2011

# Ufit® dental implant

## Sealing Abutment Concept and Development

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# **The Ufit**® Dental Implant History.

| | |
|---|---|
| *2001 JULY* | ***Established T.STRONG (Manufacturer)*** |
| | Reported One year Clinical Experiments |
| *2002 MAY* | Registered Product Licensed by the Korea Food & Drug Administration (KFDA). Brand Name: UFIT |
| | Registered Product Licensed by the Busan Regional Korea Food & Drug Administration |
| *2003 SEPT* | Recognition of Materials & Components Enterprise by MCT (Materials & Components Technology) |
| | Certified ANSI/ISO/ASQ Q9001-2000. Certificate NO: 17162-QMS-2538 |
| | Contracted for Dental Implant Technical in cooperation with KOREA INSTITUTE OF MACHINERY & MATERIALS (KIMM) |
| *2003 OCT* | Applied Patent Registration for Torque Wrench Driver Adapter |
| *2004 FEB* | Applied Patent Registration for Dental Locking Abutment |
| *2004 FEB* | ***Established T.STRONG INC. (Corporation)*** |
| *2004 MARCH* | Acquired Patent Registration for Torque Wrench Driver Adapter (Registration No. 0345598) |
| *2004 MAY* | Acquired Patent Registration for Dental Locking Abutment (Registration No. 0350606) |
| *2004 AUG* | Participated in Gyeong Nam Regional Specialized Industry and Technology Development |
| | (GYEONGNAM REGIONAL INNOVATION AGENCY, KOREA INSTITUTE OF SCIENCE AND TECHNOLGY EVALUATION AND PLANNING) |
| *2004 SEPT* | Contracted for Dental Implant Technology in cooperation with KOREA INSTITUTE OF MACHINERY AND MATERIAL (KIMM) |
| *2004 OCT* | Signed an Agreement for Technology Development for the Removal of 3D (Difficulty, Dirty, Danger) |
| | in Manufacturing (KOREA INSTITUTE OF INDUSTRIAL TECHNOLOGY) |
| | Success of TRANSPLANTATION test for External and Internal Type Dental Implant System (KOREA TESTING AND RESEARCH INSTITUTE) |
| *2004 NOV* | Designated as a CLEAN place of business (Ministry of Labor) |
| *2004 DEC* | Received a Commendation for Medical and Pharmaceutical Product superiority and Good Example Enterprise |
| *2005 JUNE* | Signed an Agreement for Technology Development (CHANGWON UNIVERSITY) |
| *2005 OCT* | Acquired Product License (Grade:4) from the KOREA FOOD AND DRUG ADMINISTRATION (KFDA) |
| *2006 APR* | Selected as Top Company with Best Technology Innovation in Business and Brand Sector by Sports Seoul (LIFE Section) |
| *2007 SEPT* | Acquired Certification from KOREA GOOD MANUFACTURING PRACTICE (KGMP) (Certificate No.: MGK-537) |
| *2008 JAN* | Sealing Abutment Development |
| *2009 SEPT* | Sealing Abutment Application |
| *2010 FEB* | ***Applied Domestic Patent for Sealing Type Abutment*** |
| *2010 JUNE* | Registered Product License of Sealing Type Abutment and Launching |
| *2010 JUL* | Registered Product License of Hybrid Surface Treatment of Laser Neck Implant |
| *2010 AUG* | ***Established UFIT Implant Inc.*** |
| *2010 NOV* | Renewal of KGMP Certificate (Certificate NO: KTR-AB-090778) |
| *2011 FEB* | ***Applied PCT Patent for Sealing Type Abutment*** |
| *2011 JUL* | ***Received Certified ISO 130485 License, CE Product License (GT2 Fixture)*** |
| | Established branches in Australia and The Philippines |
| *2011 SEPT* | ***Received Domestic Patent for Sealing Type Abutment*** |

CE 1293 GMP ISO 13485

*ISO 13485*

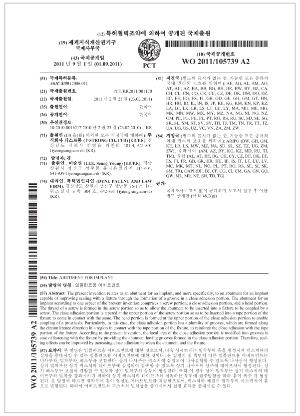

*GMP Certificate*

*CE Certificate*


Product License

Product License

*PCT*

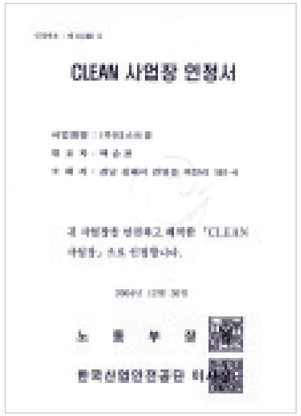


*Domestic Patent*

*Patent Registration for Torque Wrench Driver Adapter*

*Patent Registration for Dental Locking Abutment*

*CLEAN place of business (Ministry of Labor)*



*Agreement for Technology Development (Changwon University)*

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# Summary

After joining the abutment on top of the bone-fused fixture, the most important things is the mechanical condition of the surfaces interlock for the two parts to be able to withstand the chewing pressure when applied. But at the moment, the surfaces interlock condition of the two-piece form of dental implant system is faced with many problems. After the completion of the prosthesis and as the occlusal surface has settled, screw loosening and screw fracture problems occur.
In the case of the Internal system as compared to the External system, there are many relatively unseen problems of the exterior form and the fact is, when one looks deeper, there are many problems that needs to be resolved.
Every Implant manufacturers say that their implants make perfect union but they're actually embellishing some incorrect assertions. However, these unsubstantiated assertions are bound to be yet seen. The cause of the problem is scientific approach. By observing and solving the problem one by one, the problem can be resolved.
This study is about the case of the Internal System fastened with the Taper.

- Problems faced when fastening the Taper with the Fixture and Abutment caused by manufacturing process is reviewed
- The proposal of others is also reviewed to resolve the problem
- The designed top structure is described to the company
- The description of the experiments and analysis to prove such functions

## 1. Manufacturing of Implants - Precision & Correlation of Surfaces Interlock

### 1.1 Measurement of Surfaces Interlock and Various Dimensions in Implant Production

When manufacturing the implants, measurements in the initial setting (diameter, length, shape) are checked then full-scale production is done.

During production, set dimensions of inspected items are checked and maintain within the tolerance range. The most important here is the surface interlock of the joined upper prosthesis. This surface interlock is more dependent on inspections by advance-made gauge rather than dimensional measurements by gauge machine. When a gauge made to check the contacted state is used while the contact state of the abutment is shaped, the point of contact can be easily checked. However, to expect perfection when checking with the naked eye is also quite difficult. So a microscope is used and magnified 40 times. This method is used to have the least amount of error.

However, at that point, in-time inspection standards change so an absolute standard is difficult to set. As companies try to minimize their defective product (this matter is vital to a company) that standard changes according to reality.

### 1.2 The Problems and Causes of Surface interlock

The author of this paper is also concerned about faulty products and surface interlock in terms of precision. In 2004 upon learning about implants for the first time, I also learned that there is still not enough knowledge about the distinction between surgery with Internal and External. So from 2005, as I had directly entered into manufacturing, I found out that the majority of domestically produced implants were all copy-processed. Namely, the ITI compatible type with 8 degree declination and old-type ASTRA with an 11 degree declination SUB TYPE, keeping in mind that all compatibility is decided from a commercial viewpoint and the inadequacy in the making of a new contact-point form that reflected the mechanical and clinical problems.

For a long period of time, during the course of production, although the problem is known it wasn't addressed in reality. However, in conclusion, the production problem of surfaces interlock could be resolved alone and a conclusion has to be brought. If the description of the implant manufacturing process is understood, the following sections will be easy to follow.

### 1.3 Factors Affecting the Precision of the Implants' Surface Interlock

In implant manufacturing, a lathing machine is used with Titanium rods in the production process. In the following, the same factors affect the precision of the surface interlock of the final implant.

## 1) Variations in Diameter depending on Longitudinal Ti-rods

When center less grinding rods are used the roundness can be affected by improving the intensity. Errors are bound to happen as Titanium rods which changes diameter according to length are made with normal process.

**Fig. 3**
After measuring the diameter of the stored Titanium rods then scheduled to be classified according to the range of diameter of diameter

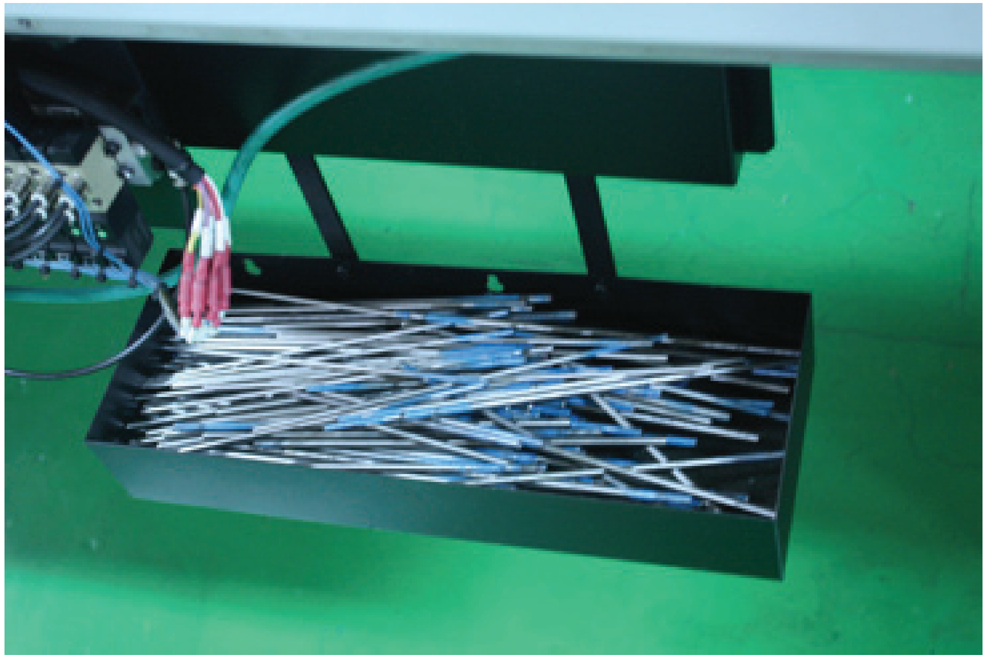

**Fig.4**
Remnants after use

## 2) Manufacturing of Guide Bush Type Guide Bush and Degree of Gaps on materials.

**Fig. 5**
Guide Bush and Chuck
Slot for Gap Adjustment according to Diameter of the materials

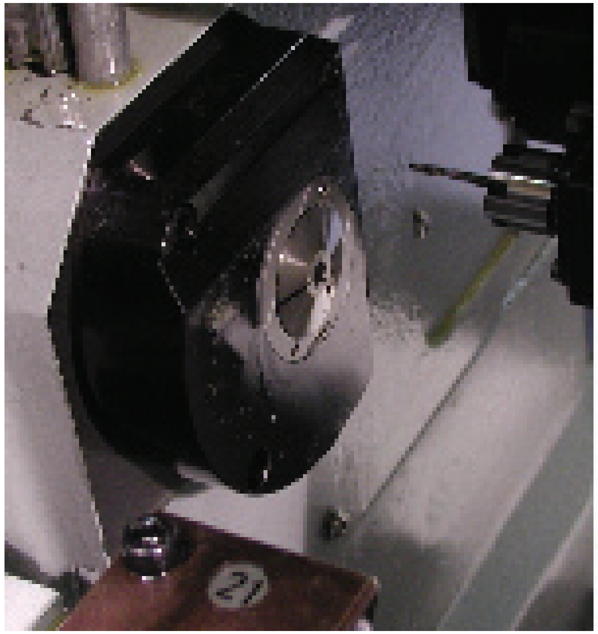

**Fig. 6**
Installed image after Gap Adjustment

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### 3) Manufacturing Impact on Ball Bearing Space which is inserted into the Guide Bush Unit as he Titanium Rods are processed using the Guide Bush

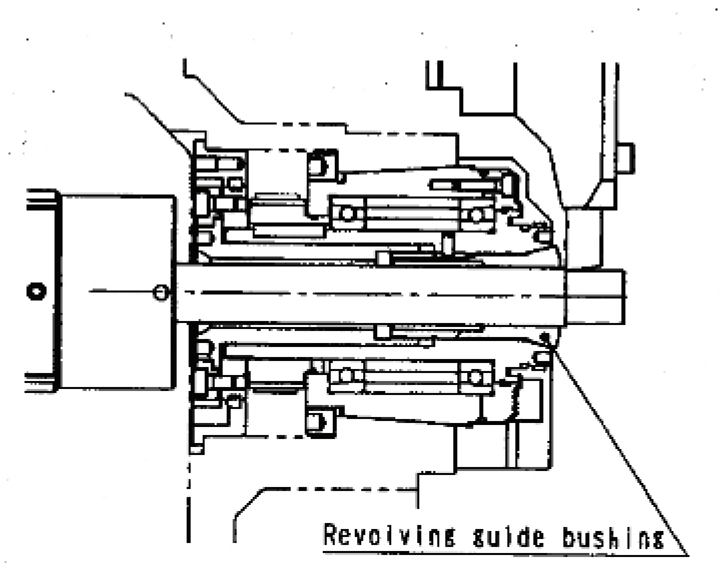


**Fig. 7** Rotary Guide Bush Type must install 2 to 4 Ball Bearings

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## 4) Main Chuck holding and turning the titanium rods and the manufacturing accuracy according to Guide Bush's own precision


**Fig. 8** measured precision in the Guide Bush production maker
In this case if ±3μm is classified as AA grade, precision is considered the best)

## 5) Choice of Tools and Changes according to Manufacturing Conditions

Every tool maker can produce the best result according to processed goods. As tool manufacturers' efforts continues up until now only made in Switzerland, Germany and Sweden tools has the best characteristics. For example, Switzerland's Diametal for Turning, DIXI for Drill and Germany's Zecker could be included. In addition, in Japan, Israel and elsewhere, many kinds of tools are being produced. As its application in the manufacturing sites continues, with failures and repeated effort, one can look forward to best processing conditions. In this area, when NC programming is separated from Tooling, in NC production, preferably lots of manpower is needed more than the NC programmer.

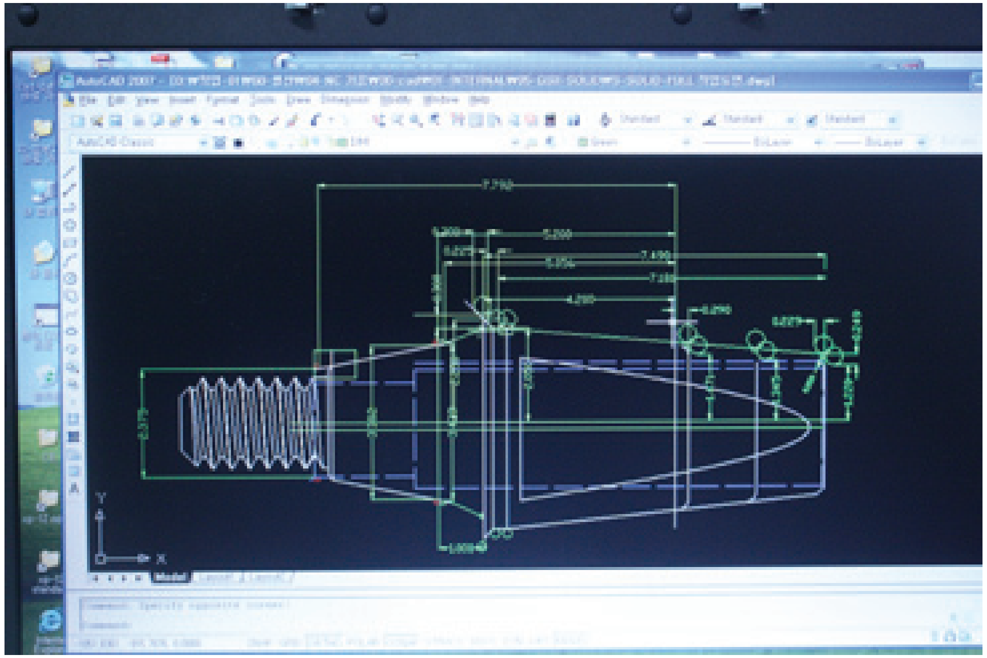

**Fig. 9**
In the CAD drawing, Nose-R tool is chosen as Path tool is selected

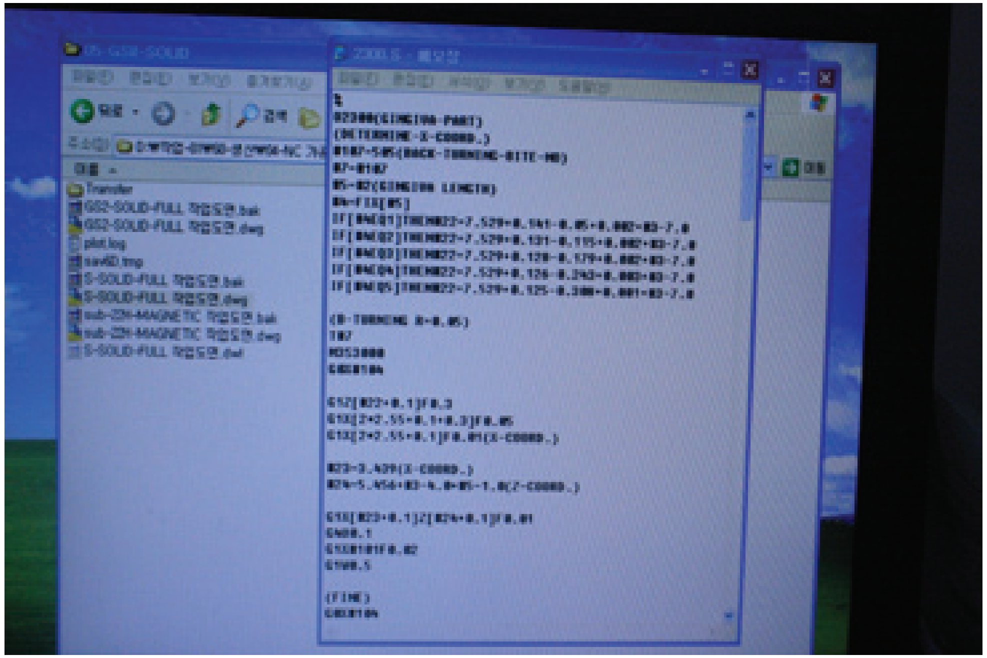

**Fig. 10**
Fit the final machine to be used and the NC program is complete

## 6) Effect of Tools Abrasion on Manufacturing Accuracy

If a tool used is with abrasion, the build-up edge formed by fusion, chipping etc. the tool appearance is accompanied by deformation; this immediately affects the final work piece precision. Accumulated data can accurately predict the minimum defects and establish the foundation for a stable production.

## 7) Effect of Cutting Lube on Manufacturing Accuracy

When a tool is used, heat occurs due to friction. Thus cutting lube whose role is cooling and lubricating is very important. Particularly in the case of implants, thorough cleaning must be done henceforth in cutting lube selection, environmental friendliness and detergence acts as very important factors.


**Fig. 11**
Swiss Type Portable Lathing must use insoluble cutting lube according to every cutting  lube maker's detergence effect

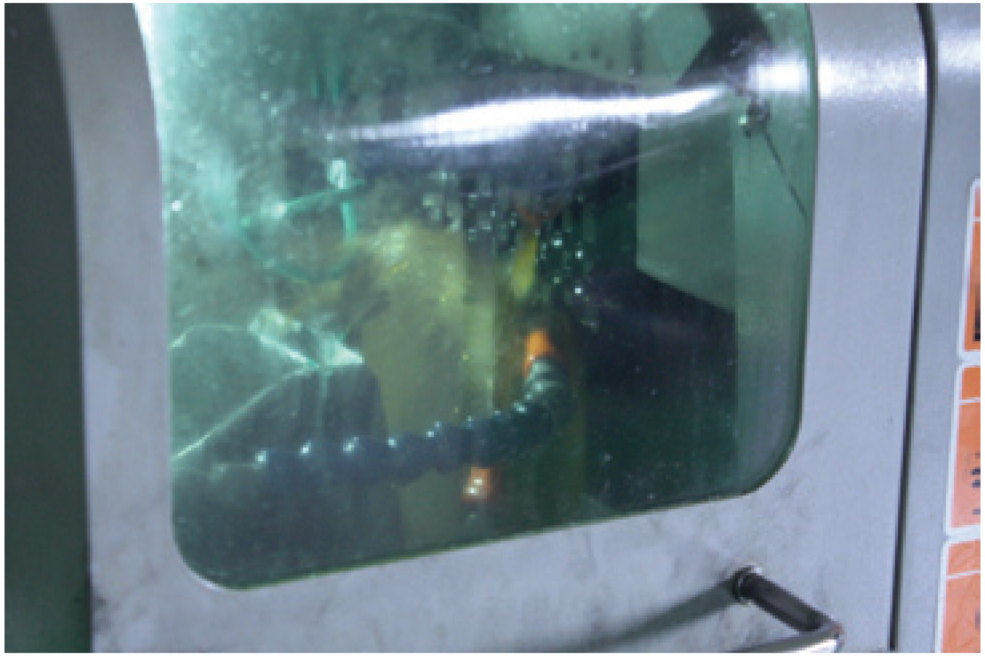

**Fig. 12**
Machining Cutting Lube's dispensing Form

## 8) Effect of Manufacturing Laborer's Workmanship and Know-how on Manufacturing Accuracy

In the field of manufacturing, experience and know-how is very important. The worker's job has a lot of correlation with diligence and perseverance. Of course, lots of efforts are done to minimize the worker's range of errors through standardization.

## 9) Effect of Vibration and Machine's Temperature Change according to time on the Manufacturing Accuracy

**Fig. 13**
An equipment with a center rest structure is used to minimize the proceeding supplied materials and the forthcoming vibrations

10) These can all be done better for improvement but at the moment the impossible part to be resolved by the NC technology is the need to use X, Z axis in manufacturing the Taper surface. If a worker cannot resolve the errors that arise in the Linear Interpolation Algorithm, in reality, we can only depend on the precision of relevant engineering.

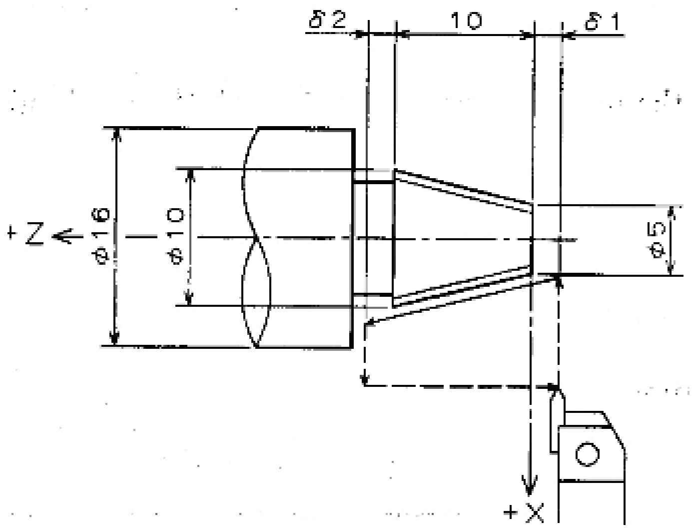


**Fig. 14**
For the sake of Taper Surface Air Hole, the X-axis and the Z-axis has to move at the same time
(Here the Linear Interpolation Algorithm operates)

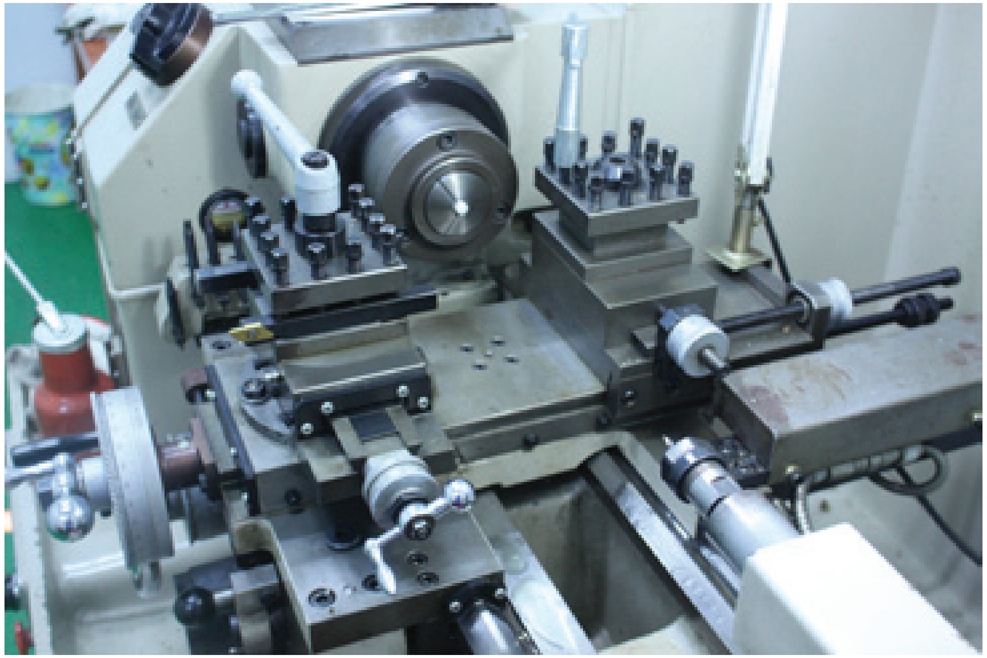

**Fig. 15**
In manufacturing the Taper the angle of the Tool Rest Head in Manual Lathe is adjusted and more precise (than NC) manufacturing can be done.

## 1-4. Methods of Improving the Manufacturing Process to resolve the problems of Surfaces Interlock

In the mechanical field, the final manufactured product that comes out of the conventional lathe machine has Feed Marks for precise machining thus the grinding process passes for certain which raises the precision by one level. Therefore chuch like turning lathes such as surface roughness is not good as well as the principle of lathe focus because it is difficult to expect the grinding stone to be the source of the grinding process.

However in Implant Normal Processing, the fixture’s gauge size is no more than 3.5mm which is very small. The second processing by polishing is very difficult in reality. Although precision machining is done by polishing the abutment’s external diameter, precision machining on the fixture’s inner side can only be done on one side thus a good joining method is very difficult.

Up until now, the only way to resolve the surface interlock problems when joining the inner of the Fixture with the external of the abutment is by precision machining that is quite costly and difficult.

# 02 Microscopic Viewpoint of present Surface Interlock Conditions

As mentioned in the previous section, there's surface roughness in the Feed Mark seen on surface condition after lathe machining.

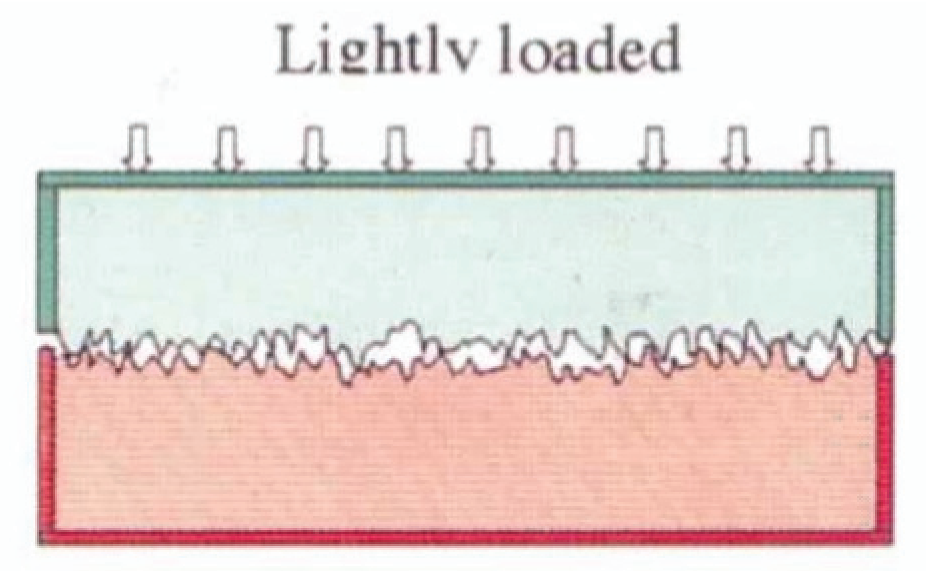


**Fig. 16**
Contact Surface Model Considering Processing

# 03 Methods of Design Improvement to Resolve Surface Interlock Problems

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### 3-1. Microscopic Viewpoint of Bicon's method solution

From 1985 in Bicon, surface interlock problems in the surface model were established as mentioned above, several problems arising from resolutions of unsolved declination of 1.5 degrees without using a screw were introduced.

This design concept is examined in the following:

- When the abutment in inserted into the fixture and the two surfaces are locked, the clamping force in the contact surface arise and shows that the vertical force in the surface interlock lowers the parallel horizontal force.

- The surface condition does not lead to motion in the lowered horizontal force. The following describes the theory of the smoothing in surfaces interlock caused by decrease in Preload existing state.

Ken reported that loosening occurs in two surfaces joined by screw and the two surfaces interlock go through the same process.

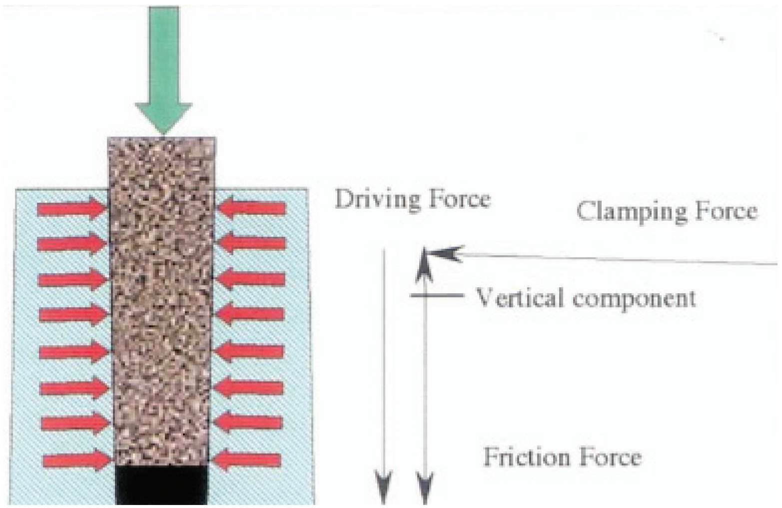


**Fig.17**
The shown forces dynamics in the contact surface of the fixture and abutment

- Surface Interlock Asperities are maintained when low surface pressure is given to the surface interlock (this is the primary stage of the surface interlock at the same time the contact has started)

- Continuously increasing the surface pressure (namely the increase in Preload), force is applied in advance to the bumps on the joined surface and this bumps rise in the Interlock and in the bumpy portion partial Welding happens.

- If horizontal force is applied in this condition, minute leveling movement happens, as the bumps act to fill each other, the spaces on the two surfaces disappear and the result is the decreased effect of the vertical force on the surface.

- Because of the decreased Preload on the initial screw this results in screw loosening.

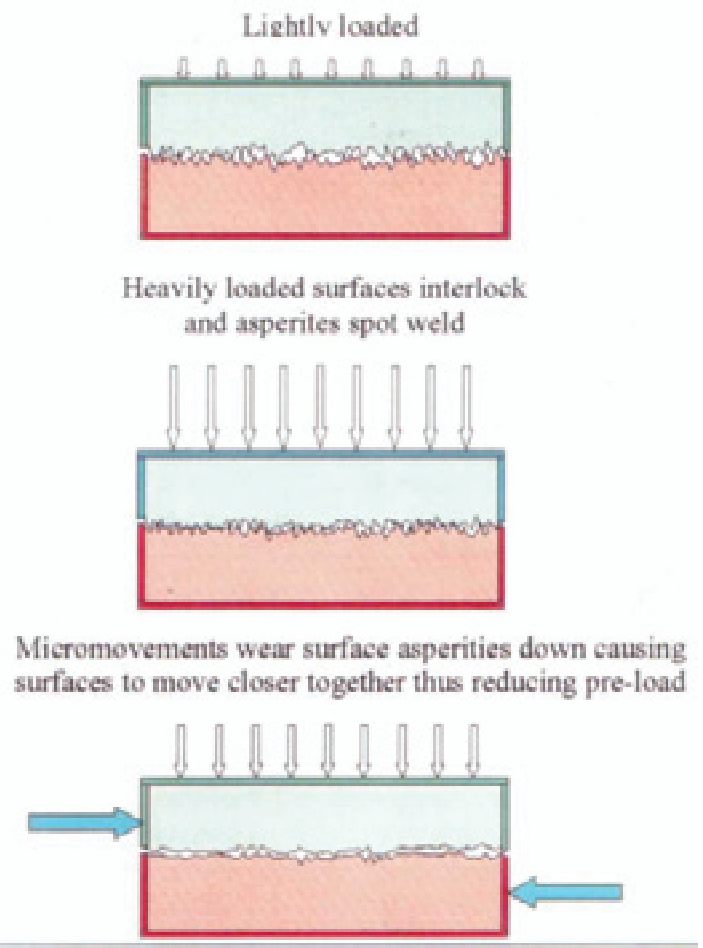


**Fig. 18**
Surface Model describes the loosening effect when Preload is applied on the two surfaces because of the screw tightening force and the case of receiving horizontal force

The generated mechanism for the design concept for the processed surface is specially considered as the horizontal force on the two joined surface structure arise. It explains that bumps on the surface are disrupted by the decrease in the Preload of the Screw's tightening force due to the Screw loosening. When the prosthesis is initially placed, after a few days when enough chewing force is received, the screw is again tightened and sinking does not appear anymore.

In Macroscopic Viewpoint, the present contact surface Roundness is not considered and only the surface bumps after processing in Microscopic viewpoint, which seems to be resolved.

## 3-2. Resolution Method at UFIT Implant Inc. – Macroscopic Viewpoint

As mentioned in 1, after lathe machining the surface characteristics such as roundness i.e. surface roundness has faults. That is unless the two things need to be perfect so as not to prevent the processing. Therefore if a structure to resolve these faults is not designed, these two will lead to unintended wrong result whenever they are used.

Two resolutions are proposed at the same time in this research. As seen above mechanically in the microscopic viewpoint, wear happens in the small regions as excessive force is applied and shear down is caused by the horizontal movement on the uneven regions. If the contact surface is extended, these conditions are reduced. Also when grooves are put on the flat surface of the epicenter of the circumference, connection is increased and complete epicenter contact is gained and this principle is used to resolve the problem. This principle can also be easily seen around us.

The principles of sealing abutment are easily discovered around us.

Tire treads | Sealing effect of a piston ring | Soles of shoes

**Fig. 19**
Typical Examples of effectively joining two surfaces

## 4-1. Proposal and Resolution on the Actuality

In a long time, in the range of surface interlock problems, the most serious is the occurrence of gaps in the contact surfaces. The examiner has discovered this in the microscopic level and as the standard on defects is vague; this is always open for debate. Therefore to improve the contact of two surfaces, grooves should be engraved in processing and the size of the size of the said grooves will be verified.

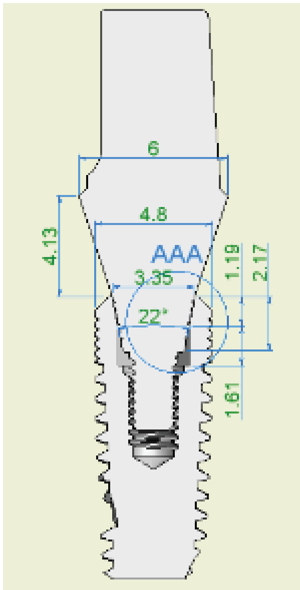


**Fig. 20** Sealing Abutment Actuality

## 4-2. Stress Analysis

Knowing the allowable load the materials are able to withstand when processing the grooves in the contact surface mechanically and also the changes that occur is very important in seeing the effect of the Sealing Groove.
The Mechanical properties of Titanium (Ti-6Al-4V ELI) can be seen in the following.

| | |
|---|---|
| *Density* | 4.620g/cm$^3$ |
| *Young's modulus* | 9.6 x 10$^4$MPa |
| *Poisson's ration* | 0.36 |
| *Tensile Yield strength* | 9.3 x 10$^2$MPa (94.86kgf/mm^2) |
| *Compressive Yield strength* | 9.3 x 10$^2$MPa (94.86kgf/mm^2) |
| *Ultimate Tensile strength* | 10.7 x 10$^2$MPa (109.1kgf/mm^2) |

**Mechanical properties of Titanium (Ti-6Al-4V ELI)**

(Unit : 10$^2$MPa= 10.2kgf/mm^2)

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Simply, when joining force of 35N-cm is applied to the screw, to some extent the mechanical form that is happening can be seen. Stress analysis result is shown.

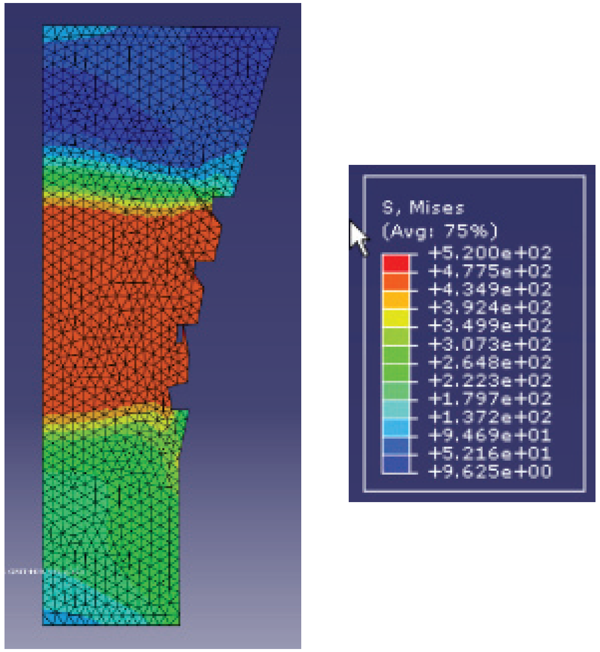



**Fig. 21** Stress Distribution

When a concentrated form of stress in the contact surface region with the size of 470N/mm^2 (48kgf/mm^2) appears, this stress in the elastic region is evenly distributed all over.

Displacement distribution can be seen.

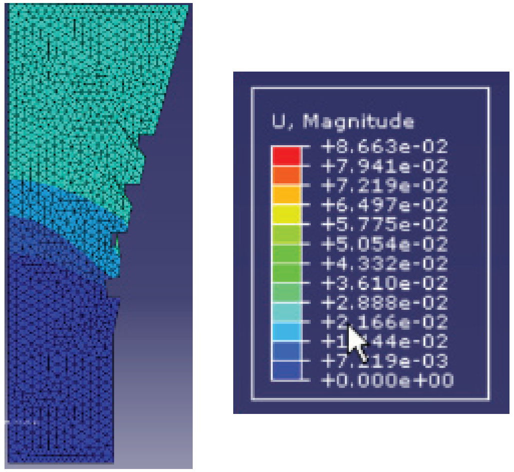


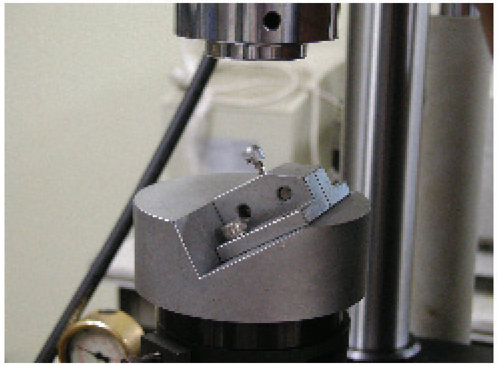

**Fig. 22** Displacement Distribution

The displacement distribution result shows that maximum displacement is within 0.02MM and the transformation that occurs because of the chewing pressure can be ignored to some extent.

Therefore this two analysis results show that the screw joined with the surface can afford the chewing pressure.

## 4-3. Effect of Sealing Groove as shown in the Fatigue Experiment

As per FDA Approved ISO 14801 Fatigue Experiment regulations, a maximum of 250N and minimum of 25N of repeated loads is applied to withstand 5 million times. Fatigue experiment was also done on the Sealing Abutment to get approval.



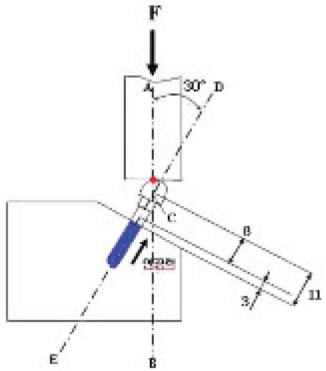
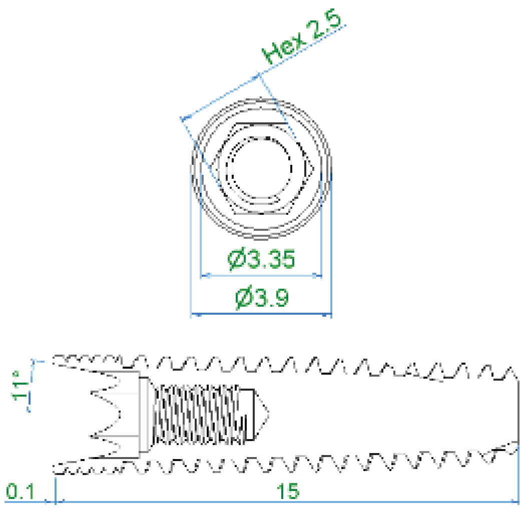
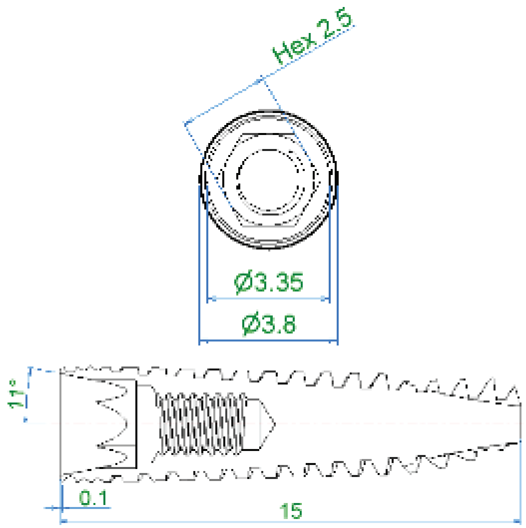
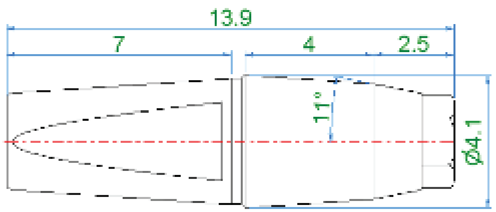
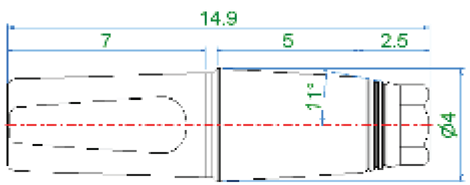



**Fig. 23** Schematic diagram of experimental system
ISO 14801 (The International Organization for Standardization)

## 4-3-1. Fatigue Experiment Result Comparison of Conventional Non-Groove Type Abutment and Sealing System Abutment

### (1) Product Details

| *Specimen* | *Non–Groove Abutment* | *Sealing System* |
|---|---|---|
| *Fixture* | <br>GT2 3915MT | <br>YS 3315 |
| *Abutment* | <br>22HTAN 3470 | <br>STA 405070H |

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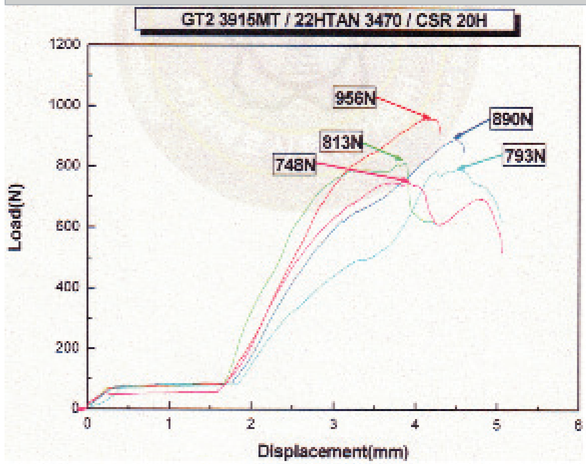
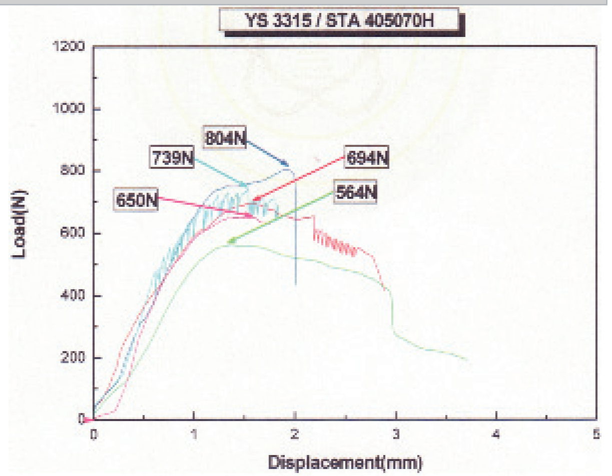
## (2) (K)University Analysis Result on Biological Materials Research at Dental Materials Test and Evaluation Center

### (2-1) Static Compression Analysis Result

| Non-Groove Abutment | | Sealing System | |
|---|---|---|---|
| Static Compression Test Data | | | |
| Specimen No. | Maximum Static Compression Strength | Specimen No. | Maximum Static Compression Strength |
| 1 | 956 | 1 | 694 |
| 2 | 813 | 2 | 564 |
| 3 | 890 | 3 | 804 |
| 4 | 793 | 4 | 739 |
| 5 | 743 | 5 | 650 |
| Standard ± Standard Deviation | 840±83 | Standard ± Standard Deviation | 690±91 |

Experiment Graph



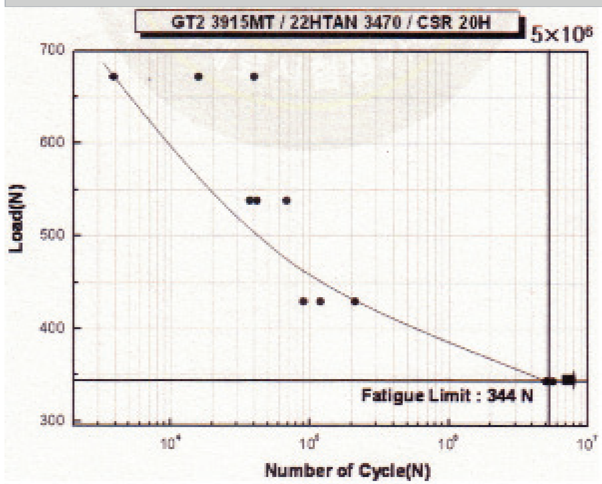



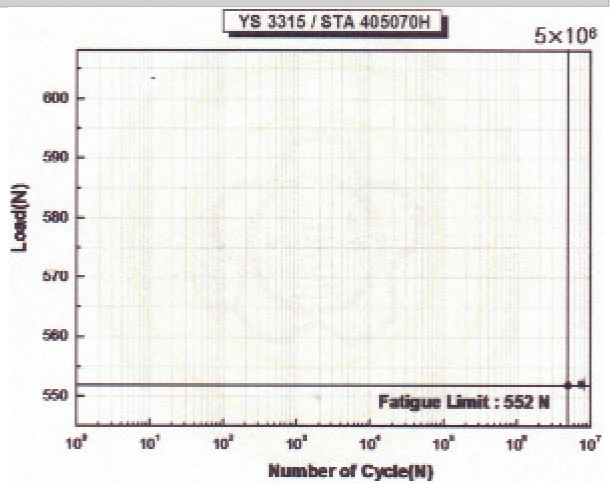
## (2-2) Fatigue Experiment Analysis

| Non–Groove Abutment | | | Sealing System | | |
|---|---|---|---|---|---|
| Fatigue Experiment Data | | | | | |
| Load (N) | Failure Cycle | | Load (N) | Failure Cycle | |
| 672 | Specimen 1 | 15,888 | 552 | Specimen 1 | 5,000,000 |
| | Specimen 2 | 3,896 | | Specimen 2 | 5,000,000 |
| | Specimen 3 | 39,982 | | Specimen 3 | 5,000,000 |
| 538 | Specimen 1 | 41,875 | | | |
| | Specimen 2 | 69,076 | | | |
| | Specimen 3 | 37,613 | | | |
| 430 | Specimen 1 | 90,459 | | | |
| | Specimen 2 | 212,755 | | | |
| | Specimen 3 | 118,825 | | | |
| 344 | Specimen 1 | 5,663,108 | | | |
| | Specimen 2 | 5,253,929 | | | |
| | Specimen 3 | 5,056,402 | | | |

552N and 55.2N Fatigue Load corresponds to 80% of Static Compression Load (690N) is applied and Fatigue Failure did not occur. (Fatigue Endurance Limit is through the 500th)

Experiment Graph



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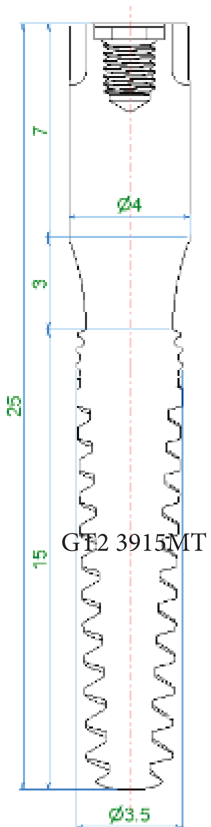
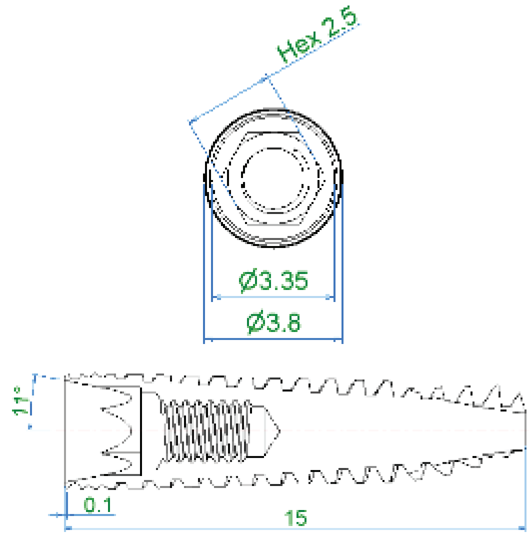
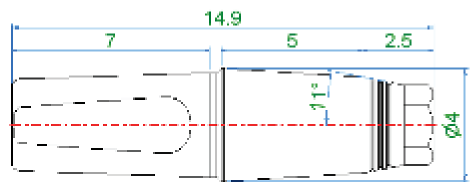
## 4-3-2. Fatigue Experiment Analysis Comparison of One-Body Type Fixture and Sealing Abutment System

### (1) Product Details

| *Specimen* | *One–Body Type Fixture* | *Sealing System* |
|---|---|---|
| *Fixture* | <br>GT2 3915MT | <br>YS 3315 |
| *Abutment* | 22HTAN 3470 | <br>STA 405070H |

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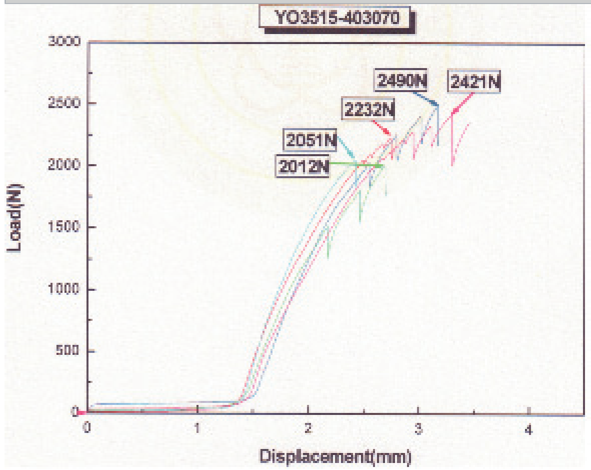
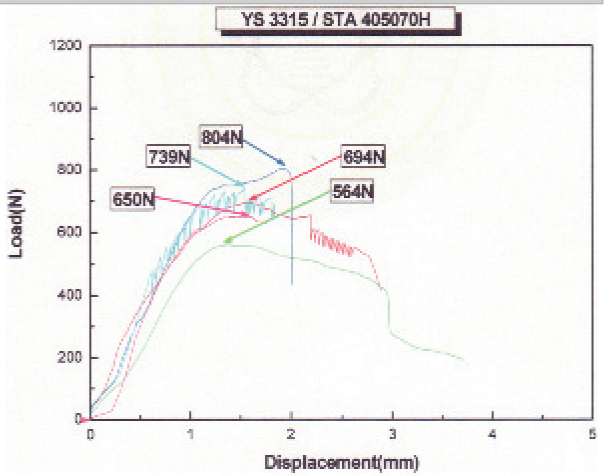
## (2) (K)University Analysis Result on Biological Materials Research at Dental Materials Test and Evaluation Center

### (2-1) Static Compression Analysis Result

| YO 3515-403070 | | Sealing System | |
|---|---|---|---|
| Static Compression Test Result | | | |
| Specimen No. | Maximum Static Compression Strength | Specimen No. | Maximum Static Compression Strength |
| 1 | 2232 | 1 | 694 |
| 2 | 2012 | 2 | 564 |
| 3 | 2490 | 3 | 804 |
| 4 | 2051 | 4 | 739 |
| 5 | 2421 | 5 | 650 |
| Standard ± Standard Deviation | 2241±214 | Standard ± Standard Deviation | 690±91 |

Experiment Graph



## (2-2) Fatigue Experiment Analysis

**Fatigue Experiment Data**

*Non–Groove Abutment*

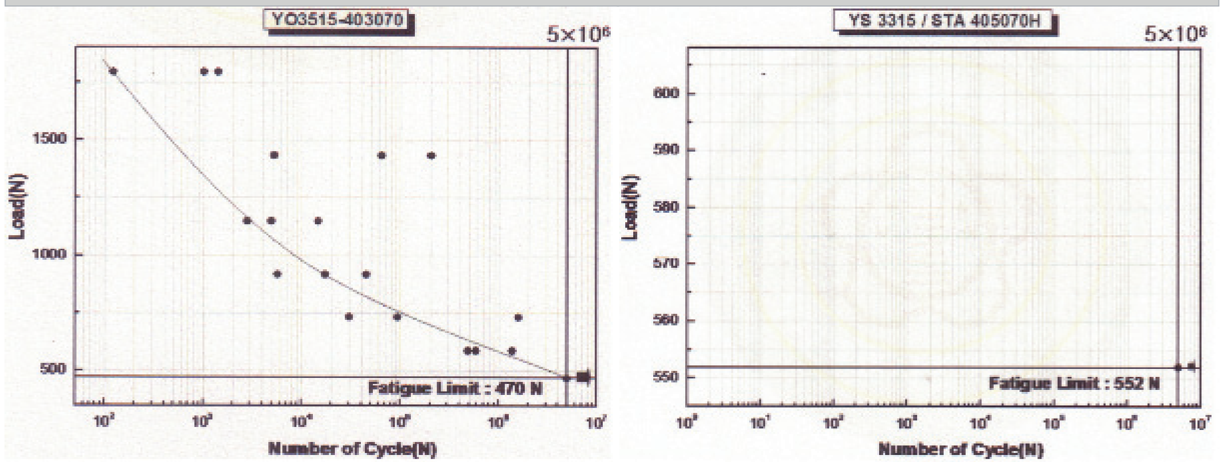
| Load (N) | Failure Cycle | |
|---|---|---|
| 1793 | Specimen 1 | 1,023 |
| | Specimen 2 | 1,424 |
| | Specimen 3 | 122 |
| 1434 | Specimen 1 | 64,961 |
| | Specimen 2 | 5,329 |
| | Specimen 3 | 205,371 |
| 1147 | Specimen 1 | 14,592 |
| | Specimen 2 | 4,975 |
| | Specimen 3 | 2,853 |
| 918 | Specimen 1 | 5,743 |
| | Specimen 2 | 47,290 |
| | Specimen 3 | 17,357 |
| 734 | Specimen 1 | 1,617,024 |
| | Specimen 2 | 94,926 |
| | Specimen 3 | 30,307 |
| 588 | Specimen 1 | 484,921 |
| | Specimen 2 | 587,103 |
| | Specimen 3 | 1,394,991 |
| 470 | Specimen 1 | 5,000,000 |
| | Specimen 2 | 5,000,000 |
| | Specimen 3 | 5,000,000 |

*Sealing System*

| Load (N) | Failure Cycle | |
|---|---|---|
| 552 | Specimen 1 | 5,000,000 |
| | Specimen 2 | 5,000,000 |
| | Specimen 3 | 5,000,000 |

552N and 55.2N Fatigue Load corresponds to 80% of Static Compression Load (690N) is applied and Fatigue Failure did not occur. (Fatigue Endurance Limit is through the 500th)

**Experiment Graph**



# 05 FEM Result on the Sealing Abutment

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Analysis is done after the abutment is locked to the fixture by a screw of 35N-cm and the prosthesis is put on then an assumed relevant pressure of 25kgf (250N) of chewing force is applied.

### 5-1. Used Program : ANSYS V12.1

### 5-2. Mechanical properties of Titanium

| | |
|---|---|
| *Density* | 4.620g/cm$^3$ |
| *Young's modulus* | 9.6 x 10$^4$MPa |
| *Poisson's ration* | 0.36 |
| *Tensile Yield strength* | 9.3 x 10$^2$MPa (94.86kgf/mm^2) |
| *Compressive Yield strength* | 9.3 x 10$^2$MPa (94.86kgf/mm^2) |
| *Ultimate Tensile strength* | 10.7 x 10$^2$MPa (109.1kgf/mm^2) |

(Unit : 10$^2$MPa= 10.2kgf/mm^2)

### 5-3. Mesh Generation

### 5-2. Mechanical properties of Titanium

Nodes : 124,111 Nodes
Element : 76,741 Elements

## 5-4. Boundary Conditions

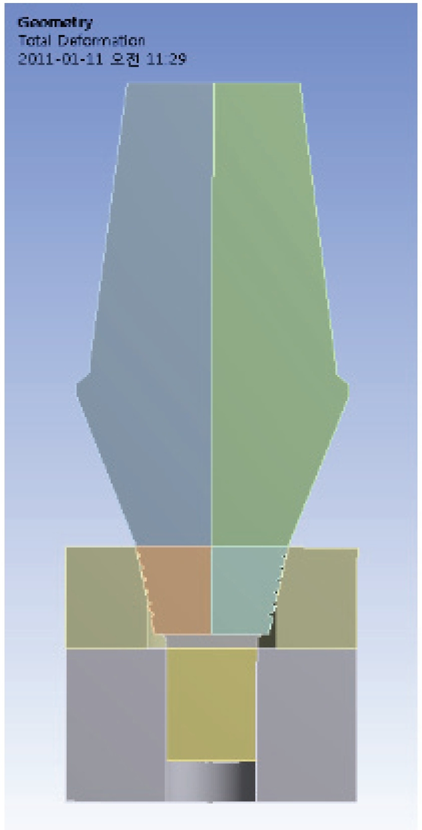



**Fig. 51** Modeling

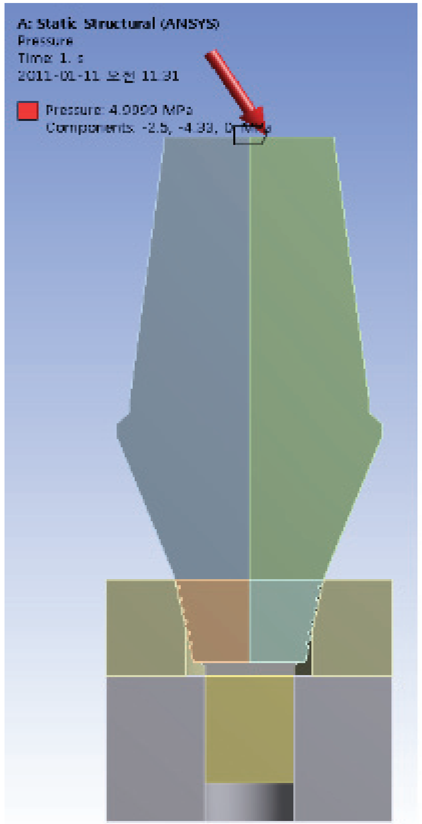



**Fig. 52** 5MPa on 30˚ Tilt pressure
(25kgf of pressure is applied to the top surface)

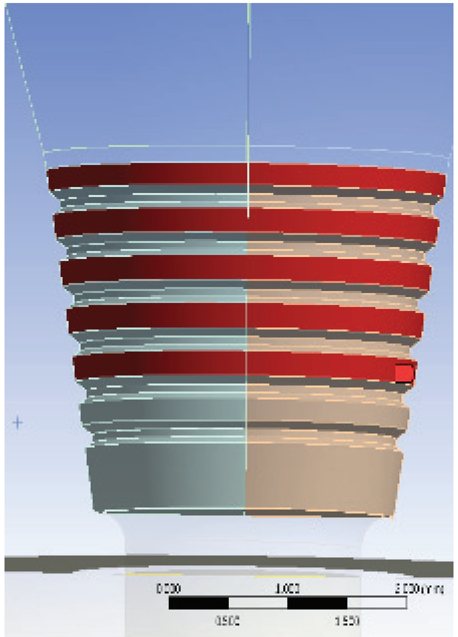


**Fig. 53** Frictional Contact Conditions

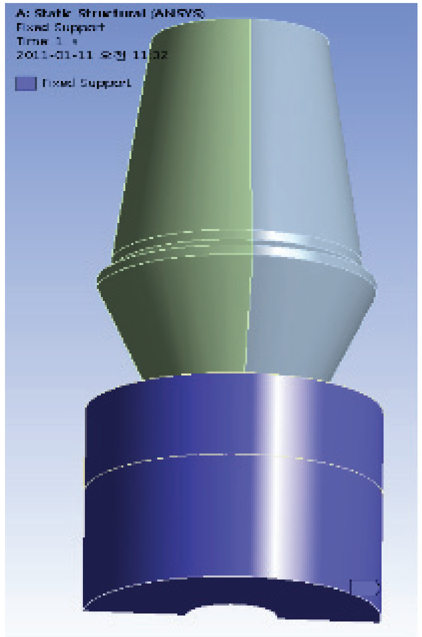



**Fig. 54** Fixed Support

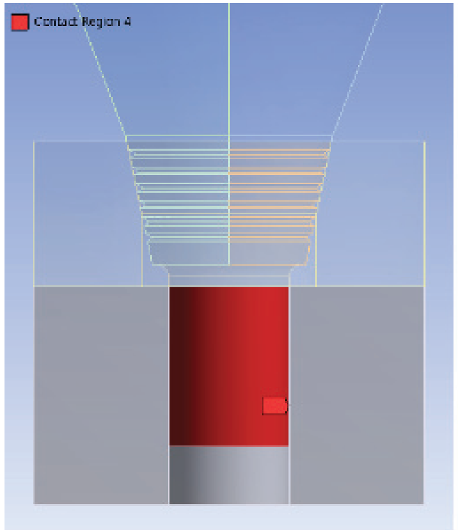



**Fig. 55** Bonded Contact Conditions

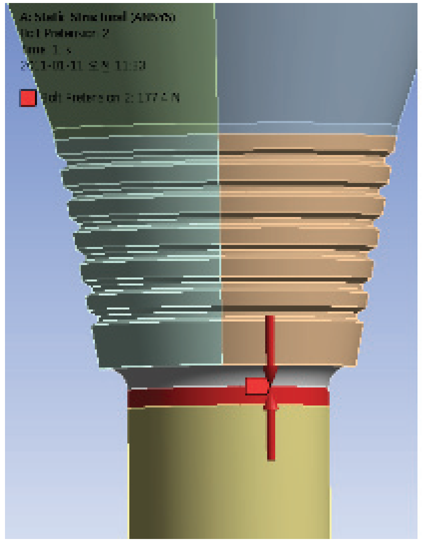
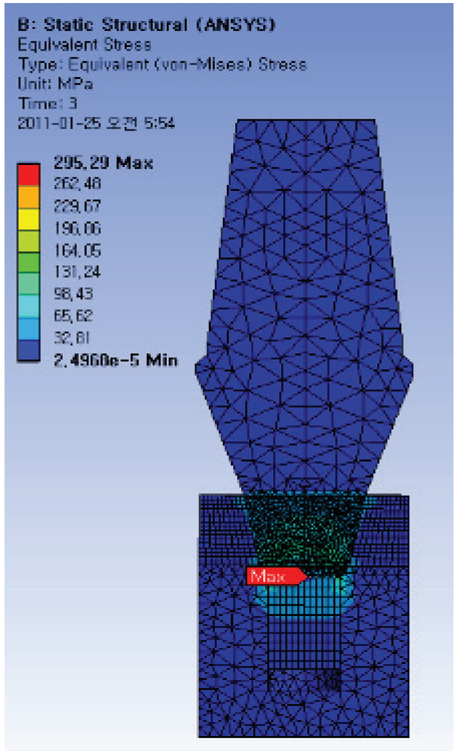
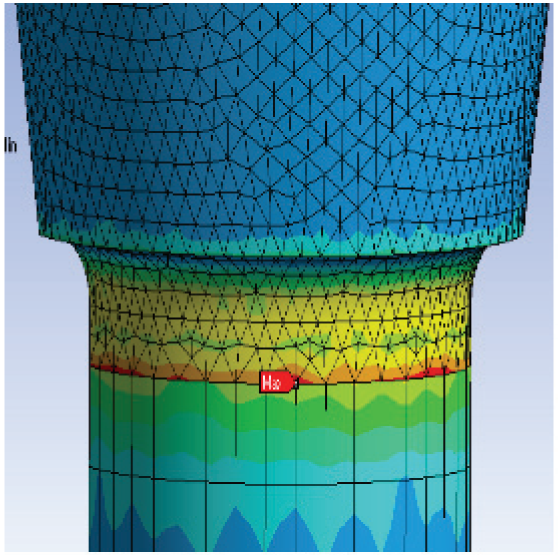


**Fig. 56** Joining Force Direction (177.4N)
(Locked at 35N-cm Torque action)

## 5-5. Analysis Conditions

### (1) Fastening of Screw to the Conventional Abutment



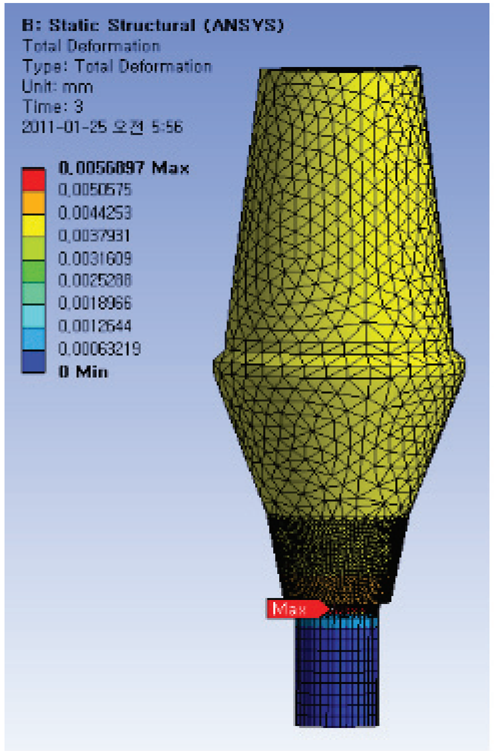



**Fig. 57** Stress Result

**Fig. 59** Displacement Result

## (2) Bending action relevant to chewing pressure on the top region after the Screw is fastened to the Conventional Abutment

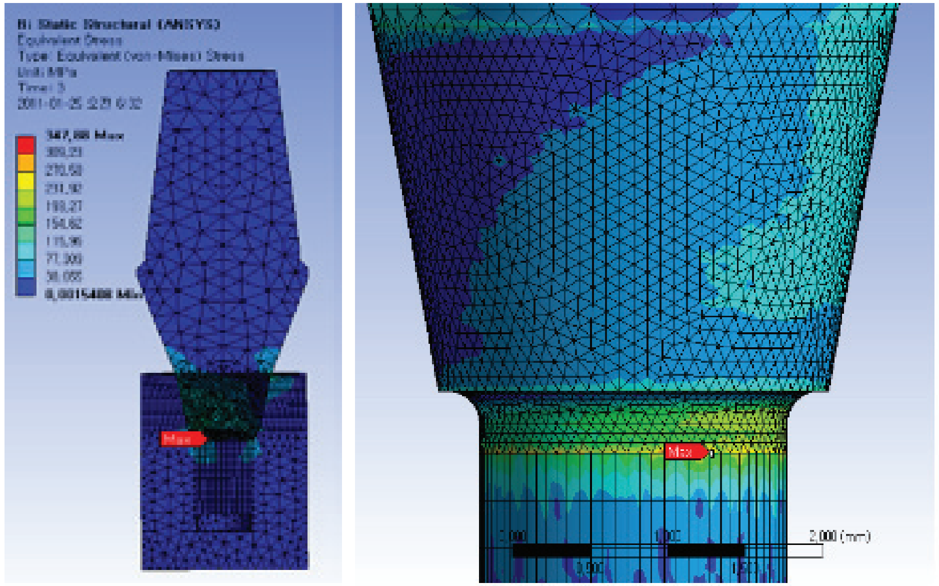



**Fig. 60** Stress Result (Joining Force + Bending)

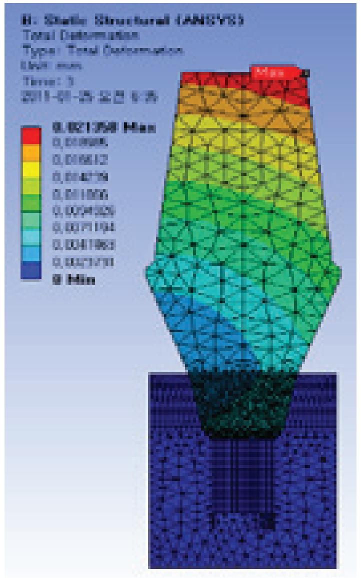



**Fig. 62** Displacement
(Joining Force + Bending)

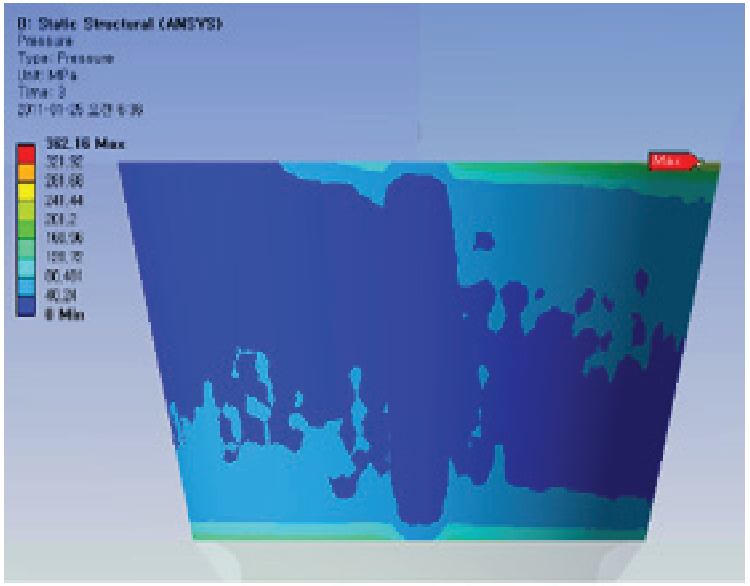



**Fig. 63** Pressure
(Joining Force + Bending)

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## (3) Fastening of Screw to the Sealing Abutment

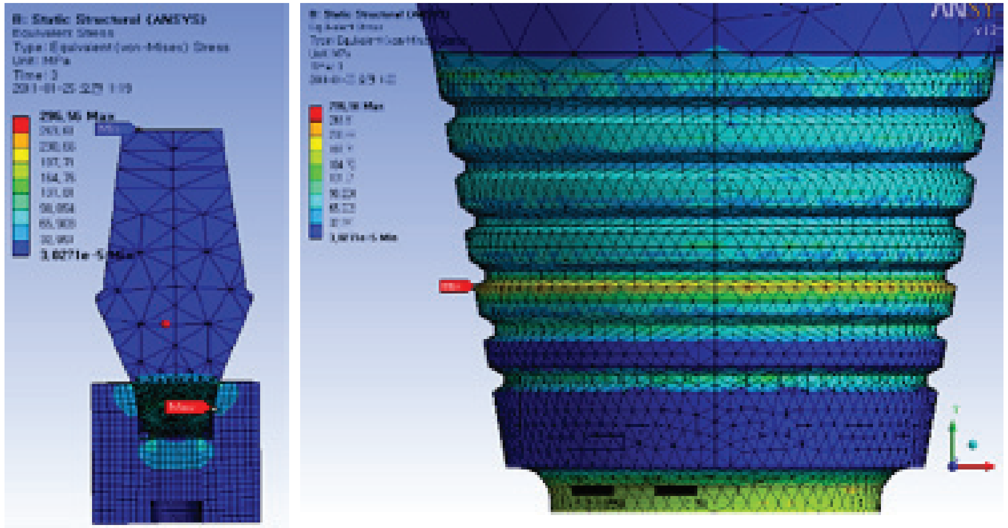


**Fig. 64** Stress

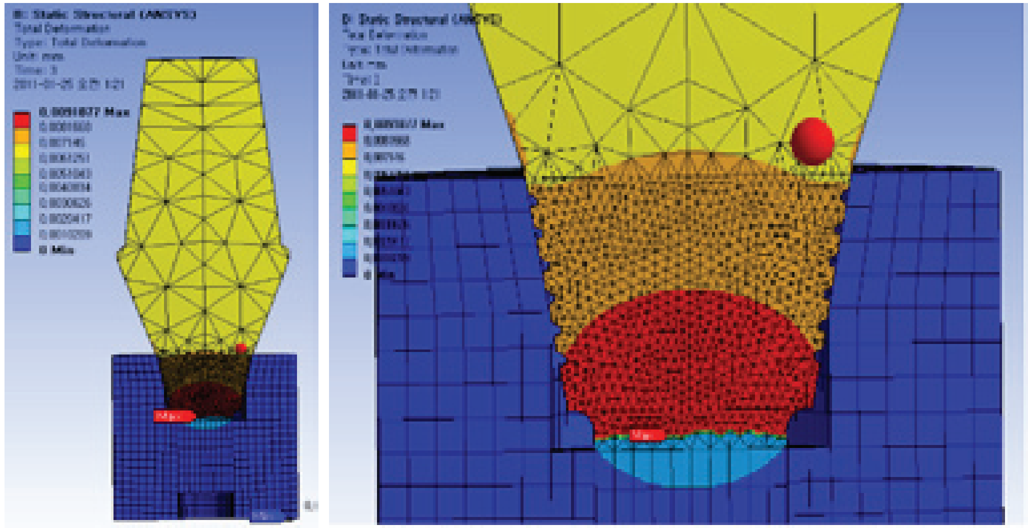


**Fig. 66** Displacement Joining Force

(4) Bending action relevant to chewing pressure on the top region after the Screw is fastened to the Sealing Abutment

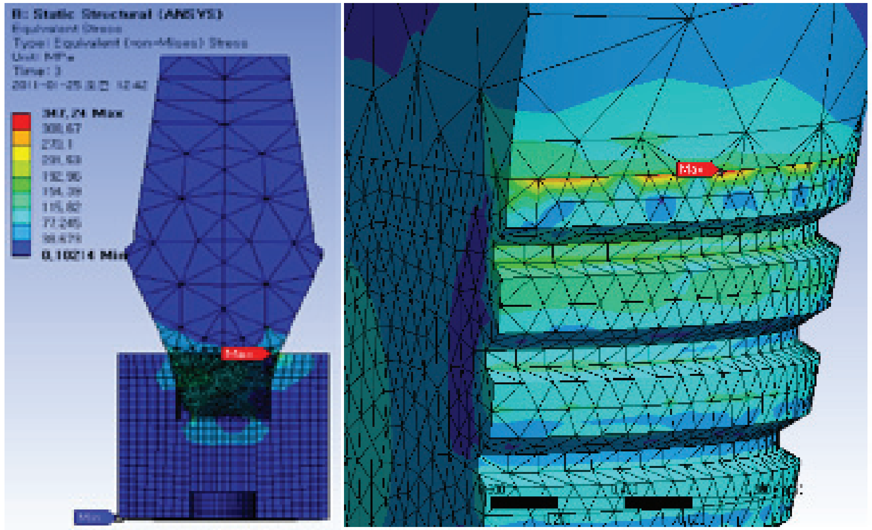


**Fig. 68** Stress (Joining Force + Bending)

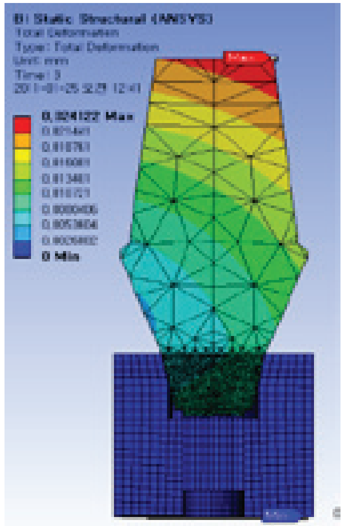


**Fig. 70** Displacement

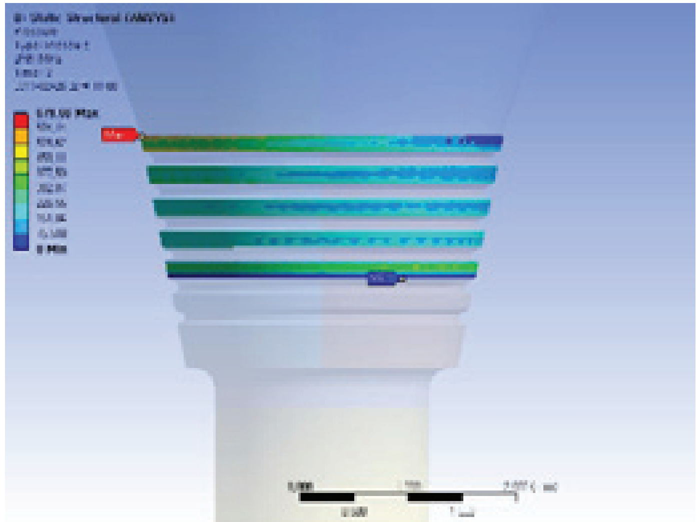


**Fig. 71** Pressure (Joining Force + Bending)

## (5) Examination

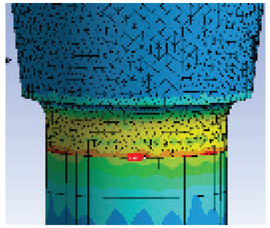
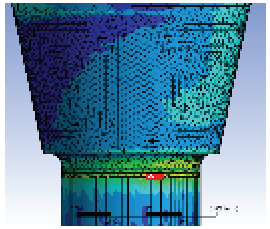
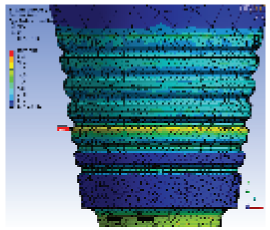
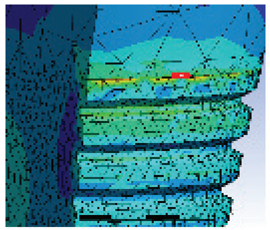
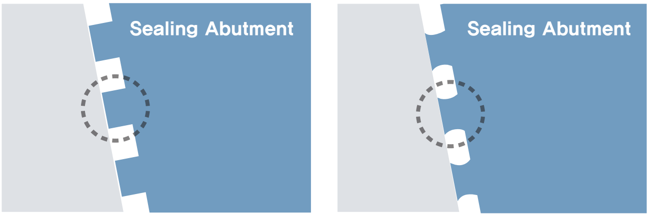
| | Stress | Displacement | Contact Displacement Pressure | Max Stress Location |
|---|---|---|---|---|
| (1) Non–Groove Screw Lock | $5.69 \times 10^{-3}$mm | 694 | Confirmation not needed |  |
| (2) Non–Groove Screw Lock Chewing Force Applied | $2.14 \times 10^{-2}$mm | 564 | 362.16Mpa |  |
| (3) Groove Screw Lock | $9.19 \times 10^{-3}$mm | 804 | Confirmation not needed |  |
| (4) Groove Screw Lock Chewing Pressure Applied | $2.41 \times 10^{-2}$mm | 739 | 681.08Mpa |  |

**Table 9** From Contact Displacement Pressure's Viewpoint, Sealing with grooves is the most effective

The most important decision that can be made in this analysis result is taking surface interlock into consideration. As shown above, after the fixture and the abutment is fastened and a 25kgf of chewing pressure is applied to a 30˚ tilt, the minimized region of the contact surface is noticeably smaller. This is shown in the following forms that happen in the Sealing Groove.

# 5. FEM Result on the Sealing Abutment

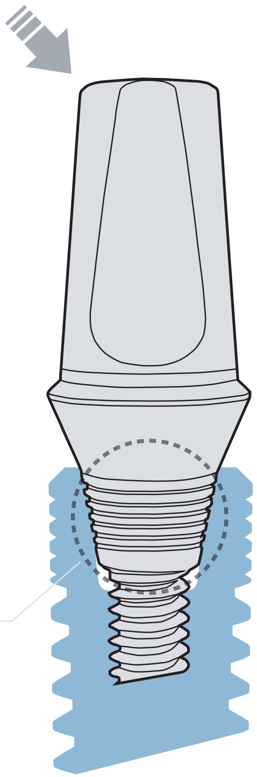




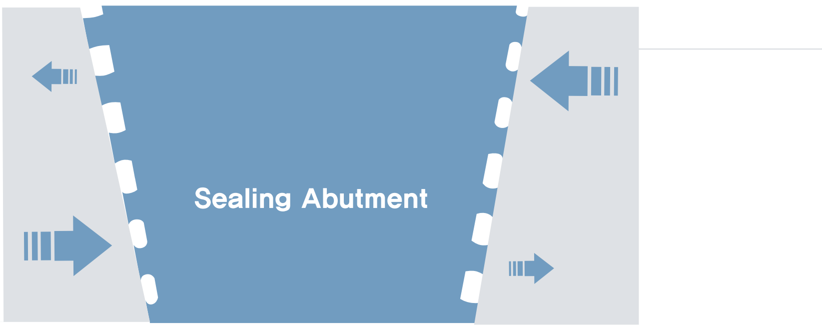

Before fastening the Abutment Screw

After fastening the Abutment Screw

When the abutment screw is fastened, elastic modification occurs around the grooves of the sealing abutment, creating a force which moves the abutment and fixture together.



## The reason why Sealing abutment is strong against fatigue (2)




The circular pattern section of Abutment receiving chewing forces

As shown in the figure above, chewing forces are experienced asymmetrically due to the grooves of the sealing abutment acting as an elastic body. This firmly maintains the sealed state of the abutment and distributes the chewing forces evenly in the fixture.

Namely, as soon as the Sealing Groove is locked to the Abutment Screw, elastic deformation happens in the interior of the groove due to asymmetry even when additional chewing force is received. This sealing effect works every time due to restoration of elastic deformation.

**Fig. 76** Role of Grooves in the Sealing Abutment

# 06 Role of Grooves in the Sealing Abutment from a Mechanical Engineering Perspective

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In the field of machinery, different methods are used to prevent the screw from loosening according to their causes.

## 6-1. Causes of Screw loosening

3 Causes of screw loosening as per analysis of the screw form

### (1) The length of the screw expands when external force is applied to the Bolt and Nut's tightening system

Counter-measures are as follows:
1) Bolt & But is replaced with strong quality.
2) Diameter is raised.
3) Shorten the rest if possible except for the effective threads

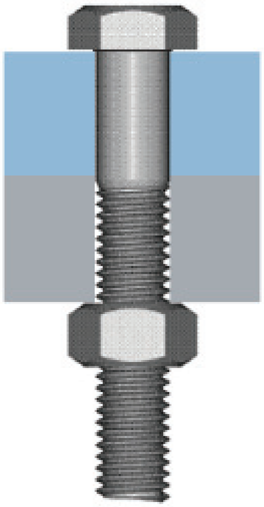


**Fig. 77** Bolt & Nut Tightening Object

## (2) Nut reverts due to vibration and other materials (lubricants)

Counter-measures are as follows.
1) Use a nut that prevents loosening.
2) Use a filler.
3) Use a set screw.

**Fig. 78**
Loosening Prevention Nut


**Fig. 79**
Sealant adhesive to fill the Bolt and Nut top region

**Fig. 80**
Set Screw is fastened to prevent Nut revertion

## (3) These measures are used when materials are trapped in between the bolt and nut which creates gap as the thickness is decreased.

1) Spring washer is used

Many ideas can be adopted from the suggested methods above but the most important are the different provisions according to the cause.

**Fig. 81** Spring Washer is used to compensate for the thickness decrease

## 6-2. Function of loosening prevention in Sealing Abutment

Among the above mentioned, (3) Gaps appear in between the bolt and nut as the thickness is decreased when materials are trapped, has the function to prevent loosening. The clamping force of the screw in the grooves of the sealing abutment raises the elastic deformation and later when chewing force is received, elastic recovery function is restored and prevents the screw from loosening.

# 07 Review of Other Companies' Abutment Design Concept

## ISP SCRP Multi Abutment's Sinking Prevention System

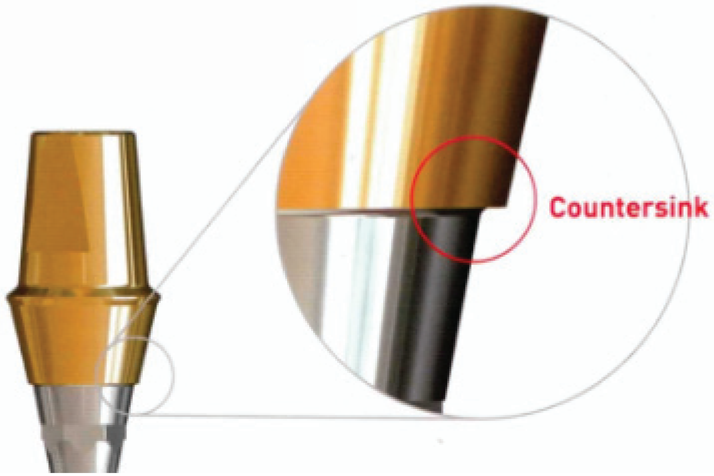
- Problem of IS SCRP Multi Abutment

Because the connecting piece of the fixture and abutment of the Internal submerged SCRP multi abutment all consist of a taper structure, sinking happens in the finished final prosthesis due to the chewing pressure inside the abutment and the fixture thus causing the screw loosening.

- Countersink

- When sinking occurs, the existence of countersink in the abutment causes it to get stuck in the fixture's platform thus preventing further sinking.

- The countersink makes the optimal connection for fixture and abutment because it is designed to slip to the platform at 0.1mm to prevent sinking. It is because there is no gap in the 0.1mm design. There are times when the fixture and the abutment cannot properly connect when the countersink touches the fixture platform because of the manufacturing allowance in the fixture and abutment design.




**7-1. (N) Company's Idea**

Sinking happens as a consequence to having a technology that has not understood the causes and has settled on the provisions of those causes so progress was not made.

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- Optimal connection of the abutment and fixture – there is a 50-100 ㎛ gap between the countersink and the fixture platform.
- Even with high chewing force, the abutment's countersink is stuck to the fixture platform thus preventing sinking.

## 7-2. M's explanation for causes of Jammed conditions

**2. All final abutments are made with a strong hermetic sealing with just light pressure**

- Joining Torque: 25-35Ncm
- Once the abutments are fastened, even when the screw is removed, the strong cold welding cannot be removed by hand
- Specially designed "abutment removal driver" is used to separate the abutment.

They argue the speculation that "Welding" happens in the joined surface of the abutment screw. Titanium (Ti) surface is accurately covered by oxygen ($TiO_2$) in the air so "Welding" in the Titanium could not happen in the two locked by screw. In the field of Dental Implant System, the term "Cold Welding" has been used for some time. In the Welding sector, this term has not been used.

Also the "Hermetic Sealing" mentioned by (M) – in this research, the mentioned manufacturing precision effect is considered and the jammed condition of the screw clamping force in the surfaces interlock (local plastic deformation) analysis would also be different.

**A revolution** in dental implant system.

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