Overcome the Limitation in Surface Processing of Implant! UV Irradiation

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Ⅱ. Clinical difference between SLA surface finishing and UV irradiated implant

In the last issue, it was confirmed that biologic aging phenomenon that hinder the binding of bone and implant occurs due to organic matters such as hydrocarbon in the air even for the Sandblasted with large grit and acid etched (SLA) surface finishing, which is evaluated as the most stable and outstanding surface processing technique until now. As a solution, UV irradiation of the implant surface can remove the organic matters from the implant surface and convert the hydrophobic surface into superhydrophilic surface, thereby inducing quick osseointegration by inducing high level of bio−friendliness in the mutual interaction between the implant and the bone generation factors such as protein and cells. In addition, with improvement in the bone to implant contact rate (BIC) for the UV irradiated implant to approximately 2 times higher than that of the SLA surface finishing without UV irradiation, it was conformed that UV irradiation accelerates synostosis process and enhances the extent of osseointegration.

In this issue, the usefulness of UV irradiated implant will be reviewed through comparison of the effects of the SLA surface and UV irradiated implant on osseointegration in actual cellular experiment, animal experiment and in clinical settings to verify the theoretical considerations presented in the previous issue.

Ⅱ. Clinical difference between SLA surface finishing and UV irradiated implant

[In Vitro Test] Cell proliferation experiment prior to and after UV irradiation (Dental College of Kyunghee University)

Titanium disk with diameter of 10mm was used as a control group after having subjected it to SLA surface treatment. Same titanium disk with SLA surface treatment was further subjected to irradiation with UVC wavelength for 10 minutes for use as the experimental group. Cell proliferation experiment was then conducted by using MC3T3−E1 cell line (mouse osteoblast cells) applied to these disks.

As illustrated in Fig. 1, there was rapid increase in cell proliferation for the disk with UV irradiation in comparison to the control group without UV irradiation since the 3rd day of the commencement of experiment. Based on the results of increase in the quantity of proliferated osteoblast cells, which is an osteogenesis factor, for disk with UV irradiation in comparison to the disk without UV irradiation, it can be presumed that UV irradiation has substantial effect on proliferation of osteoblast cells.

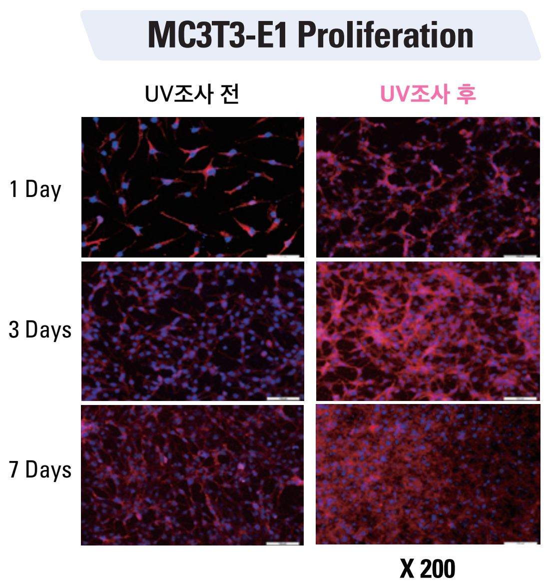


Fig. 1 Cellular proliferation experiment (Dental College of Kyunghee University)

Osteo−mineralization experiment was carried out with the same cell line by applying them onto the titanium disk subjected to SLA surface processing. While SLA surface processed titanium disk displayed approximately 40% increase in osteo−mineralization at the transition time from the 3rd to the 4th week, titanium disk with UV irradiation displayed the effects of approximately 50% increase in osteo−mineralization at the transition time from the 2nd to the 3rd week (Fig. 2). This is deemed to be the result of increase in the activation of osteoblast by reforming the surface of titanium disk subjected to SLA surface processing into positive (+) charge by removing the residual organic matters such as hydrocarbon by means of UV irradiations, thereby further enhancing the proliferation of osteoblast and osteo−mineralization.

It can be seen that same results are obtained from a diverse range of clinical trials. That is, following the embedding of implant, mechanical binding force is maintained by the existing bone (primary stability) before such binding force is rapidly weakened due to the absorption of the existing bones with passage of time. Meanwhile, the growth of newly generated bones with passage of time increases the binding force with the implant biologically (secondary stability). However, there is a temporary period in which the binding force between the implant and bone drops rapidly (stability dip). In clinical settings, this period of stability dip is evaluated to be in the range of 3~4 weeks after the embedding of the implant.

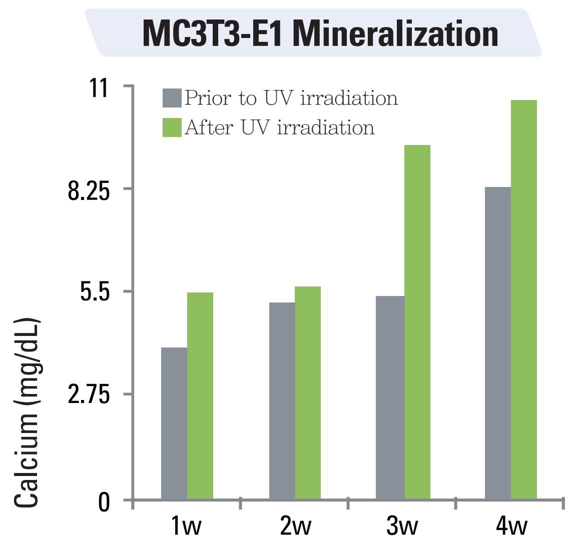


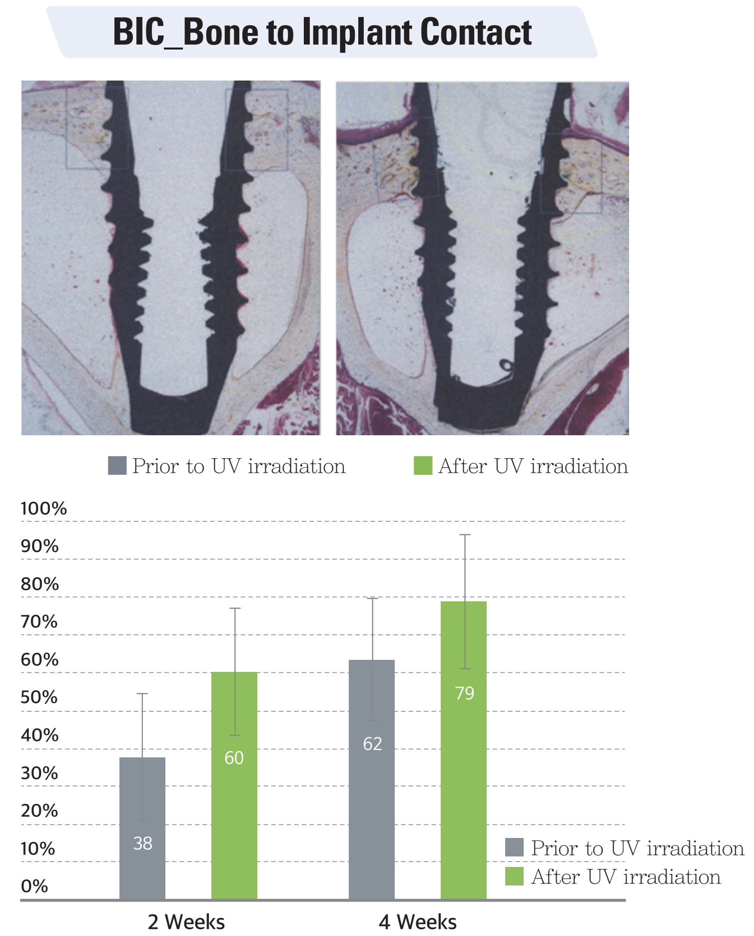
Fig. 2 Osteo−mineralization experiment (Dental College of Kyunghee University)

Therefore, it is deemed possible to prevent failure in the implant embedding and induce quick osseointegration in the early stage by inducing secondary stability at earlier stage by irradiating UV to SLA processed surface.

[In Vivo Test] BIC experiment prior to and after UV irradiation (Dental College of Kyunghee University)

The following are the results of animal experiment on the bone to implant contact (BIC) rates of the SLA surface processed implant and UV irradiated (10 minutes) implant (Fig. 3~4). Experiment was executed by embedding 2 each of the SLA implants and UV irradiated implants into the left and right tibia of 3 white rabbits. BIC observations were made at the 2nd and the 4th week of the experiment and there was no death of rabbit during the experiment. As illustrated in Fig. 4, BIC of the UV irradiated implant was measured to be higher than that of the SLA surface processed implant. In particular, BIC for the UV irradiated implant was at a substantially higher level at 80% in comparison to 62% for the SLA surface processed implants at the time of measurement in the 4th week.

Although there was no difference in BIC between the values prior to and after UV irradiation of SLA surface processed implant by more than 2 folds as in the case of the values measured in the experimental rat model of professor Ogawa of UCLA, USA (BIC of 98.2% for UV irradiated implant and BIC of 53% for non−UV irradiated control group at the 4th week of experiment), there nonetheless was approximately 30% higher BIC measured for the UV irradiated implant in comparison to the SLA surface processed implant prior to UV irradiation in this experiment. Therefore, it was possible to confirm that the acceleration of the synostosis process and enhancement of the extent of osseointegration are possible by maintaining synostosis between the bone and implant more advantageously in the latter stage of healing through UV irradiation.



[Clinical case] Overdenture by using 2 mandibular implants

A 66−year old female patient with systemic illnesses including high blood pressure, hyperlipidemia and diabetes, etc. was using her 2nd denture. Having used the denture for 5~6 years, she visited our hospital due to the complaints of the lower denture becoming loose and inconveniences including sticking of food in the gaps of the denture.

The maxillomandibular area was in full edentulous state with severe overall bone loss in the area of embedding of implant (Fig. 5). As such, 2 permanent implants were embedded into #33 and #43 in the mandible and 2 interim implants were embedded into #31 and #41 in the mandible to execute treatment in locator overdenture format.

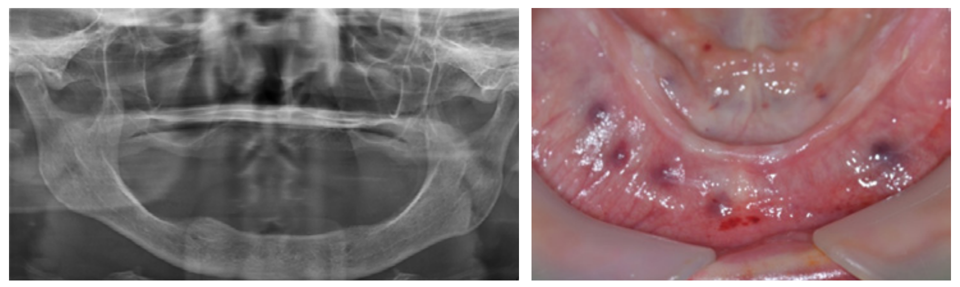
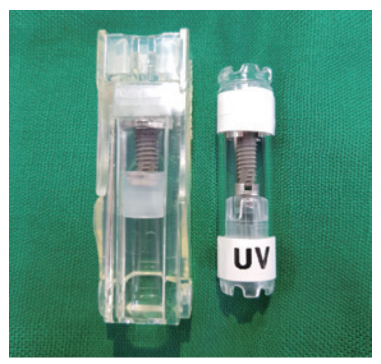


Fig. 5 Panoramic view prior to the procedure and image of the oral cavity (in overall, there is severe bone loss along with poor bone density)

SLA surface processed implant (DIO UFII Ø4.5x11.5mm) was embedded into #33 and UV irradiated implant (DIO UV Active Ø4.5x11.5mm) was embedded into #43 (Fig. 6). UV irradiation was executed for 15 minutes for the implant in Quartz ampoule state by using UV irradiator (DIO UV Activator, Fig. 7).



2 implants (#33 and #43) and 2 interim implants (#31 & #41) were embedded without additional bone graft after having made incision, and the incision was sutured after having attached healing abutment (Fig. 8).

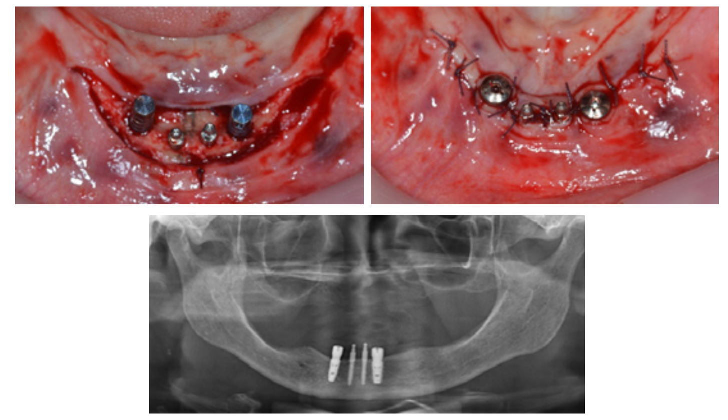


Fig. 8 Panoramic view after embedding of implant and relevant procedures

Implant stability quotient (ISQ) of 68 for #33 and 70 for #43 were measured immediately after embedding of the implant.

ISQ values are measured through a wide range of formats. While striking format that measures the repulsion velocity and contact time of implant after having struck the implant by using striking device has the advantages of diversified subjects of measurements including natural tooth and implant, etc., it has the limitations including imparting of impact on the implant in the initial stage of embedding with physical force as well as manifestation of different measurement values depending on the location and angle of measurement.

On the other hand, resonance frequency format uses Resonance Frequency Analysis (RFA) to display measurement values that are consistent regardless of the overall conditions of measurement without imparting impact on the implant. As such, it is evaluated as the most scientifically reliable measurement method, and RFA format is used in majority of theses for evaluation of objective data value. In this case, ISQ value was measured by using DIO IDx (Osstell, Sweden, Fig. 9) in the RFA format and continuous measurement data were recorded in the device itself for the corresponding patient for effective utilization in clinical setting.

At 4 weeks after the embedding of implant, ISQ of 72 for #33 (SLA) and 86 for #43 (UV) were measured, thereby illustrating that the ISQ value increased by substantial margin for the UV irradiated implant. Although it was a case of poor bone tissues and insufficient bones, ISQ value was maintained stably. As such, setting of dental prosthetics was executed earlier at the 8th week after the embedding of the implant (Table 1 / Fig. 10).

	1ST op	4week	8week(Loading)
#33(SLA)	68	72	79
#43(UV)	70	86	87

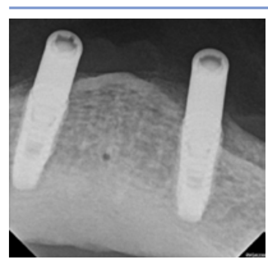
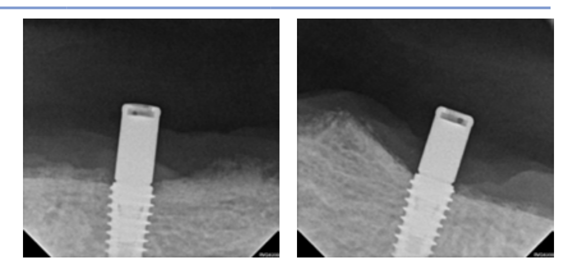


Image of cross−section of dental root after final attachment dental prosthetics



Images of cross−section of dental root after 3 months

Overdenture by using locator in the event of insufficient support for dentures due to lost alveolar bones under full edentulous condition is deemed to be an effective clinical treatment method. As the results of comparison of the extent of osseointegration until the time of attachment of dental prosthetics by embedding 2 implants, one with only SLA surface processing and the other with additional UV irradiation, in this case, higher extent of osseointegration could be obtained for the UV irradiated implant.