

Surface roughness analysis of the AVANA dental implant

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ABSTRACT In order to investigate topographical characteristics of AVANA dental implant, Top Scan 3D system(Heidelberg Instruments, Heidelberg, Germany) was used. Top Scan 3D system is an optical instrument which employs a scanning laser spot and has depth discrimination property of confocal scanning microscopy. Two- and three-dimensional topographical findings were obtained and comparatively analyzed on the basis of Nobel Biocare dental implants. Following values displayed the roughness of the AVANA dental implant (mean±s.d).

1. Top: Sa 0.64 ± 0.28 m, Scx : 12.04 ± 2.06 m, Sdr : 14.57 ± 10.58 %
2. Valley: Sa 0.47 ± 0.16 m, Scx : 8.13 ± 0.59 m, Sdr : 13.60 ± 9.29 %
3. Flank: Sa 0.58 ± 0.16 m, Scx : 9.02 ± 0.70 m, Sdr : 14.04 ± 6.70 %

In general, the implant used in this study showed good surface quality. However, there were some defects.

To get full understanding of surface characteristics of dental implant, it is necessary to investigate chemical, physical, and mechanical properties as a whole. Further profound studies are needed.

Key Words : AVANA, Top Scan 3D, topography

INTRODUCTION

Use of implant has increased and efforts to develop domestic implant brand have been continued. A multitude of implant brands is on the world market and the design also

varies. Any domestic implant brand should meet the criteria of human biocompatibility and satisfy several conditions to be competitive on the global market. Therefore, development of macroscopic structure like material, shape, as well as development of microscopic structure such as surface roughness and precision should be accomplished. Surface roughness plays the critical role in osseointegration and the optimum surface roughness is known as more

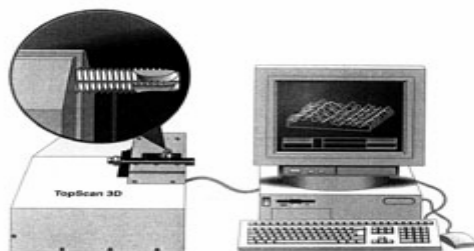
or less of $1\mu\text{m}$. Few studies have been conducted on AVANA® implant (South Korea) at clinical and laboratory level. Implant is never a panacea in dentistry but the long life span is one of the strong characteristics. Thus, long-term success should be one of the criteria of quality implant. The purpose of this study is to investigate the surface characteristics of AVANA® implant.

MATERIALS AND METHODS

The surface characteristics of ten 10mm in length and 3.75mm in diameter AVANA®implant was performed using Top Scan 3D(Heidelberg Instruments, Heidelberg, Germany) and compared with those of Brånemark implant. Every implant kept sterilized were opened carefully and mounted on Top Scan 3D. The structure of implant screw was divided into top, flank and valley. Since 6 tops, flanks and valleys were measured from every 120° three directions of

each implant, 18 tops, 18 flanks and 18 valleys are measured from 1 implant. Since 10 implants were used, 180 values of tops, flanks and valleys respectively were measured. Three parameters of surface roughness are measured. Sa: arithmetic mean deviation of the profile and the surface, Scx: mean spacing of profile peaks at the mean plane, and Sdr: ratio of the developed surface area which is one of the method to represent surface roughness.

Fig. 1. Schematic drawing of Top Scan 3D system.



RESULTS

Table 1. Roughness of AVANA® implant surface (mean ± standard deviation)

| | Sa(μm) | Scx(μm) | Sdr(%) |
|--------|-----------|------------|-------------|
| Top | 0.64±0.28 | 12.04±2.06 | 14.57±10.58 |
| Valley | 0.47±0.16 | 8.13±0.59 | 13.60±9.29 |
| Flank | 0.58±0.16 | 9.02±0.70 | 14.04±6.70 |

Table 2. Roughness of Brånemark implant surface (mean ± standard deviation)

| | Sa(μm) | Scx(μm) | Sdr(%) |
|--------|-----------|------------|-------------|
| Top | 0.56±0.24 | 10.82±1.21 | 19.07±10.08 |
| Valley | 0.52±0.16 | 8.02±0.23 | 15.60±7.20 |
| Flank | 0.55±0.04 | 8.09±0.36 | 16.41±4.67 |

There was no statistical significant difference between values of AVANA® and implant Brånemark implant (t-test, p-value>0.01).

Fig 2. a,b,c. Three dimensional surface topography of AVANA® implant: (a) top, (b) valley, (c) flank.

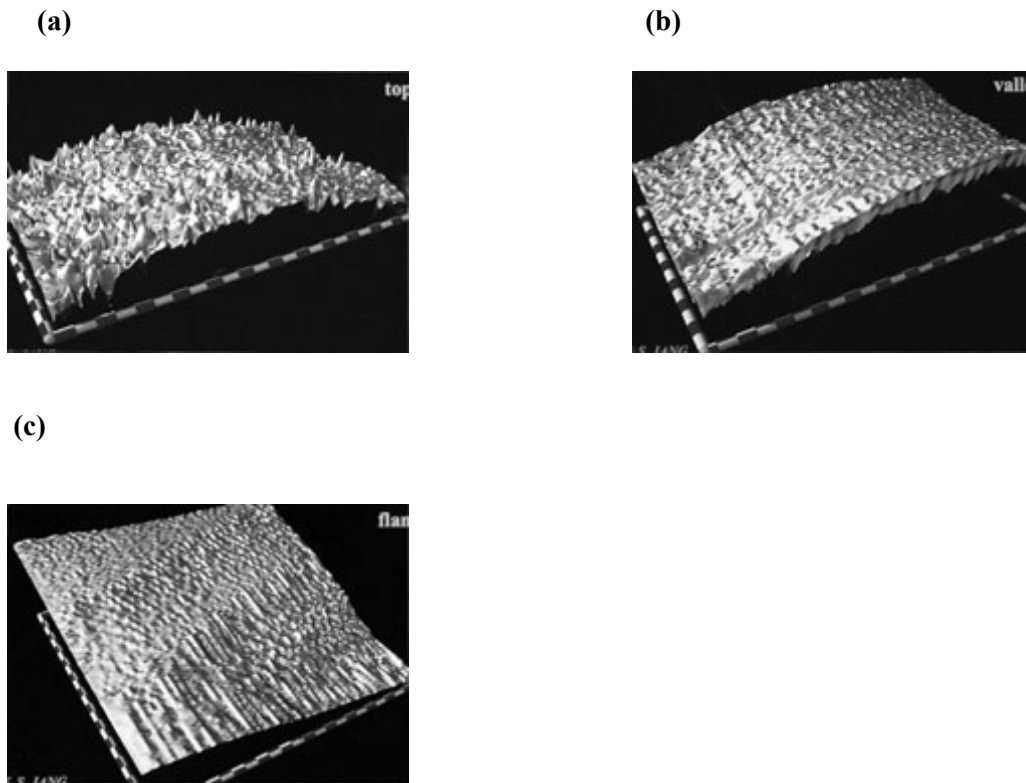
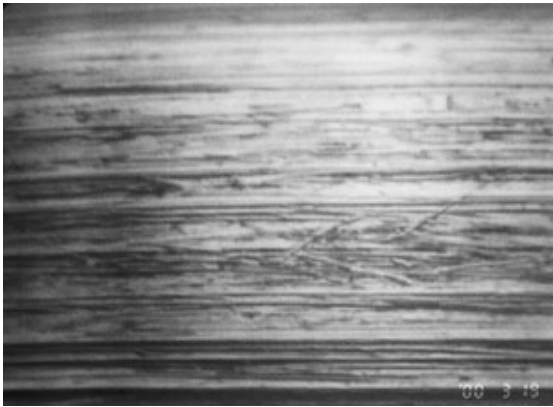


Fig 3 shows magnified image of AVANA® implant surface using microscope. Well smooth surfaces are observed (Fig 3, a & b). Too rough surface is observed on (Fig 3, c). Irregular surface is observed (Fig 3, d). The finishing of machined surface at the bottom is not smooth (Fig 3, e).

Fig 3 a,b,c,d,e. Microscopic image of AVANA® implant

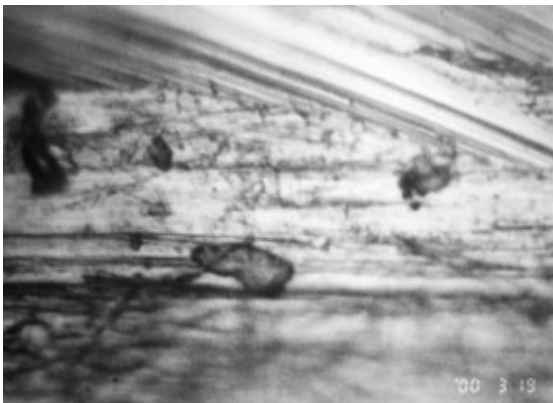
(a)



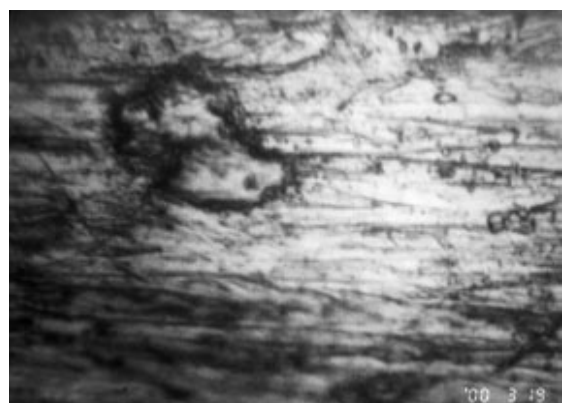
(b)



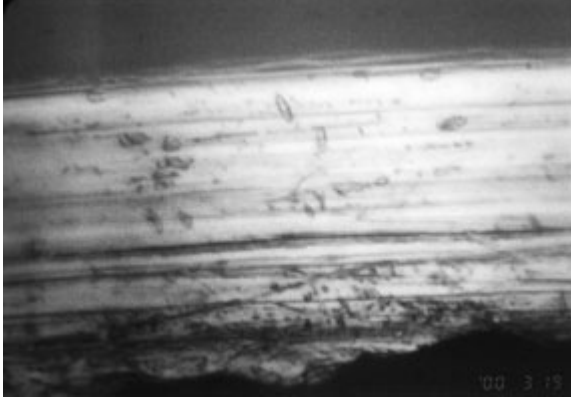
(c)



(d)



(e)



DISCUSSIONS

Many researches supported that surface roughness plays the critical role in osseointegration. surface roughness of every implant brand varies. The current study shows that surface roughness of AVANA® implant is almost equal to that of Nobel Biocare, 3i, Impl-Med, and Screw-Vent. Various methods to measure surface roughness were proposed. Top Scan 3D used in the current study has a capability of measuring surface roughness with ease. A 1 μ m laser spot of Top Scan 3D functioning light microscopic explorer reduce the error occurred by the displacement of image advantageously. The fundamental mechanism of this device is confocal laser scanning microscopy's depth differentiation capability, which makes the maximum detection range 0.80 μ m horizontally and 6 μ m vertically.

Overall roughness for osseointegration was

appropriate and subtle structure did not include any particular defects. This feature was similar to Brånemark implant. Design, however, lack originality and precision is more or less inferior in comparison with Brånemark implant. The machined preparation determines surface roughness of titanium implant. Thus, more delicate and precise designing and development of technology makes the birth of better domestic implant brand possible.

The shape of cell is substantially dependent on whether it grows at the smooth surface or irregular surface. The shape of cell determines the growth, enzyme release, and genetic expression. The outer surface of implant interacts with adjacent tissue. Thus maintenance of surface cleanness, prevention of contamination, and careful handling in manufacturing process are very critical.

On studies of osteoblast's ability to adhere to titanium implant surface, Brower et al reported that irregular rough surface adhered better than smooth surface. Keller et al also observed similar results, and so did Martin et al.

Histological studies also show the similar results. Thomas, Cook, Carlsson et al reported that successful osseointegration occurred on properly rough surface but soft tissue intervention was observed on the smooth surface. Gotfredsen et al the interface contact of rough surface is superior to that of smooth surface.

Wilke et al argued that a consistent relationship between surface roughness and osseointegration does not exist always. More than that, it is too soon to make a conclusion regarding the most ideal surface roughness to guarantee osseointegration and long-term success of implant. It is sure that surface roughness is not the only factor to determine the success of implant.

This current study dealt microscopic aspect of implant surface characteristics. However, for fully understanding of implant surface characteristics and making it the most optimal, chemical characteristics including thickness of impure material and oxygen, ions composition and release, physical characteristics such as surface energy, electric charge, and mechanical characteristics, for example, stress, elastic deformation, frictional force, hardness should be evaluated collectively. Therefore, readers should be reminded that the current study evaluated only a part of surface characteristics.

In addition, implant of this current study has pure titanium machined surface. Currently, many trials such as surface treatment with acid, spray, fluoride, electric grinding, and glow discharge to vary the surface structure.

Most importantly, any clinical long-term follow-up study and other characteristics of implant surface are lacking. Therefore, further studies are called to follow.

CONCLUSION

In order to investigate topographical characteristics of AVANA dental implant, Top Scan 3D system(Heidelberg Instruments, Heidelberg, Germany) was used. Two- and three-dimensional topographical findings

were obtained and comparatively analyzed on the basis of Nobel Biocare dental implants. Following values displayed the roughness of the AVANA dental implant (mean±s.d).

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There was no statistical significant difference between values of AVANA® and implant

Brånemark implant (t-test, p-value>0.01). In general, the implant used in this study showed good surface quality. In part, however, there were some kind of rough and irregular defects.

Since surface roughness determines quality of osseointegration, it is necessary to investigate chemical, physical, and mechanical properties in future studies.

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