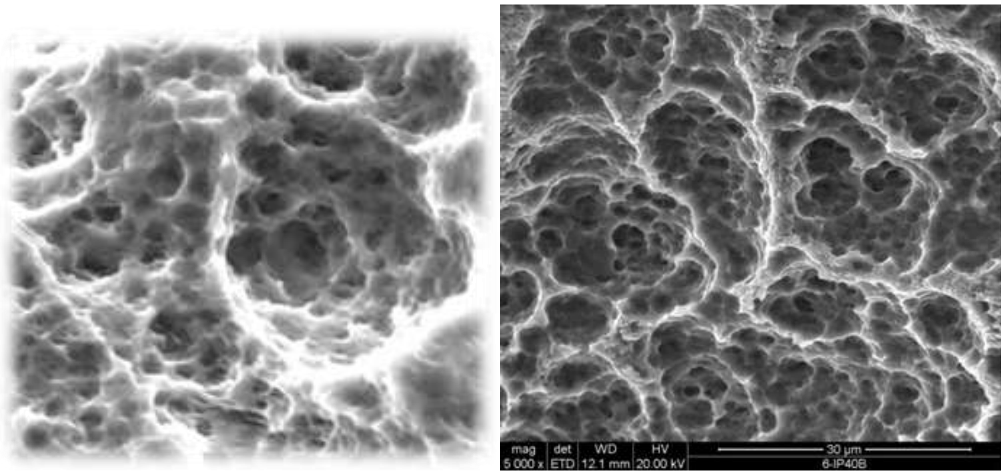

Fig-3: T.A.G implant micro surface (after modification)

Table-1: Typical (XPS) that characterize the surface of the TAG dental implants

Implant	**area**	**C**	**Ti**	**O**	**N**	**Ca**	**Si**	**S**	**V**	**Cl**	**P**	**K**	**Al**	**Na**	**Mg**	**Zn**
TAG	#1	29.57	15.81	52.58	0.21	0.24	-	0.08	0.29	-	-	-	0.84	0.34	-	-
	#2	27.86	16.32	53.54	0.84	0.31	-	-	0.54	-	-	-	0.63	-	-	-

FATIQUE STRENGTH

The fatigue strength is the maximum force of an implant/abutment connection structure in the worse cases (angulation) that can survive at least five million cycles.

The tests are performed according to the requirements of FDA Guide and ISO 14801 Standard "Dentistry Implants - dynamic fatigue test for endosseous dental implants".

A static test should be performed first in order to determine the peak magnitude of the force needed for the fatigue test.

The fatigue test should be performed with a cyclic load of R=0.1 load ratio. The implant is mounted to a jig, with the requirements stated in ISO 14801. The abutment was mounted to the implant using a screw tightened to 30±2NCm.

Base on the European and FDA standard the dental implants of TAG show an exceptional resistance to fatigue load due to the geometry that reduce the stresses concentration.

An improvement of fatigue strength can be achieved for newly conceived geometries over conventional geometries.

The internal tight fit gap connection as accuracy of 0.005 to 0.015µmm improves the mechanical properties of the structure.

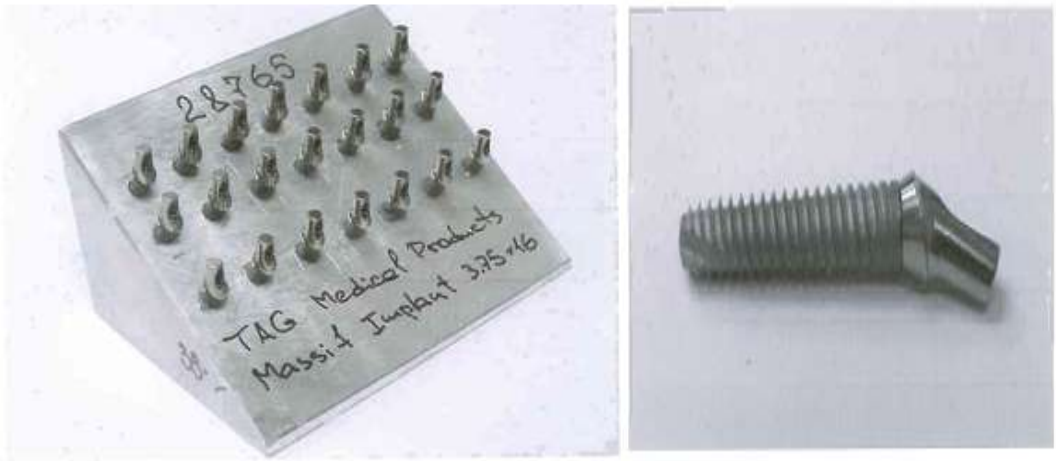

Fig-4: Testing bench for fatigue strength and tested implant.

The following is an example for the tests results, which were gathered during the study performed by T.A.G dental:

Implant 3.3mm can be use in areas with limited space in safe placement. The performed staticandfatigue testreveals:

Average staticload=666N
Fatiguelimitdetermined340N

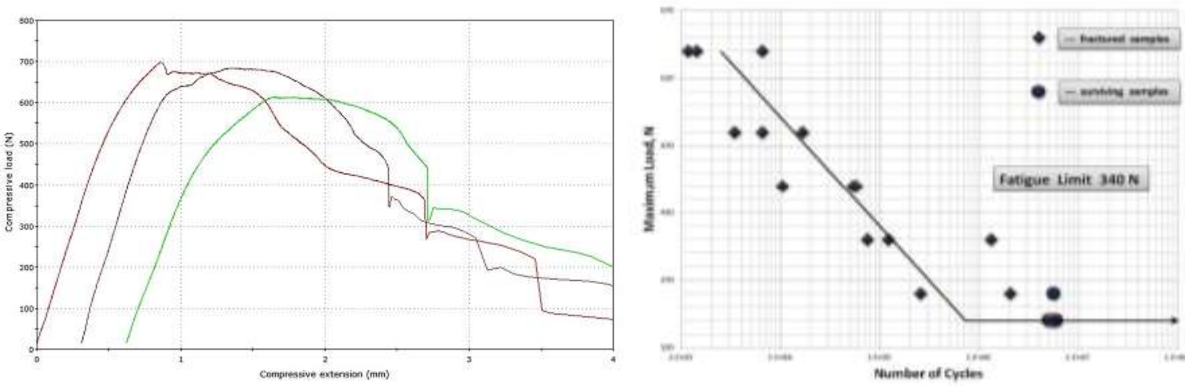

Fig-5: Static loading test – 3.3mm T.A.G implant.

Implant 3.75 mm
Average staticload=666N
Fatiguelimitdetermined340N

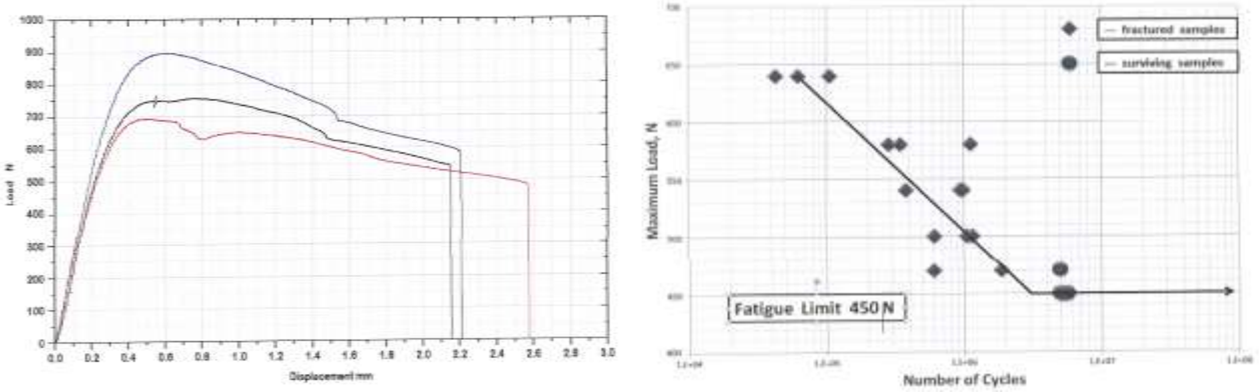

Fig-6: Static loading test – 3.75mm T.A.G implant.

CONCLUSION

The mechanism of the bone formation and its mechanical maturity around the implant due to this surface modification remains under investigation.

Observations of the dual acid-etched and grit-blasted/acid-etched surfaces showed that different roughness patterns can be obtained depending on the processing condition.

The new generation of implants developed by TAG Medical Company in Israel optimized the different parameters as geometry, topography, surface property and surface quality that conduct to a high success rates.

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