FINITE ELEMENT ANALYSIS ON AN ABUTMENT IN CONSIDERATION OF THE PRETENSION AND SURFACE CONTACT

***D. U. KIM, Y. J. KIM, D. S. HONG (dshong@changwon.ac.kr), S. Y. LEE**
Changwon National University, T-Strong Inc.*

1. Introduction

In 1966 after Branemark reported the concept of osseointegration between the body and metals, many experiments and researches and after clinical applications passed, implants were developed. Implants are now a reliable dental treatment. In order to perform a successful function, an implant has to have not only a bioaffinity to structure material but also designed to have the strength to withstand external force.

This implant study is a research on size of thread and shape, research on size of abutment and shape, and a research on the impact of joining force. Of them, joining forces impact left a residual stress during placement has been reported as one that has the major impact. This paper is a finite element analysis on an abutment in consideration of the pretension and surface contact.

2. Research Method

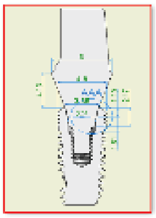
Fig. 1 shows the KFDA ISO 14801 guideline for Fatigue Experimental Method for Dental Implant System.

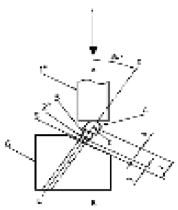
In this research, the ISO 14801 method is applied, force subject analysis is done after applying force to the abutment's top. Table 1 shows the abutment and fixtures mechanical properties. Except for the contact state part, the modeling was simplified.

Table 1. Mechanical Properties of Ti-6Al-4V

	Abutment	Fixture
Density	$4.430 g/cm^3$	
Poissons Ration	0.342	
Tensile Strength, Yield	790Mpa	
Tensile Strength, Ultimate	860Mpa	
Compressive Yield Strength	860Mpa	

Fig. 1 Abutment & ISO 14801





3. Analysis Method

In Fig. 2 analysis is done on the modeling of the same Axi-symmetric model. Here in the case of contact between the abutment and the fixture the friction coefficient was 0.2. Due to tensile stress when excessive joining force is applied, loosening result can occur according to the plastic deformation of the screw. Therefore to determine maximum the life of the screw both optimal tightening torque and the screw's self-locking requirements should be considered. In this research pretension load is added to the screw of the abutment, the joining torque that is actually used 35Ncm applicable to 177.4N. Analysis is done on the state of inclined force of 30 on the upper abutment and the screw portion's joining force. The exterior of the fixture gives fixed support and symmetry is given to the symmetric modeling as boundary conditions. In Fig. 3 the space area in the abutment and the fixture, the pretension of the screw takes place when 177.4N is given.

4. Analysis Result

3 Cases were considered when inclined force and joining force were analyzed. Case 1 – Only inclined force of 30 is given, Case 2 – only the pretension is given, Case 3 – two separated forces are given. Analysis of the result shows in Fig. 4 and in Table 2. In this result, Case 3 shows the maximum stress occurs while Case 1 shows the biggest transformation.

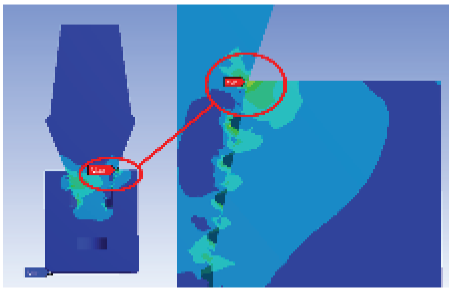


Fig. 4 Result of the Stress (Case-3)

	Max Stress	Max Deformation
Case−1	269.9Mpa	$2.74\times10^{-2}mm$
Case−2	264.1Mpa	$7.38\times10^{-3}mm$
Case−3	334.6Map	$2.41\times10^{-2}mm$

Table 2. Result of the FEA

4. Conclusion

This research is the finite element analysis on an abutment in consideration of the pretension and surface contact. Analysis of the 3 cases were done, case 3 and case 1 results were compared, Case 3 had 30% more maximum stress was confirmed.
This result confirms the impact of maximum stress on the joining force of the abutment and the application of the range allowed force in proper joining force on the abutment is known.

5. REFERENCES

1. Branemark PI. Osseointegration and its experimental background. J Prosthet Dent 1983;50:399-410.
2. Haack JE, Sakaguchi RL, Sun T, Coffey JP. Elongation and preload stress in dental implant abutment screws. Int J Oral Maxillofac Implants 1995;29-36
3. McGlumphy EA, Mendel DA, Holloway JA. Implant Screw Mechanics. Dent Clinics North Am 1998;42:71-89.
4. Murat C. , Kivan Ak a, Ergin To¨nu ¨k. Accuracy of a manual torque application device for morse-taper implants: a technical note Int J Oral Maxillofac Implants 2004;19:743-8