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Fatigue limit of implant with different fastening methods

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Abstract. Fatigue limit test was conducted using the compression tester (858 Bionix, MTS, USA) after fastening 3 types of implant fixture and abutment with different fastening methods with the use of set screw in order to compare the difference in results of fatigue limit test. As a result of conducting the experiment, fatigue limit of internal hexagon connection implant of submerged type was the highest and the correlation between difference in fastening methods of implant fixture and abutment and fatigue test presented statistically significant difference ($p<0.05$).

Keywords: Implant, Fatigue Limit, Implant Fixture and Abutment

1 Introduction

With the increase in demand of implant among prosthodontics, a great number of implant treatments is being conducted in clinics. In general, implant is fastened and fixed within the mouth with fixture, abutment, and set screw that is placed surrounding the alveolar bone and then it is ultimately placed within the mouth by manufacturing gold crown, dental guide members, or others [1].

Although titanium is used for various dental treatment methods with outstanding compatibility and sufficient mechanical strength, the loosening of set screw followed by the generation of repetitive load to implant fixture and abutment fastening area[2] causes the generation of more abrasion and fracture to the fastening area of implant restoration[3,4,5]. In order to resolve the problem of such implant, studies on screw loosening related to precision of fastening area[6,7] are being conducted, studies related to shear compression strength of implant based on fastening methods are being reported[8], and the fracture by fatigue limit can occur to implant when repetitive load is exerted with strength weaker than shear compression strength[9]. However, there is a lack of study which compares and tests the implant with same fastening method and same size.

The objective of this study lies in selecting fixture and abutment with same diameter (Ø) and same length for each fastening method among 4 implants with different fastening methods, conducting the fatigue limit test, and examining the difference in implant stability based on fastening methods to utilize it as dental health

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data.

2 Research Methods

2.1 Test Methods

With 4 types of implant fixtures manufactured and sold in Korea as its subject, regular sized with similar diameter at the top of fixture was selected for each fastening method. Internal Morse taper type Implant (YI Implant, yesbiotech, KOREA), External submerged type Implant (YE Implant, yesbiotech, KOREA), Internal submerged type Implant (YS Implant, yesbiotech, KOREA), and Internal hexagon connection Implant of submerged type (A&B Implant, A&B Biomedi, KOREA) currently used in clinics were used as its subject.

The size of 4 types of fixture is Ø 3.6×15mm and abutment size of 4 types was unified to Ø 5.0×5.7mm. After fastening the fixture and abutment of each implant with strength of 30N·cm using screw and electronic torque tester (MGT50E, MARK-10, USA), test specimen was prepared so that the direction of load forms 30° with specimen using zig for specimen fixation and distance between regulating point and load point is about 11mm. Load waveform shall be sine waveform, control method shall be load control, and load control method shall be compression load (Pn) – compression (0.1Pn) with the ratio of minimum load toward maximum load of 0.1. In regards to the condition of test environment, the fatigue limit test was conducted with the use of compression tester (858 Bionix, MTS, USA) based on the specification of ISO 14801 at room temperature and load cycle of over 2Hz and under 15Hz.

2.1 Analysis of test results

The processing of fatigue limit test data of 4 types of implant fixture and abutment fastened and fixed with 30N·cm in this study was conducted with statistics program SPSS ver. 18.0. To verify the difference in fatigue limit test of implant fixture and abutment, Kruskal Wallis test was used for its analysis. .

3 Results

As a result of measuring fatigue limit test of internal Morse taper type, the highest fatigue limit result was presented at the strength of 396 N as implant specimen no.2 was fatigue-fractured at 163,745 cycles followed by 134,835 cycles for implant specimen no.1 and 78,521 cycles for implant specimen no.3 (Fig 1).

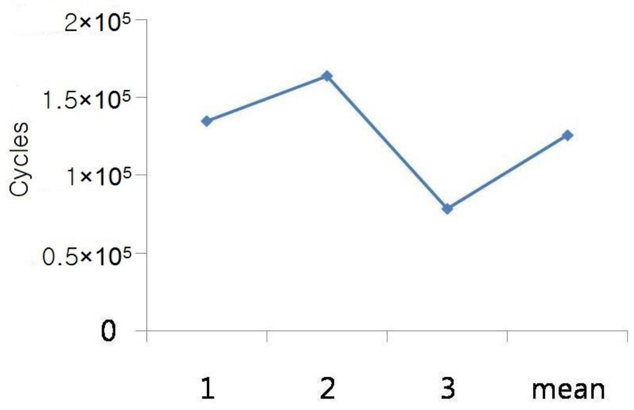

Fig 1. Fatigue limit test result of internal Morse taper type Implant

As a result of measuring fatigue limit test of external submerged type Implant, the highest fatigue limit was presented at the strength of 468N as implant speciment no.2 was fatigue-fractured at 48,754 cycles followed by 46,574 cycles for implant specimen no.3, and 38,957 cycles for implant speciment no.1 **(Fig 2).**

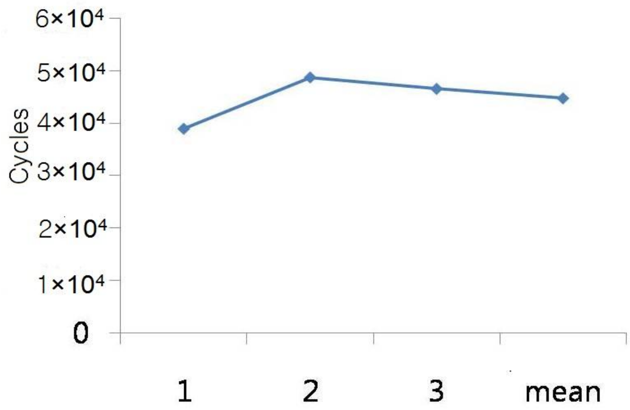

Fig 2. Fatigue limit test result of external submerged type Implant

As a result of measuring fatigue limit test of internal submerged type Implant, the highest fatigue limit result was presented at the strength of 395N as implant specimen no.1 was fatigue-fractured at 25,719 cycles followed by 23,096 cycles for implant specimen no.3, and 19,453 cycles for implant specimen no.2 **(Fig 3).**

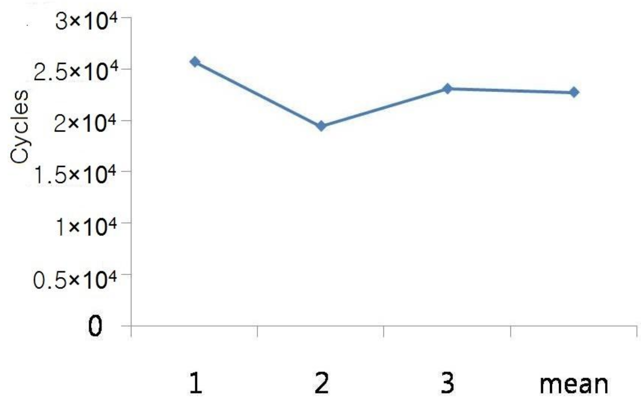

Fig 3. Fatigue limit test result of internal submerged type Implant

As a result of measuring fatigue limit test for internal hexagon connection Implant of submerged type, the highest fatigue limit was presented at strength of 321N as implant specimen no.2 was fatigue-fractured at 748,349 cycles followed by 534,376 cycles for implant specimen no.1 and 495,240 cycles for implant specimen no.3 **(Fig 4).**

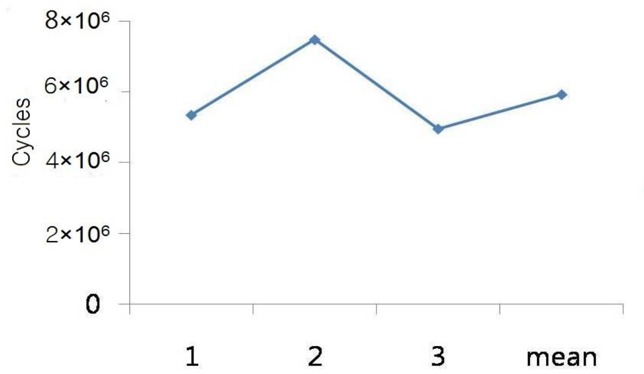

Fig 4. Fatigue limit test result of internal hexagon connection implant

In regards to the correlation of fatigue limit for 4 types of implant fastening method, the fatigue limit for internal hexagon connection implant of submerged type was the highest presenting 592, 655 cycles followed by 125,700 cycles of internal morse taper type Implant, 44,761 cycles of external submerged type Implant, and 22,756 cycles of internal submerged type Implant. Statistical significance was presented for fatigue limit for each fastening method of 4 implants ($p<0.05$) (Table 1).

Table 1. Correlation of fatigue limit for each implant fastening method

Implant type	N	Mean	SD	X^2	p-value
Internal morse taper type	3	125,700.33	43,340.10		

External submerged type	3	44,761.67	5,143.804	10.385	0.016
Internal submerged type	3	22,756.00	3,146.81		
Internal hexagon connection Implant	3	592,655.00	136,247.47		

Kruskal Wallis test.

4 Discussion and Conclusions

In this study, below results were acquired by selecting 4 types of implants with same size but different fastening methods and conducting the fatigue limit test.

In regards to the difference in numbers of fatigue-limited cycles, a difference was presented for each fastening method of 4 implants and the fatigue limit for internal hexagon connection implant of submerged type was the highest presenting 592,655 cycles.

Although the fatigue limit test was conducted based on the specification of ISO 14801 in this study, there is a necessity to conduct fatigue limit study which can endure 5×10^5 cycles with lower standard considering the shear compression load of fastening method in the future.

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