International Journal of IT-based Public Health Management
Vol. 5, No.1 (2018), pp. 45-50
http://dx.doi.org/10.21742/ijiphm.2018.5.1.08

Study on Torsional Strength of Screw-fixed Implants

Sung-Min Kim[1]and Soo-chul Park[2]*

[1]Department of Dental Technology, Gimcheon University,
[2]14 DaehakroGimcheon City, Gyeongbuk 740-704, KOREA
[1]smgim81@gmail.com

*[2]*remedios-1@hanmail.net*

Abstract

The goal of this study was to evaluate the stability of implant structures under various pressures that may occur in the oral cavity. The study used test implants with three different fastening methods, and a total of 12 implants were tested. Implant fixtures and abutments manufactured using a CNC automatic lathe were tightened with a screw to 30N·cm using an electric torque meter (SMTT03-50, MARK-10, USA). The torsional strength was then tested by tightening until the implant structure fractured in the direction of the fastening. The results show that the implants in Group 1 had higher torsional strength than the implants in groups 1 and 2.

Keywords: *Screw-fixed, implant, fastening method, mechanical strength, torsional strength*

1. Introduction

In the early stages of dental implant development, the prosthetic treatment was used only for edentulous patients. Implants are now used to treat single and multiple dental bone defects as well as edentulous patients, and there are various types of implant. As the uses of these implant protheses become more diverse, research on the long-term success rates of treatments is being carried out [1][2]. However, various studies have focused on uncovering the main causes of implant prothesis failure, and have found that those causes include implant screw loosening [3][4], fixture, abutment, and screw fracturing [5][6], bone loss in the implant site [6], etc.

Screw loosening is the most common cause of implant failure. When implant structures are connected by screws, stress can occur in the implant prosthesis, and fixture and abutment sites, due to incorrect fastening [7][8]. Although fracturing of dental implants does not occur often, the biggest cause of fracturing is when pressure occurs in the dental cavity due to metal fatigue fractures and bone resorption surrounding the implant, the implant then begins to move around and eventually fractures. Bone resorption is caused by the dissolution of nickel ions which have cytotoxicity because of oral galvanism between the titanium metal used in the implant and the [1]nickel-chrome alloys used in the upper prosthesis, and alveolar bone resorption occurs as the bone is fused to the implant fixture [6]. Prosthetics using noble metal alloys, which cause less oral galvanism than non-noble alloys, have fewer implant fractures.

If the fixture is implanted at a tilt in the alveolar bone during implant surgery, then eventually occlusal loading on the prosthesis is transferred to a non-vertical load. There is a

Article history:
Received (November 2, 2017), Review Result (November 12, 2017), Accepted (November 22, 2017)

ISSN 2205-8508, eISSN:2207-3965 IJIPHM

bending moment, which causes high stress on the implant. Various types of failure may then occur, including abutment fractures, screw fractures, fixture fractures, etc. [9]. The mechanical strength of a screw-type implant system is affected by various factors, such as the strength, thickness, shape, maximum load, fit, etc. of the metal materials in the fixture, abutment and screw [10]. There are also differences in the load that causes fractures depending on the fastening method of implants [11].

While there have been various studies on the mechanical stability of implants [3][7], there is currently no research on the torsional strength of implant fastening sites. Implant torsional strength can be affected by gliding movements in the oral cavity when occlusal loading occurs. In the case of implant dentures, horizontal movements in the denture can cause torsional loading on the fixture and abutment fastening site when there is excessive loading on the artificial tooth part of a denture which is separate from the implant. Most implants used in clinical practice use different types of screw depending on their manufacturer and fastening method. Since there may be differences in mechanical strength depending on the type of screw used to fasten the implant, it is necessary to study the mechanical strength of implants based on fastening method and using implant fixtures and abutments that have the same internal structures.

The purpose of this study was to evaluate the stability of implant structures considering the various loads that may occur in the oral cavity with a dental implant. Fixtures and abutments for three types of screw-fixed implant were manufactured using a CNC automatic lather, screw joints were made in the same shape for all three types of implant, and they were then subjected to the torsion test.

2. Study methods

2.1. Production of test materials and testing

Three types of screw-fixed implant with different fastening methods were chosen from the screw-fixed implants that are currently used in clinical practice.[Table 1]. shows the three implant types, which are as follows: Screw-fixed implant with a non-submerged type internal octagon connector with a 8° morse taper (Group 1), screw-fixed implant with a submerged type external hexagon connector (Group 2), and screw-fixed implant with a submerged type internal hexagon connector with an 11° morse taper. In order to reduce variation of torsional strength that might appear in the test results depending on the structure of the fixing screws, the screws and screw holes inside the implant fixtures were designed and processed using the same structure for all three types of implant. The test implants were made using a CNC automatic lathe [Figure 1].

The three types of implant fixture and abutment were fastened with a fixed screw to 30 N·cm using an electric torque meter connected to an implant driver. A total of 12 implants were fastened in a clockwise direction using an electric torque meter until the implant fractured, and the highest torque at the time of fracturing was measured for each implant.

2.2. Test results and analysis

The results of the torsional strength tests for all three fastening methods were compared and analyzed by putting the data into graphs.

Figure 1. Test implant production

Table 1. Size of the test implants (mm)

Type		Diameter	Length	N
Group 1	Fixture	5.0	10	4
	Abutment	4.8	5.5	4
Group 2	Fixture	4.0	10	4
	Abutment	4.5	5.0	4
Group 3	Fixture	3.6	10	4
	Abutment	4.0	5.5	4

Group 1: Non-submerged type internal octagon implant, Group 2: Submerged type external hexagon implant, Group 3: Submerged type internal hexagon implant.

3. Results

The results of analysing the graph showing the torsional strength of the test implants produced in Group 1 show that, among the 4 implants, implant numbers 1, 2 and 4 had the highest torsional strength at 72.5 N·cm and implant number 3 had the lowest at 67.5 N·cm [Figure 2].

Analysis of the graph showing the torsional strength of the test implants produced in Group 2 show that, among the 4 implants, number 4 had the highest torsional strength at 66.5 N·cm and number 1 had the lowest at 56.5 N·cm [Figure 3].

Analysis of the graph showing the torsional strength of the test implants produced in Group 3 show that, among the 4 implants, number 4 had the highest torsional strength at 64.5 N·cm and number 1 and 3 had the lowest at 63.5 N·cm [Figure 4].

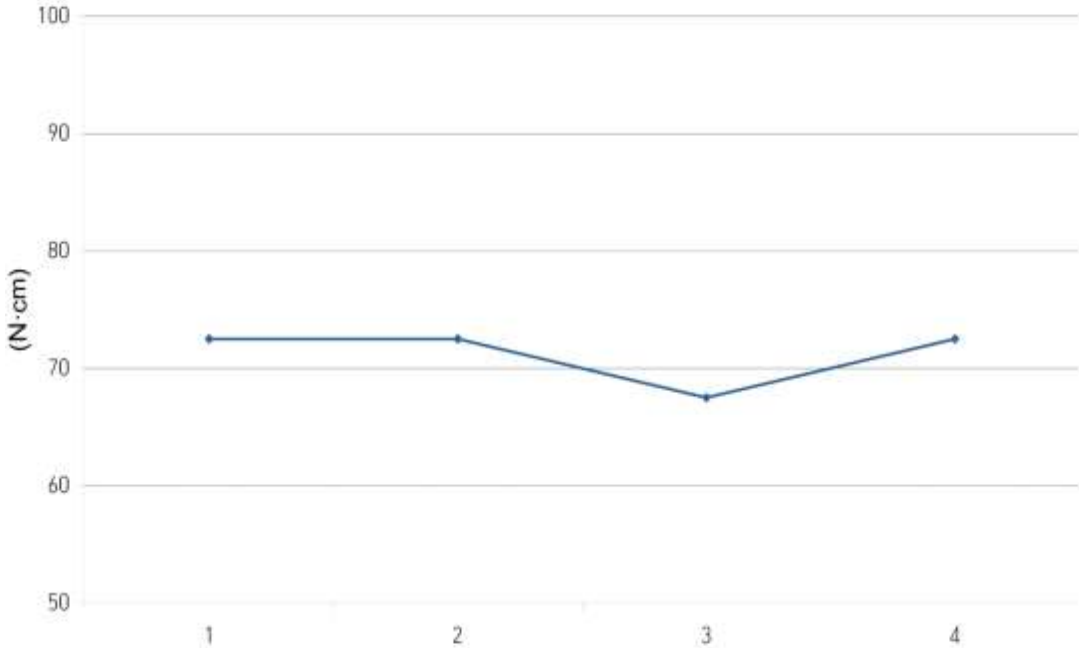

Figure 2. Group 1 implants torsional strength test (N · cm, N=4)

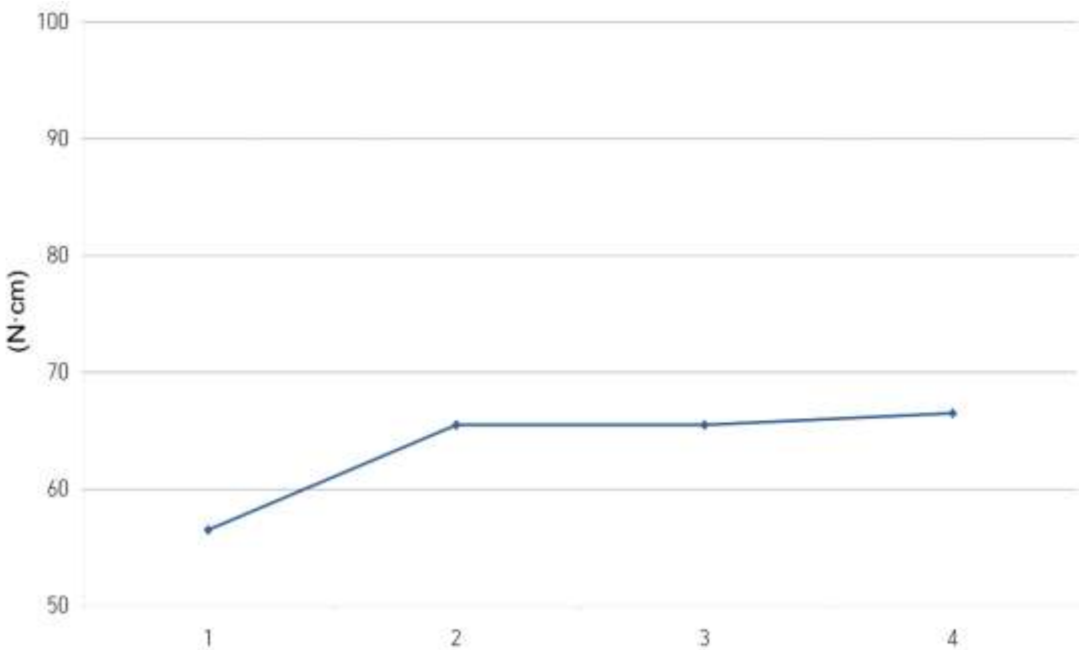

Figure 3. Group 2 implants torsional strength test (N · cm, N=4)

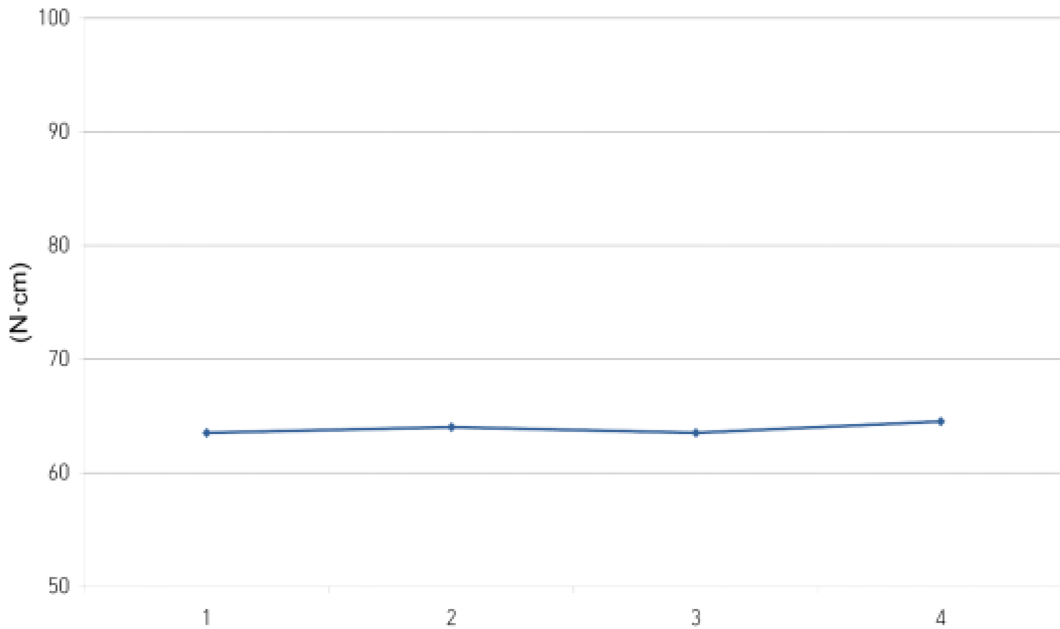

Figure 4. Group 3 implants torsional strength test (N · cm, N=4)

4. Discussion and conclusions

The purpose of this study was to evaluate the stability of implant structures under the various loads that can occur on dental implants in the oral cavity. Three types of implant fixture, abutment, screws, etc. were manufactured using a CNC automatic lathe and the torsional strength test was carried out by fastening the test implants.

The test results show that of the three types of implant those in Group 1, manufactured with fixtures 5.0mm in diameter, had the highest torsional strength. Group 2, manufactured with fixtures 4.0mm in diameter, and Group 3, manufactured with fixtures 3.6mm, had lower torsional strength.

The study is considered to have a limitation in representing the implants' torsional strength due to the difference in diameter between the three types of implant. In the future, it would be necessary to use implants of exactly the same size in studies of torsional strength.

References

[1] P. Simonis, T. Dufour and H. Tenenbaum, "Long-term implant survival and success: a 10-16-year follow-up of non-submerged dental implants". Clinical Oral Implants Research, Vol. 21, pp. 772-777 **(2010)**

[2] E. S. Rosenberg, S. C. Cho, N. Elian, Z. N. Jalbout, S. Froumand C. I. Evian, "A comparison of characteristics of implant failure and survival in periodontally compromised and periodontally healthy patients: a clinical report". International Journal of Oral & Maxillofacial Implants, Vol. 19, pp. 873-879 **(2004)**

[3] A. Khraisat, A. Hashimoto, S. Nomura and O. Miyakawa. "Effect of lateral cyclic loading on abutment screw loosening of an external hexagon implant system". Journal of Prosthetic Dentistry, Vol. 91 pp. 326-334 **(2004)**

[4] D. L. Dixon, L. C. Breeding, J. P. Sadler and M. L. McKay. "Comparison of screw loosening, rotation, and deflection among three implant designs". Journal of Prosthetic Dentistry, Vol. 74, pp. 270-278 **(1995)**

[5] H. W.Wiskott, J. I. Nicholls and U. C. Belser, “Stress fatigue: basic principles and prosthodontic implications”. International Journal of Prosthodontics, Vol. 8, pp. 105-116 **(1995)**

[6] G. N. Tagger, E. E. Machtei, J. Horwitz and M. Peled, “Fracture of dental implants: literature review and report of a case”. Implant Dentistry , Vol. 11, pp. 137-143 **(2002)**

[7] W. Att, S. Kurun, T. Gerdsand J. R. Strub. “Fracture resistance of single tooth implant supported all ceramic restorations after exposure to the artificial mouth”. Journal of Oral Rehabilitation, Vol. 33, pp. 380-386 **(2006)**

[8] P.Vigolo, F. Fonzi, Z. Majzoub and G. Cordioli, “An evaluation of impression techniques for multiple internal implant prostheses”. Journal of Prosthetic Dentistry, Vol. 92, pp. 470-476 **(2004)**

[9] M. E. Kreissl, T. Gerds, R. Muche, G. Heydecke and J. R. Strub, “Technical complications of implant-supported fixed partial dentures in partially edentulous cases after an average observation period of 5 years”. Clinical Oral Implants Research, Vol. 18, pp. 720-726 **(2007)**

[10] C. R. Leutert, B. Stawarczyk, T. C. Truninger, C. H. Hämmerleand I. Sailer, “Bending moments and types of failure of zirconia and titanium abutments with internal implant-abutment s: a laboratory study”. International Journal of Oral & Maxillofacial Implants, Vol. 27, pp. 505-512 **(2012)**

[11] L. Steinebrunner, S. Wolfart, K. Ludwig and M. Kern, “Implant-abutment interface design affects fatigue and fracture strength of implants”. Clinical Oral Implants Research, Vol.19, pp. 1276-1284 **(2008)**

Authors

Sung-MinKim

26 Aug. 2012 : Ph.D. degree at Busan University, South Korea
1 Sep. 2016 ~ Recent: Assistant professor**,** Department of Dental Technology, Gimcheon University, South Korea

Soo-chul Park

Oct. 2006 ~ Feb. 2013: N&F Dental Laboratory, Representative
22 Feb. 2012: Ph.D. degree at Yeungnam University, South Korea
1 Mar. 2013 ~ Recent: Assistant professor**,** Department of Dental Technology, Gimcheon University, South Korea