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The Study of Compression Shear Load of Implanting in Four Different Fastening Method

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Abstract

The purpose of this study is to compare the differences between Shear compression load using shear compression loads tester (858 Bionix, MTS, USA) with fixed screws in the force of 30 N·cm using in four different fastening methods with implanting(N=5) fixture an abutment. As a result of the experiment, the compression load of YI Implant which is the compression load of Internal octagon connection Implant , Non submerged type taking morse taper of 8° was the highest as 1208.20 N·cm, that of Internal hexagon connection Implant which is submerged type taking morse taper of 11° was the lowest as 617.60 N·cm. The relevance of the shear compression load test which was done by four different fastening methods with implanting fixture an abutment, showed a statistically significant difference (p <0.001).

Keywords: *Shear compression load, Implant systems, fixture to abutment joint*

1. Introduction

In the past, the bridges and removable denture were produced after carefully removing many dental defects, but nowadays, without removal of the defects around dental implants with the development of dental restorative prosthetic technology the prosthetic implant has been used as much as possible, and recently even edentulous patients use a variety of implant methods.

Divided into an outer and an inner connection depending on where the implant fixture and abutment is fastened, External connection Implant is combined the abutment screw of 06 square (hexagon) form of the fixture that the upper is projected, and Internal connection Implant is combined the abutment screw of the fixture that a portion of the lower outer wall of the abutment is inserted into the hexagonal recess (hexagon) or octagonal (octagon) forms the inner surface of the upper portion of the fixture is fastened and can be classified in a way that the screw. And according to the gingival method of implant, placement types can be classified submerged type whose upper portion of the implant fixture is covered on the same height of the alveolar bone and Non submerged type which is also exposed above the gum line out of the fixture.

While periodontal ligament, which is between the natural tooth root and the alveolar bone, protects the teeth and bone by absorption of some of the load, implant is directly coupled with osseous tissue and Osseo integration, so the force that happens to masticatory and occlusal movements is directly transmitted to the maxillary. It is necessary to design a load-bearing prosthesis that should be sufficient to withstand that force by selecting the size, implant method, coupling method of implant and the appropriate prosthesis from the stage of implant treatment planning. [1, 2, 3].

Implant is mainly produced by using titanium implants with a high corrosion resistance and biocompatibility. While implant has primarily been produced by the commercially

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pure titanium Grade 3, in recent manufacture implant fixture and abutment, commercially pure titanium Grade 4 is often used due to its hardness and the abutment screw is mainly made of titanium alloy (Ti-6Al-4V) superior to mechanical strength.

Though implant with a locking structure has mechanical properties that it is strong to the Axial Load, but poor at the resistance to lateral loads [4], and various types of prosthesis by applied position, types of prosthesis and the quality of oral bone, many studies have been reported that clinical success rate is more than 90% [5, 6]. However, it is also reported for the mechanical properties of the implant in a variety of studies, such as fracture, loosening of the screw phenomenon, fatigue strength, and stress due to the difference between the prosthetic implant made to the fastening system and Osseo integration failure [7, 8, 9, 10]. The hardness of the implant, which is made of commercially pure titanium Grade with the same hardness, has to be compared by the mechanical properties of the implant according to the difference of the coupling method because it is determined by the properties of the alloy, however, previous studies were a mixture of commercially pure titanium Grade 3 and commercially pure titanium Grade 4, so there was a limitation of the comparison of the difference between the coupling method of the implant to the work [11]. The study the test specimen, but note that the study limitations shear compression load test using the other three implants signed with commercially pure titanium Grade 4 way with the same hardness produced by the implant, and have different mechanical characteristics of the coupling method was limited to a comparison of the pay-off phenomenon of the screw and the implant study [7, 12], there is no research based on the differences between shear compression loads using commercially pure Titanium Grade 4 fixed the same hardness with different fastening methods with implanting fixture an abutment in the same vender.

The purpose of this study is to take advantage of the data on oral health by shear compression load tests on examining the differences from fastening methods with implanting fixture and abutment made of commercially pure Titanium Grade 4 after selected fixture and the abutment with the same diameter (Ø) and the same length of four different fastening methods with implanting fixture an abutment in the same vender.

2. Research Methods

2.1. Test Methods

Currently used in clinical Internal octagon connection Implant of Non submerged type with 8° morse taper (YI Implant, Yesbiotech, KOREA), External hexagon connection Implant of submerged type with 8° morse taper (YE Implant, Yesbiotech, KOREA), Internal hexagon connection Implant of submerged type with 11° morse taper (YS Implant, Yesbiotech, KOREA) and Internal hexagon connection Implant of submerged type with 1.5° morse taper (YZ Implant, Yesbiotech, KOREA), the fixtures and abutments with different 4 kinds of fastening methods were targeted, and the size of four kinds of fixture was unified into Ø 3.6 × 15mm, that of abutment was unified into Ø 5.0 × 5.7mm(Table 1, Fig 1). Each fixtures and abutments of the implant were locked by a screw with the power of 30 N·cm using the electric torque meter (MGT50E, MARK-10, USA) and then fitted the standard specimen ISO14801(2007) to 30° fulfilling direction, set about 11mm from the distance to the loading point. Furthermore, the hemispherical shape of the cap of about Ø 4mm was fixed along the long axis of the implant body to match the top of the abutment, and was measured shear compression load using a compression test machine with the cross head speed of 1mm/min. (Fig 2).

Table 1. The Size of Four Kinds of the Implant Fixtures and Abutments (mm)

Implant type	N	Ø	length
YI Implant	fixture	3.6	15
	abutment	5.0	5.7
YE Implant	fixture	3.6	15
	abutment	5.0	5.7
YS Implant	fixture	3.6	15
	abutment	5.0	5.7
YZ Implant	fixture	3.6	15
	abutment	5.0	5.7

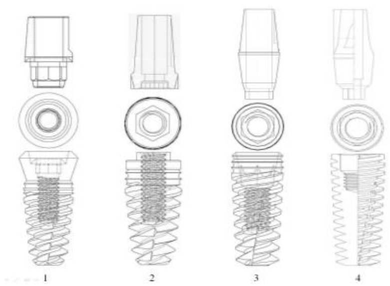

Figure 1. Fastening Structure of Tested Four Kinds of Implant Fixtures and Abutments 1. YI Implant. 2. YE Implant. 3. YS Implant. 4. YZ Implant

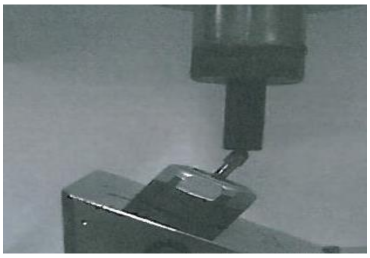

Figure 2. Implant Shear Compression Load Test

2.2. Analysis of Test Results

This study used a statistical program SPSS ver. 18.0 to analyze the data on shear compression load test, and analyzed by using one-way analysis of variance to test the 4 different types of shear compression load such as Internal octagon connection Implant of Non submerged type with 8° morse taper, External hexagon connection Implant of submerged type with 8° morse taper, Internal hexagon connection Implant with submerged type with 11° morse taper and Internal hexagon connection Implant with submerged type 1.5° morse taper and then carried out post-hoc comparison using TuKey HSD.

3. Results

According to the test of the compression load of Internal octagon connection Implant of Non submerged type with 8° morse taper, the shear compression load of specimen 1 implant is the highest as 1371 N·cm and the specimen 3 is the lowest 1050 N·cm (Fig 3).

According to the test of the compression load of External hexagon connection, the shear compression load of specimen 1 implant is the highest as 1272 N·cm and the specimen 5 is the lowest 1057 N·cm (Fig 4).

According to the test of the compression load of Internal hexagon connection Implant of submerged type with 11° morse taper, the shear compression load of specimen 2 implant is the highest as 647 N·cm and the specimen 4 is the lowest 599 N·cm (Fig5).

According to the test of the compression load of Internal hexagon connection Implant of submerged type with 1.5° morse taper, the shear compression load of specimen 3 implant is the highest as 1077 N·cm and the specimen 4 is the lowest 895 N·cm (Fig6).

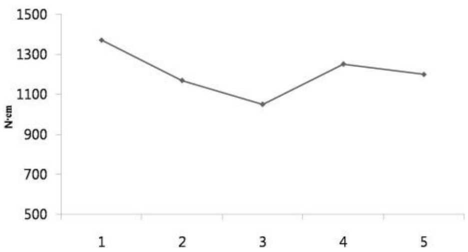

Figure 3. The Result of Shear Compression Load in Internal Octagon Connection Implant with 8° Morse Taper

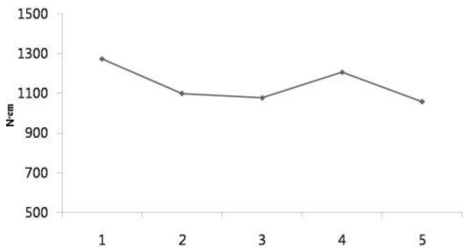

Figure 4. The Result of Shear Compression Load in External Hexagon Connection Implant

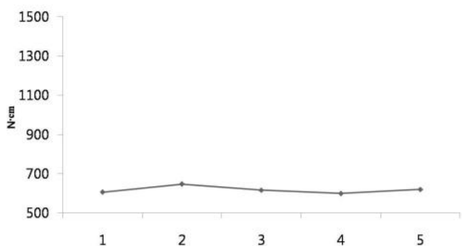

Figure 5. The Result of Shear Compression Load in Internal hexagon Connection Implant of Submerged Type with 11° Morse Taper

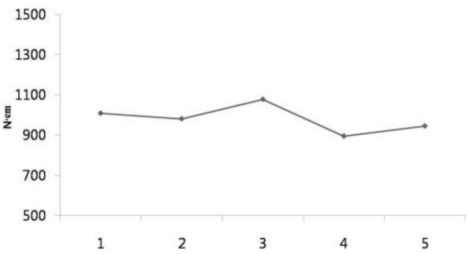

Figure 6. The Result of Shear Compression Load in Internal hexagon Connection Implant of Submerged Type with 1.5° Morse Taper

According to shear compression load tests for examining the differences from fastening methods with 4 different implanting fixtures and abutments, the shear compression load of Internal octagon connection Implant of Non submerged type with 8° morse taper and that of External hexagon connection are the highest as 1208.20 N·cm and 1141.41 N·cm, that of Internal hexagon connection Implant of submerged type with 1.5° morse taper is 981.00 N·cm, and Internal hexagon connection Implant of submerged type with 11° morse taper is the lowest as 617.60 N·cm. The shear compression load test by the fastening methods with Implant fixtures and abutments showed a statistically significant difference ($p<0.001$).

Table 2. The Relevance of Shear Compression Load with 4 Different Fastening Methods using Implanting Fixtures and Abutments

Implant type	N	Mean	SD	*F*	p-value
YI Implant.	5	1208.20[c]	52.42	51.05	0.000
YE Implant.	5	1141.60[c]	92.72		
YS Implant.	5	617.60[a]	18.39		
YZ Implant	5	981.00[b]	68.26		

TuKey HSD:[a,b,c].
Within mean±SD values column, values with different letter were significantly different between the groups.

4. Discussion

Dental prosthesis with the implant needs not to delete healthy teeth surrounding defected area, can be used even when an existing dental prosthetic treatment is not possible and has sufficient mechanical strength. However, many implants have been reported in the clinical treatment of a variety of failure of the dental implant. Many causes of failure were associated with the mechanical properties, such as the fracture the oral implant failure [9, 10, 14] and loosening of the screws and fracture which occurred after implant prosthetic fixture and abutment [15], and causes undue load failure has been reported to cause failure due to the oral environment, such as the oral cavity and poor bone quality, and the like[16].

This study tested the Implant fixtures and abutments with different 4 kinds of fastening methods to determine the compressive strength of the shear coupling method according to the difference between the implant fixture and abutment of the same size on the basis of the ISO14801 standard [13].

ISO14801 standard, the implant compressive load shear test standard [13] loads in a tilted state the specimen and 30° instead of 0° using the specimen fixed to the jig for loading, because the implant is strong to the vertical occlusal forces but considered as the weak force in an oblique direction, such as only the lateral occlusion. Implant surgeries have been reported that in generation of the lower occlusal load than that of oral bone implant tilt orientation of the fixture, which may be a high concentration of stress in the fastening region Implant fixture and abutment problems [17].

YI Implant (Yesbiotech, KOREA) used to the test is Internal octa connection Implant of Non submerged type with 8° morse taper having ITI Syn-Octa Implant (Straumann, Switzerland), SwissPlus Implant (Zimmer Dental, USA), ExFeel internal Implant (Megagen, Korea), SS Ⅲ Implant (Osstem, Korea), YE Implant (Yesbiotech, KOREA) is External hexagon connection Implant of submerged type having a similar structure as the form and signed such as Brånemark Implant (Nobel Biocare, Sweden), ExFeel External Implant (Megagen, Korea), US Ⅱ Implant(Osstem, Korea). YS Implant (Yesbiotech, KOREA) is Internal hexagon connection Implant of submerged type with 11°morse taper having a similar structure as the form and signed such as MegaFix Implant (Megagen, Korea), GS Ⅲ Implant (Osstem, Korea), etc. have a similar shape and fastening structure, OsseoSpeed Implant (Astra Tech, Sweden) with 10° morse taper also has signed a similar structure, but the angle difference of 1° and, YZ Implant (Yesbiotech, KOREA), Internal hexagon connection Implant of submerged type with 1.5° morse taper has a similar form and a fastening structure Implant with Screw-Vent Implant (Zimmer Dental, USA).

According to the difference between different ways of tightening implants it shows the difference of the contact surface of the implant abutment and the fixture, the conical seals of YI Implant and YS Implant the implants which are 8° and 11° angle of morse taper can be more accurate contact than any other form of coupling method because the contact with the fixture contact surface area is increased. And as to Norton [18], Internal connection Implant is to stabilize in the vertical occlusal forces as well as to promote resistance to intraoral lateral occlusal due to a wide conical shape of the contact area between the fixture and the abutment, as to the comparision of the bending moment of Internal hexagon connection Implant of submerged type with of External hexagon connection Implant of submerged, the result of the study reported that the strength of Internal hexagon connection Implant is higher. But in this study of shear compression load test, YS Implant, Internal hexagon connection Implant of the submerged type is 617.60 N·cm, lower than 1141.41 N·cm as the External hexagon connection Implant of submerged type compression shear strength.

As to Norton [19], both ITI Syn-Octa Implant having Internal octagon conical implant of Non submerged type with 8° morse taper and OsseoSpeed Implant having Internal hexagon conical implant of submerged type with 10° morse taper were reported to be superior to clinical, but in the present study , the compression shear strength of YI Implant having Internal octa connection Implant of Non submerged type with 8° morse taper is 1208.20 N·cm that is higher than the compression shear strength of YS Implant having Internal hexagon connection Implant of the submerged type with 11° morse taper. It's the case of YS Implant morse taper to form a 11 ° inclined upper inner wall of the fixture (Fixture) is the thin edge of the fracture of the upper region than the implant platform on top of the other three species of the thickness measurement of the compression shear strength. Sufficient thickness of the top of the platform compared to other Internal connection Implant, in the case of 8° morse taper and slope, above the inner wall of the fixture (Fixture) is noticeable in the form widens towards the top of the outer wall of the congestion and the fastening in a wide cone shape fixture and abutment of the contact area, , YI Implant is determined to be the most excellent in the stability of the mechanical strength associated with the front end of the compression strength and the measured resistance value of the lateral occlusion increases.

In this study, the compression and shear load test results after the signing four kinds of different fastening methods Implant fixtures and abutments are all over 500 N·cm which is based on the standard of ISO 14801[18], so there is no problem to use in clinical.

5. Conclusions

This study was to compare the differences between Shear compression load using shear compression loads with fixed screws using in four different fastening methods with the same size of implanting fixture an abutment. As a result of the experiment, the compression load of YI Implant which is the compression load of Internal octagon connection Implant of Non submerged type with 8° morse taper and that of YE Implant which is External hexagon connection Implant were the highest, that of YS Implant which is Internal hexagon connection Implant of submerged type taking morse taper of 11° was the lowest. The relevance of the shear compression load test which was done by four different fastening methods with implanting fixture an abutment

The results of this study were different statistically compression shear strength of the four species of the implant for the difference in the coupling methods ($p < 0.001$), and were investigated that the 4 kinds of compressive strengths of the implant are higher than the standard of ISO 14801.

More research is needed on the Internal hexagon connection Implant of the submerged type with 11° morse taper having the lowest shear of the compression load on these results, also needed to utilize a variety of oral health data over the study so, patients with implants is expected to be fully considered during treatment planning of dental implants practitioner.

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