

The Effect of Surface Area of Implant on Bonding Strength between Implant and Bone

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임프란트의 외표면적이 임프란트와 골과의 결합력에 미치는 영향

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초 록 임프란트의 외표면적이 골과의 결합의 정도에 미치는 영향을 알아보기 위하여 10개의 grade II 티타늄 임프란트를 사용하여 이를 직경 3mm와 5mm의 2개의 군으로 나누어 10마리의 토끼의 무릎뼈에 삽입하였다. 6주후에 동물들을 희생시키고 회전제거력을 Tohnichi 15-BTG-N Torque gauge Manometer로 측정하여 5mm 직경 그룹의 회전제거력이 3mm 직경 그룹의 회전제거력보다 큰 것을 확인하였다. ($p=0.008$)

Abstract The effect of the surface area of implant on degree of osseointegration was investigated by putting the 10 grade-II titanium screw implants into 10 isogenic rabbits tibia. Implants were divided in 2 groups into 3mm diameter and 5 mm diameter. After 6 weeks, animals were sacrificed and removal torques were measured with Tohnichi 15 BTG-N Torque Gauge Manometer. The results were as follows: The removal torques was higher in 5 mm diameter group than the 3 mm diameter group. ($p=0.008$).

1. Introduction

Osseointegration is defined as a state of direct contact of an implant to living bone on a light microscope or a structural, functional contact which can transmit external loads to bone directly without any interposition of connective tissue.¹⁾

Factors such as careful surgical technique, a healthy implant bed, controlled primary loading conditions, proper implant configuration, a primary good implant-host fit, and a suitable surface finish of the implant are also important for direct bone-to-metal contact.²⁻⁴⁾

An undisturbed integration of foreign materials in bone, without the subsequent development of an interfacial fibrous tissue layer, is not solely dependent on the use of a biocompatible implant material such as titanium. Currently, titanium (Ti) is the material of choice for uncoated implants because of its biological acceptance in bone.⁴⁾

This high degree of biocompatibility is thought to result, in part, from the protective and stable oxide layer that presumably aids in the bonding of the extracellular matrix at the implant-tissue interface.⁵⁾

The characteristic composition and structure of the

oxide layer often differ depending on the technique used to prepare the surface of the metal.⁶⁾

In these days, in clinical field, the use of diameter of 3mm and 5mm fixture have been increased very much, especially to anterior region for 3mm and to maxillary posterior region for 5mm diameter fixture.

But there seems to be few report for comparison of removal torque of these special diameter implant.

The object of this study is to estimate the effect of the surface area size of implant on the removal torque of titanium implant inserted in rabbit tibia.

2. Experimental materials and methods

5 screw-type implant, 4 mm long and with a diameter of 3mm and 5mm were made from C.P. titanium.

10 isogenic rabbits were used in the experiment. Average body weight was 3.05Kg.

Implants were cleaned by ultrasonic-wave in ethanol and autoclaved before use. The surgery was carried out in an aseptic state, no prophylactic antibiotics was administrated.

General anesthesia was done via IM with Xylazire (Rompum, Byer Chemical Co., Korea) 5mg/Kg of weight and Ketamine (Ketara, Yuhan, Korea) 35mg/

Kg of weight before surgery.

After shaving on the operation area, local anesthesia was done in tibial metaphysis with 2% Lidocane (Kwangmyung chemistry Korea) 2ml. Before surgery, skin was carefully cleaned with iodine and 70% alcohol sponge. A layered incision was done at the tibial metaphysis located anterior, medial side of the same level with tibial tuberosity for reason of good bone quality and visibility.

The skin & fascia, muscle, and periosteal flap was elevated and the bone was denuded.

Implants were inserted in the conventional method of Branemark implant system. A tapping drill and countersink drill were not used in this experiment.

The 3 and 5mm diameter fixture were implanted on the right side. The experimental group 2 was implanted on the left side.

The periosteal flap was sutured with 4-0 absorbable suture material, and the skin sutured. After the layered suture, antibiotics (Baytril, Byer Chemical Co. Korea) 1ml and metabolism activator (Castosal, Byer Chemical Co. Korea) 1ml was injected via I.M. Pressure dressing was done for protection of wounds and prevention of infection.

Six weeks after implantation, the radiographs were taken to identify the states of implantation. The radiographs were taken at a right angle to implanted specimen for better vision of the screw of the implanted specimen.

Six weeks after implantation, sacrificed the animals and an incision was made and soft tissues was reflected and the implanted site was denuded. After carefully removing the overgrowth bone above the screw. Tochini 15 BTG-N Torque Gauge Manometer (Tochini Mfg Co, Ltd, Tokyo, Japan), was used to measure the removal torque with a connector specifically made to connect the torque gauge and the fixture.⁷⁾ The result was recorded by measuring the maximum removal torque at which fracture occurred between implant and bone.

The significance verification was done by using the student t- test with the 5% level of significance.

3. Results and discussion

The unicortical bony contact was confirmed by periapical standard films.

The mean values of the removal torque of 3mm fixture were 1.52 ± 0.50 Ncm, 3.44 ± 1.13 Ncm for 5mm fixture group and p value were 0.008.

Significantly higher values of the removal torque was found in 5mm fixture group than that of 3mm fixture

Table 1. The values of removal torque.

Animal No.	Removal Torque(Ncm)	
	3mm diameter	5mm diameter
1	1.0	4.0
2	1.6	2.6
3	2.0	4.8
4	2.0	3.8
5	1.0	2.0
Mean	1.52	3.44
S.D.	0.50	1.13

group.

The results was obtained as table 1.

Osseointegration is defined as a direct bone anchorage to an implant body which can provide a foundation to support a prosthesis.^{1,4)}

This means that the implant must be in direct contact with bony tissue, without soft tissue interface.

To obtain the state of direct contact with bony tissue, the biocompatibility of the implant material and the microscopic structure and morphology of the surface could be considered.⁹⁾

Various methods to identify the contact with bone are reported such as histological studies,⁹⁾ pull and push strength tests¹⁰⁾ and removal torque tests.¹¹⁾ Among these, the removal torque method introduced by Johanson et al¹²⁾ at first to measure the binding forces of the bone and the screw type implant, is commonly used currently.

The removal torque method was used in this experiment, because of Anusavice's theory¹³⁾ that measuring the tensile strength is more appropriate than measuring the shear bond strength in order to evaluate the interfacial bonding force. Removal torque is dependent on texture of the implant surface, geometric variation of implant, interfacial tissue structure, and the quality and quantity of the surrounding bone. Many experiments using removal torque test reported that the factors described above exert complex influences on removal torque.

Wide fixture show the large surface area than the narrow one by geometrically, however there seems to be not so much report to measure the removal torque between bone and screw titanium implant.

With this experiment, as we feel it could be an affecting factor to control the surface bony over growth for measuring the removal torque.

The time factor to comparing the torque between the short term and long term must be considered to find out if the diameter really could affect the torques.

As the comparison by diameter would be a factor of

mechanical bonding, it could be interesting to compare these values with the factor by chemical one.

4. Conclusion

The object of this study was to estimate the effect of the surface area of implant on degree of osseointegration.

10 grade-II titanium implants were used in this study. Implants were divided in 2 groups into 3mm diameter and 5 mm diameter.

10 isogenic rabbits were used in this experiment. Average body weight was 3.05Kg. At each 10 implants was inserted on the tibial metaphysis.

After 6 weeks, animals were sacrificed and removal torques were measured with Tohnichi 15 BTG-N Torque Gauge Manometer.

The results were as follows : The removal torques was higher in 5mm diameter group than that of the 3mm diameter group.

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