임플랜트 내측연결 시스템에서 고정체/ 지대주/나사의 연결부 적합에 관한 연구

Fit of Fixture/Abutment/Screw Interfaces of Internal Connection Implant System

2005년 2월 일

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임플랜트 내측연결 시스템에서 고정체/지대주/나사의 연결부 적합에 관한 연구

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국문초록

내측 연결 임플랜트 시스템에서 고정체/지대주/나사의 연결부 적합에 관한 연구

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본 연구의 목적은 최근 한국에서 제작되어 판매, 사용되고 있는 임플랜트 지대주의 연결방식인 내측 연결 시스템에서 광학 및 주사 전자 현미경을 이용하여 임플랜트 고정체/지대주/나사의 계면 적합을 평가하고자 하였다.

연구에서 사용된 국산 임플랜트의 고정체와 지대주, 지대나사는 내부연결시스템으로서 **AVANA**(Osstem®), **Bioplant**(Cowell-Medi®), **Dio**(DIO system®), **Neoplant**(Neobiotech®) 및 **Implantium**(Dentium®) 총 5개의 회사 제품을 선택하였다. 각 제조 회사 시스템에서 무작위로 표준형의 2개씩의 임플랜트 고정체를 선택하였다. 지대주로는 각각 지대주와 나사가 하나의 구조물인 one piece type과 2개의 분리 구조로 이루어진 two piece type의 구조물을 선택하였다. 지대나사의 경우 AVANA의 경우는 gold 나사와 일반적인 titanium 나사를 선택하였고 나머지 system은 회사의 권장 나사인 titanium 나사를 선택하였다. 레진블록에 임플랜트 고정체를 고정한 후 각각의 지대주를 연결하였고, 각 제조회사에서 권장사용하는 조임장치로 제조회사 권장 torque로 1차적으로 조인 후, 구조물간의 settling현상을 고려하여 24시간 후 다시 조였다. 그리고 액상 불포화 polyester(Epovia, Cray Vally Inc)에 매몰하고 완전히 중합시켰다. Grinder-polisher unit(OMNILAP 2000 SBT Inc)와 200, 600, 1000, 1200 grit의 silicone carbide paper를 순서대로 이용하여 절삭하고

ultrasonic cleaner에 넣어 물비누와 물로 세척하였다. 광학 현미경(Stereoscopic Zoom Microscope, Model:SV-11, Zeiss Inc, Germany) 및 주사전자 현미경(FE-SEM, Model: XL30SFEG, Phillips, Netherland)을 이용하여 임플랜트 고정체/지대주/나사 사이의 적합을 관찰하여, 다음과 같은 결과를 얻었다.

1. 국산 임플랜트 내측연결 system에서 구조물 사이의 결합 양상은 대체로 양호하였다.
   1) Abutment/Screw의 적합에선 나사의 두부 하방에서 모두 양호한 적합을 이루었다.
   2) Abutment/Fixture의 적합에선 two piece type이 one piece type 보다 일반적으로 더 적합이 우수 하였다.
   3) Screw/Fixture의 적합에선 two piece type이 one piece type 보다 일반적으로 더 적합이 우수 하였다.

2. 각 제조 회사의 시스템들은 각기 다른 재질, 기계적 구조, 절삭의 질에서 차이를 가졌다.

결론적으로 각 회사마다 내측연결 형태에 따라 약간의 차이는 보이기는 하지만, 대부분의 국산 임플랜트 system은 양호한 적합도를 가지고 있는 것으로 나타났다. 그러나 적합도는 양호하더라도 장기간의 하중 하에서 응력분산과 적합도의 변화에 대해서 앞으로 더 많은 연구가 필요하리라 사료된다.

Ⅰ. INTRODUCTION

The use of dental implant has become a successful procedure for the treatment of complete, partial edentulism, and single-tooth replacement in both the anterior and posterior regions of the mouth. Dental implant prosthesis is exposed to variable occlusal forces. The joint components of implant system are considered to be maintained under these variable loads. The geometry is important because it is one of the primary determinants of joint strength, joint stability and rotational stability and locational stability. Byrne et, al.[13] reported that passive fit between the implant components was very important. Binon[6,8] reported that accurate fit between the implant components was important because the misfit of the implant components result in frequent screw loosening, irreversible screw fracture, plaque accumulation, poor soft tissue reaction, and destruction of osseointegration.

From the mechanical aspect, Sones[45] reported that the prevention of the abutment screw fracture began with ensuring a passive framework fit. Sakaguchi et, al.[42] reported that the implant fixture and abutment with unstable joint interface result in unfair stress at the component joint screw. Boggan et, al.[9] reported that precision of the fit between the opposing contact interfaces could minimize the harmful load at abutment screw.

From the biological aspect, Quirynen et, al.[39] stated that in regard to the similarities of the soft tissue attachment and microbial colonization between natural teeth and implant, the relationship between ill-fitting margins and bacterial irritation could be a potential clinical problem such as soft tissue inflamation, peri-implantitis with implant-supported restorations. Besimo et, al.[4] and Gross et, al.[20] supported above statement that the microleakage between the interface of the osseointegrated implant and abutment usually existed, thereby resulting in soft tissue inflammation and bad ordor. These situations differed depending on each system.

The external hexagonal design guided by Brånemark system has been broadly utilized, but so many reports have showed biomechanical and clinical complications. Screw loosening and joint opening are primarily complications. Although application of controlled torque and altered screw designs have been significantly improved performance, the joint problem have not been eliminated entirely. To overcome some of the inherent design limitations in the external hexagonal connection, the internal connection system have been developed and broadly presented. The internal connection system has prosthetic advantages compared with external connection system. The advantages[2,8,34,37,46,47] are as follows. 1) reduced vertical height platform for restorative component, 2) distribution of lateral loading within the implant and shielded abutment screw 3) long internal wall engagements that create a stiff, unified body that resists joint opening and bending stress and the wall buffers vibration and provides increased resistance to screw loosening, 4) the potential ability for microbial seal, 5) it is easy, even for the inexperienced operator, to seat components on the fixture and with confidence, especially in the posterior part of the mouth.

Implant manufacture in Korea was started with AVANA system (Osstem®) in 1996. But the clinical results and informations for these implant systems are less than those for advanced imported implant system. Recently, home-made implant systems occupy half of the market in Korea. 7 or 8 manufactures are well known in Korea.

Each home-made implant manufactures emphasize the advantage and scientific superiority of their product supported by their own studies. Because most of their studies have focused on the osseointegrated state of the fixture surface, there is lack of information about the prosthetic problems, joint connection and stability.

The purpose of this study is to evaluate the machining accuracy and consistency of the implant fixture/abutment/screw interfaces of the internal connection system by using a stereoscopy and field emission scanning electron microscope(FE-SEM).

Ⅱ. MATERIALS AND METHODS

1. Materials

1) Implant fixture

The implant fixtures selected in this study were internal connection type implants from AVANA Standrad fixture(ø4.1*10 mmH; Osstem®), Bioplant Standard fixture(ø4.0*12 mmH; Cowell Medi®), Dio Standard fixture(ø4.0*12 mmH; DIO®), Neoplant Standard fixture(ø4.1*10 mmH; Neobiotech®), Implantium Standard fixture(ø4.3*12 mmH; Dentium®). All fixture made by Korean manufactures. The fixtures were chosen at random, each group was acquired 2 fixtures. Total 20 implant fixtures of 5 implant system were selected.

2) Abutment

Two piece(cemented) type abutment and one piece(solid) type abutment for use with each implant system were acquired. The abutments were regarded as a standard type and selected with the manufacture recommend. Respectively AVANA cemented abutment(4.8*5.5 mmH), AVANA solid abument(5.5 mmH), Bioplant Shoulder(cemented) abutment(5.5 mmH), Bioplant solid abutment(5.5 mmH), Dio cemented abutment(4.8*7 mmH), Dio solid abutment(5.5 mmH), Implantium dual(cemented) abutment(6.0), Implantium combi(solid) abutment(6.0*5.5 mmH), Neoplant solid abutment(5.5 mmH) were selected. Especially, Neoplant system had only a solid abutment. The abutments were chosen at random, each group was acquired 2 abutments.

3) Screw

Screw were respectively used to hold a two piece type abutment to a implant fixture. AVANA system had gold alloy screw and titanium screw. Other systems had only titanium screw. But Noeplant system didn′t have any screw because this system had only one piece type abutment.

Table 1. Kinds of implant system in this study

Type of System	**Type of Fixture** diameter(ø)* length(mmH)	**Type of Abutment** length(mmH)	**Type of Screw**	**Torque(Ncm)**
AVANA (Osstem®)	4.1*10	cemented (5.5)	gold	30
		solid (5.5)	titanium	
Bioplant (Cowel Medi®)	4.0*12	shoulder (5.5)	titanium	35
		solid (5.5)		
Dio (DIO®)	4.0*12	cemented (7)	titanium	35
		solid (5.5)		
Neoplant (Neobiotech®)	4.1*10	solid (5.5) **only**		25
Implantium (Dentium®)	4.3*12	dual(cemented) (6.0)	titanium	35
		combi (5.5)		

2. Methods

1) Implant fixture mounting in resin block

The implant fixtures were perpendiculary mounted in polymethyl methacrylate autopolymerizing acrylic resin block(Orthodontic resin, Densply international Inc. USA)

2) Connection of each abutment to implant

Each two piece abutment was secured to the implant fixture by screw and one piece abutment also secured to the implant fixture with recommended torque value using manufacture's recommended torque controller(Fig. 1). The abutment screw and one piece type abutment were retightened after 24 hours.

3) Abutment/fixture assembly mounting in polyester

Abutment/fixture assembly were mounted in liquid unsaturated polyester. Each one was embedded completely. The mounting media(Epovia, Cray Valley Inc.) was a 2-part system made up of a resin base and activator. The two components were mixed together and poured and allowed to cure completely during overnight.

4) Cross section and polishing of all samples

All samples were cross sectioned with grinder-polisher unit(OMNILAP 2000 SBT Inc)(Fig. 2,3). The initial grinding was performed with 200 grit silicon carbide paper. Polishing was continued with 600, 1000, 1200 grid silicone carbide paper. All specimens were cleaned with a liquid soap and water in an ultrasonic cleaner during 10 minutes. Finally, all specimens were steam-spray cleaned by Aquaclean3 (Degussa Dental) and dried carefully.

5) Analysis of fit between implant fixture/abutment/screw interfaces

Optical microscope(Steroscopic Zoom Microscope, Germany, Zeiss Inc, Model:SV-11) and FE-SEM(field emission scanning electron microscope, Netherland, Phillips co., Medel: XL 30 SFEG) were used to evaluate fit of all samples.

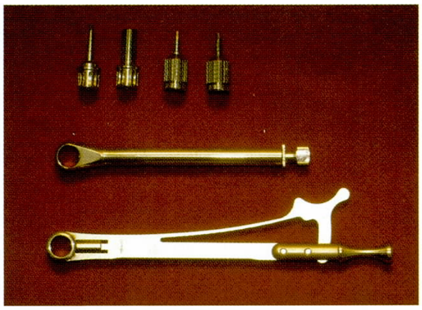


Fig. 1. Torque devices

Fig. 2. Grinder polisher unit (OMNILAP 2000 SBT Inc)

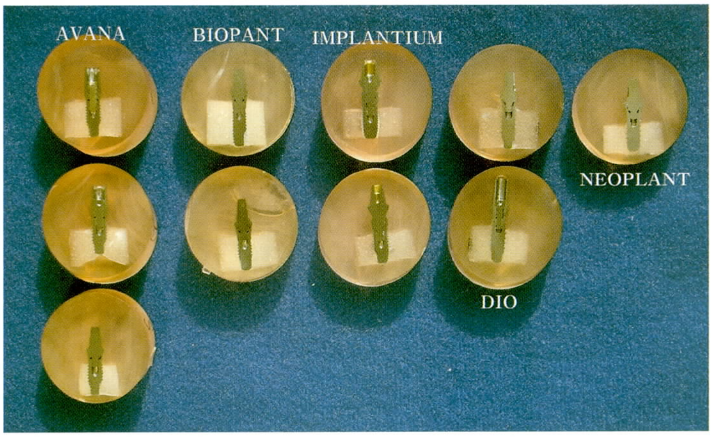


Fig. 3. Specimens which were cross-sectioned and polished

Ⅲ. RESULTS

The Fit of AVANA System (Fig. 4,5,6)

1. The fit between the implant fixture/abutment/screw interfaces in the AVANA-1 piece system (Fig. 4)

1) The fit between the implant fixture/abutment interface(Fig. 4-a,b)
The interface showed very close and broad surface contact. approximately, all abutment surface was contacted with internal wall of fixture.

2) The fit between the screw/implant fixture interface(Fig. 4-a,c,d)
The interface showed upper surface contact but that was not close. Large gap remained at lower part of the root terminal.

2. The fit between the implant fixture/abutment/screw interfaces in the AVANA-2 piece, gold screw-system (Fig. 5)

1) The fit between the abutment/screw interface(Fig. 5-a,b,c,d)
The interface showed close contact at the lower part of screw head. But variable gap existed except this area.

2) The fit between the implant fixture/abutment interface(Fig. 5-a,c,d)
The upper half surface showed close contact. But variable gap existed except this area.

3) The fit between the screw/implant fixture interface(Fig. 5-e)
The interface showed uniform close contact at upper side and fair state.

3. The fit between the implant fixture/abutment/screw interfaces in the AVANA-2 piece type, titanium screw-system (Fig. 6)

1) The fit between the abutment/screw interface(Fig. 6-a,b,c,d)

The interface showed close contact at the lower part of screw head. But variable gap existed except this area.

2) The fit between the implant fixture/abutment interface(Fig. 6-a,c,d)

The upper half surface showed close contact. But variable gap existed except this area.

3) The fit between the screw/implant fixture interface(Fig. 6-e)

The interface showed uniform close contact at upper side and fair state.

4) As compared with a gold screw, the interface of the titanium screw was similar to that of the gold screw under recommended torque.

The Fit of Bioplant System (Fig. 7, 8)

1. The fit between the implant fixture/abutment/screw interfaces in the Bioplant-1 piece-system (Fig. 7)

1) The fit between the implant fixture/abutment interface(Fig. 7-a,b)

The interface showed close contact at upper third and lower narrow area. Variable gap was existed. Approximately, 50%-surface contact existed.

2) The fit between the screw/implant fixture interface(Fig. 7-a,c,d)

The interface showed superior surface contact which was not close. Large gap remained at lower part of the root terminal.

2. The fit between the implant fixture/abutment/screw interfaces in the Bioplant-2 piece-system (Fig. 8)

The Bioplant internal 2 piece type had a unique design compared with other systems in this study.

1) The fit between the abutment/screw interface(Fig. 8-a,b,c,d)

The interface showed close contact at lower part of screw head. But variable gap existed except this area.

2) The fit between the implant fixture/abutment interface(Fig. 8-a,c,d)

Variable gap was existed in joint interface. The state of interface was not fair.

3) The fit between the screw/implant fixture interface(Fig. 8-e,f)

The interface showed uniform close contact at upper side and fair state.

The Fit of Dio System (Fig. 9, 10)

1. The fit between the implant fixture/abutment/screw interfaces in the Dio implant-1 piece-system (Fig. 9)

1) The fit between the implant fixture/abutment interface(Fig. 9-a,b,c)

The interface showed very close and broad surface contact. Approximately, all abutment surface was contact with internal wall of fixture.

2) The fit between the screw/implant fixture interface(Fig. 9-a,d,e)

The interface showed at upper surface contact which was not close. Large gap remained at lower part of the root terminal.

3) Bilateral gap at lower joint interface was not equal.(Fig. 9-a,c)

2. The fit between implant the fixture/abutment/screw interfaces

in the Dio implant-2 piece-system (Fig. 10)

1) The fit between the abutment/screw interface(Fig. 10-a,b,c)

   The interface showed close contact at lower part of screw head. And remained area showed fair joint interface.

2) The fit between the implant fixture/abutment interface(Fig. 10-a,c)

   The interface showed small gap and joint interface was fair.

3) The fit between the screw/implant fixture interface(Fig. 10-a,c,d)

   The interface showed uniform close contact at upper side and fair state.

The Fit of Neoplant System (Fig. 11)

1. The fit between the implant fixture/abutment/screw interfaces in the Neoplant-1 piece-system (Fig. 11)

Neoplant system had only 1 piece type abutment.

1) The fit between the implant fixture/abutment interface(Fig. 11-a,b,c)

   The interface showed close contact at upper third and lower narrow area. approximately, 50%-surface contact existed.

2) The fit between the screw/implant fixture interface(Fig. 11-a,c,d)

   The interface showed uniform close contact at upper side and fair stat. Large gap remained at lower part of the root terminal.

3) Bilateral gap at middle abutment joint interface was not equal. (Fig. 11-a,b)

The Fit of Implantium System (Fig. 12,13)

1. The fit between the implant fixture/abutment/screw interfaces in the Implantium-1 piece-system (Fig. 12)

1) The fit between the implant fixture/abutment interface(Fig. 12-a,b)
   The interface showed very close and good surface contact. And smallest gap existed compared with other systems in this study.
2) The fit between the screw/implant fixture interface(Fig. 12-c,d)
   The interface showed uniform close contact at upper side and fair state.
3) Bilateral gap at middle abutment joint interface was not equal.(Fig. 12-a,b)

2. The fit between the implant fixture/abutment/screw interfaces in the Implantium-2 piece-system (Fig. 13)

1) The fit between the abutment/screw interface(Fig. 13-a,b,c)
   The interface showed good fit.
2) The fit between the implant fixture/abutment interface(Fig. 13-c,d)
   The interface showed good condition at upper and lower third. And small gap existed at middle third.
3) The fit between the screw/implant fixture interface(Fig. 13-d,e)
   The interface showed uniform close contact at upper side and fair state.

Table 2. The Fit of the implant fixture/abutment/screw interfaces in all systems.

Type of system	Type of abutment	Fit of screw/fixture	Fit of abutment/fixture	Fit of abutment/screw
AVANA	solid	-	++	Non
	cemented(gold)	++	+	+
	cemented(titanium)	++	+	+
Bioplant	solid	-	+	Non
	shoulder	++	-	+
Dio	solid	-	++, NBMI	Non
	cemented	+	+	+
Neoplant	solid	+	+, NBMI	Non
Implantium	combi	+	+, NBMI	Non
	dual	++	+	+

Note

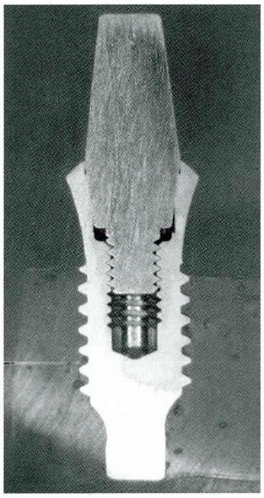
Non: Not exited

NBMI: Not Bilateral Mirror Image

++: very closed or good condition

+: To 50% closed or fair condition

-: not closed or bad condition



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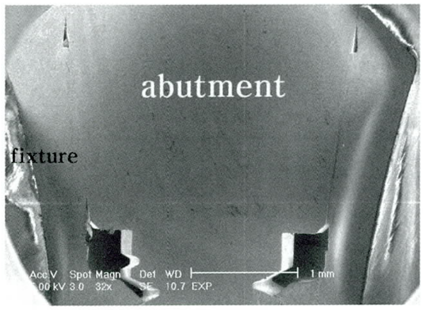

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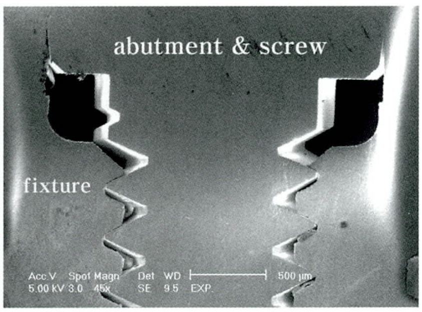

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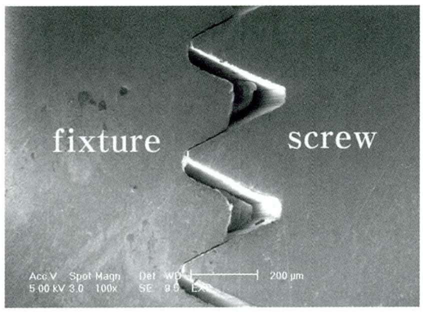
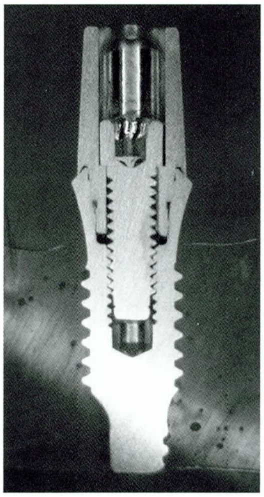


d (100x)

Fig. 4. Optical cross-section micrograph (a) and SEM (b,c,d) of joint connection in **AVANA(1 piece)** implant system.



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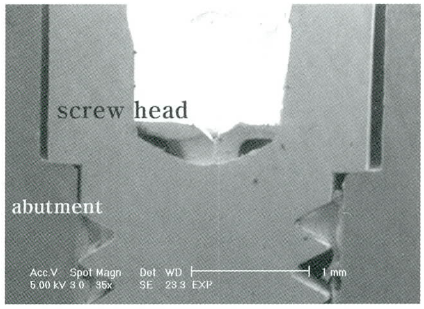

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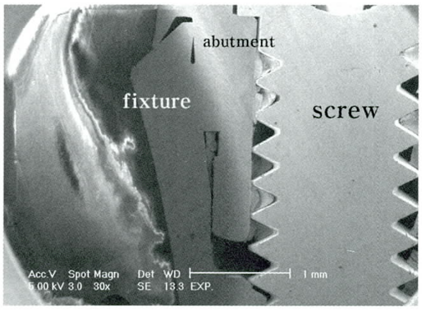

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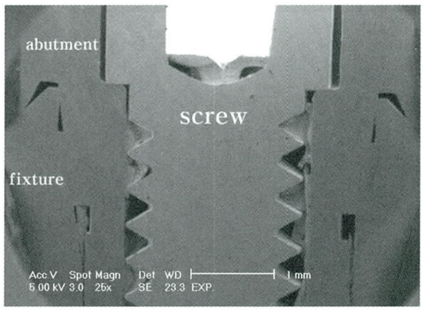

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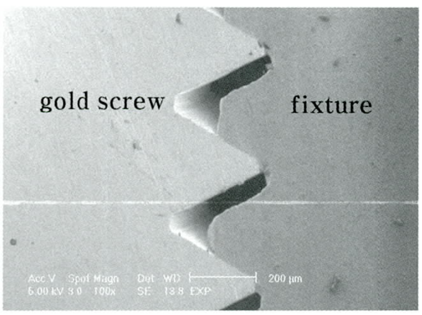
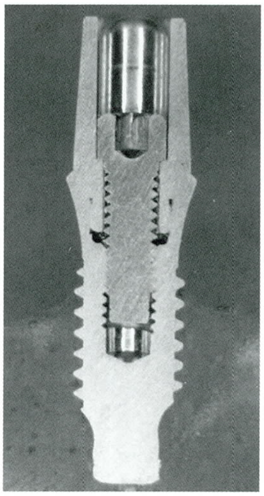
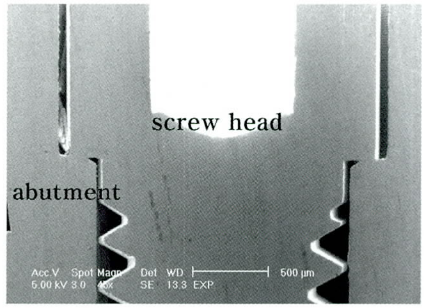


e (100x)

Fig. 5. Optical cross-section micrograph (a) and SEM (b,c,d,e) of joint connection in **AVANA (2 piece-gold screw)** implant system.



a (5x)



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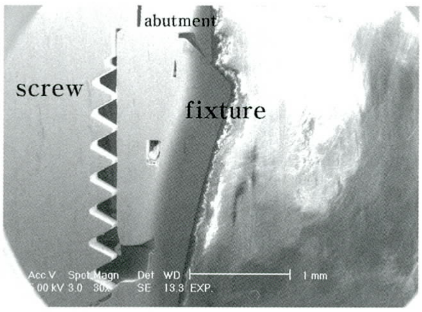

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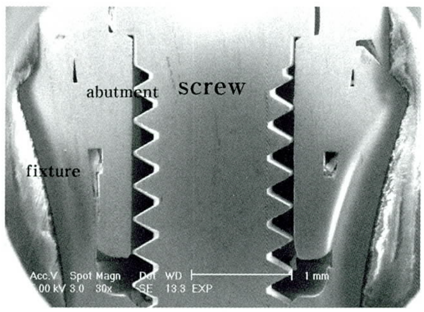
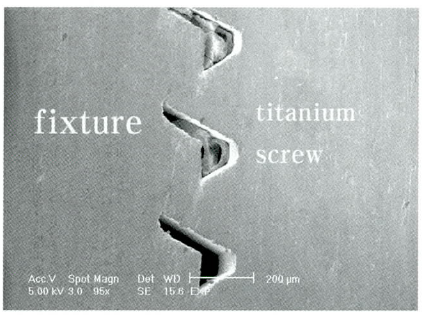
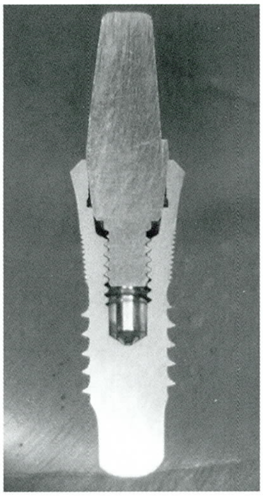


d (35x)



e (95x)

Fig. 6. Optical cross-section micrograph (a) and SEM (b,c,d,e) of joint connection in **AVANA (2 piece-titanium screw)** implant system.



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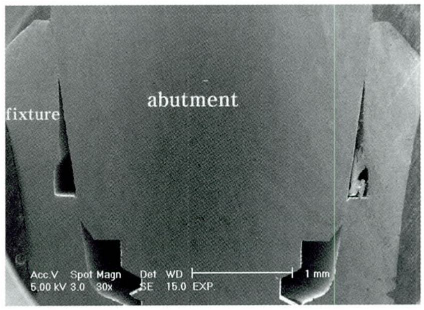

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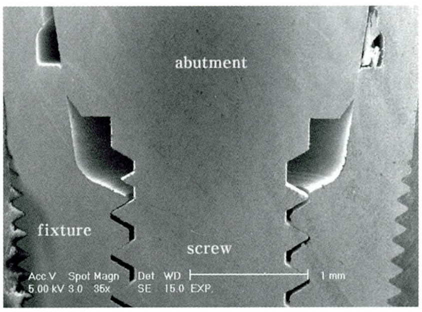

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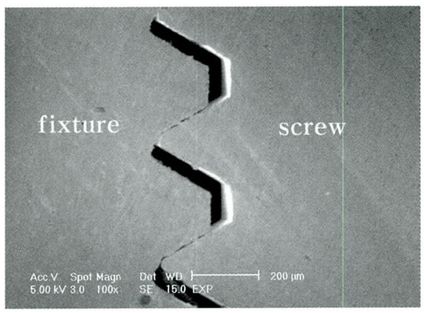
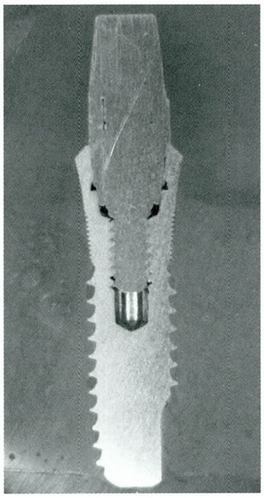
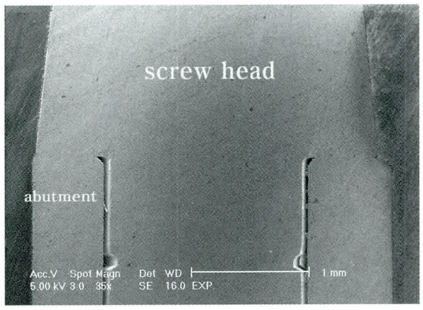


d (100x)

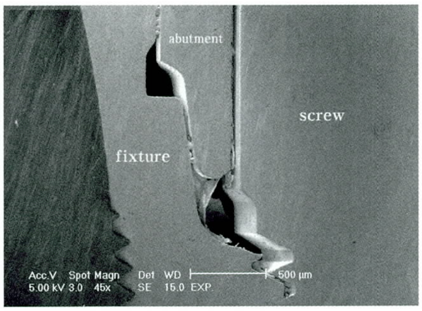
Fig. 7. Optical cross-section micrograph (a) and SEM (b,c,d) of joint connection in **Bioplant (1 piece)** implant system.



a (5x)



b (35x)



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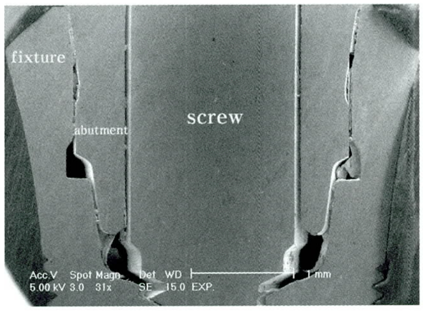
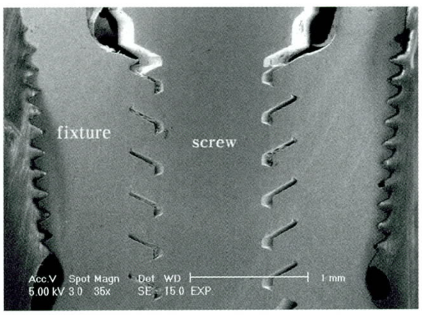


d (31x)



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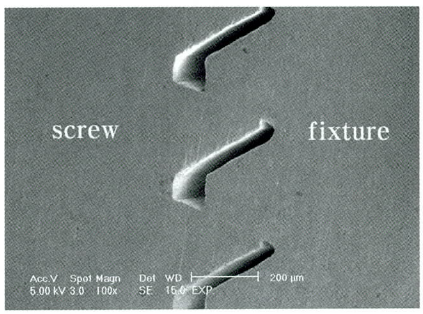
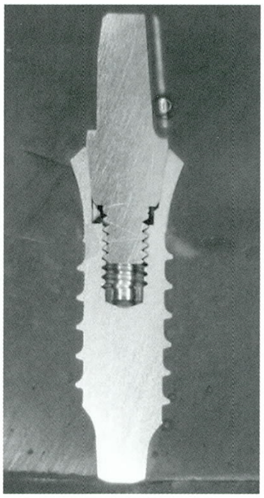
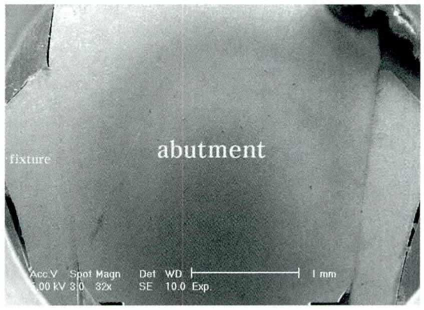


f (100x)

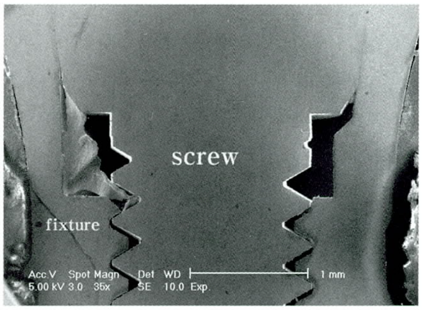
Fig. 8. Optical cross-section micrograph (a) and SEM (b,c,d,e,f) of joint connection in **Bioplant (2 piece)** implant system.



a (5x)



b (32x)



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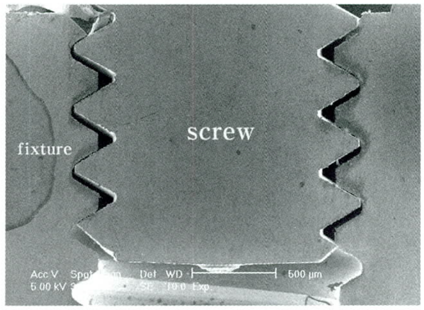
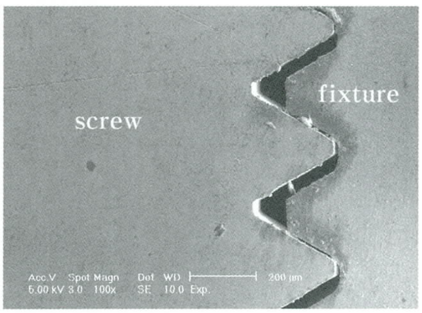
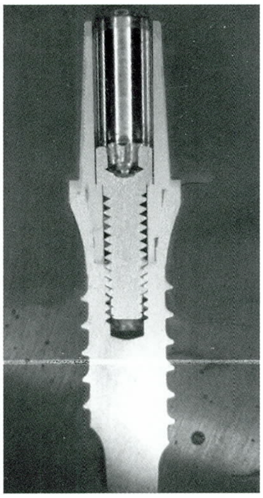


d (50x)

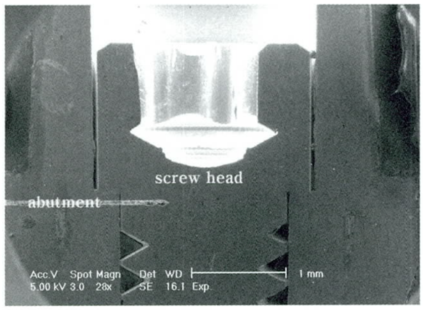


e (100x)

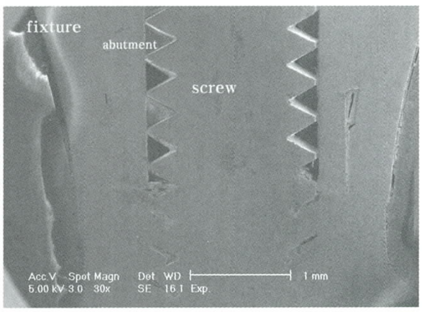
Fig. 9. Optical cross-section micrograph (a) and SEM (b,c,d,e) of joint connection in **Dio (1 piece)** implant system.



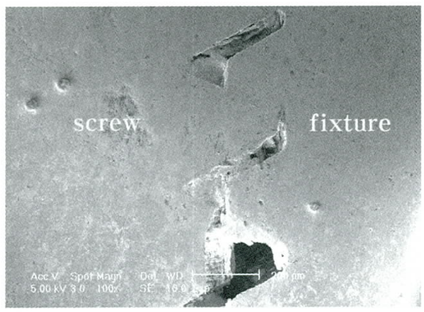
a (5x)



b (28x)



c (30x)



d (100x)

Fig.10. Optical cross-section micrograph (a) and SEM (b,c,d) of joint connection in **Dio (2 piece)** implant system.

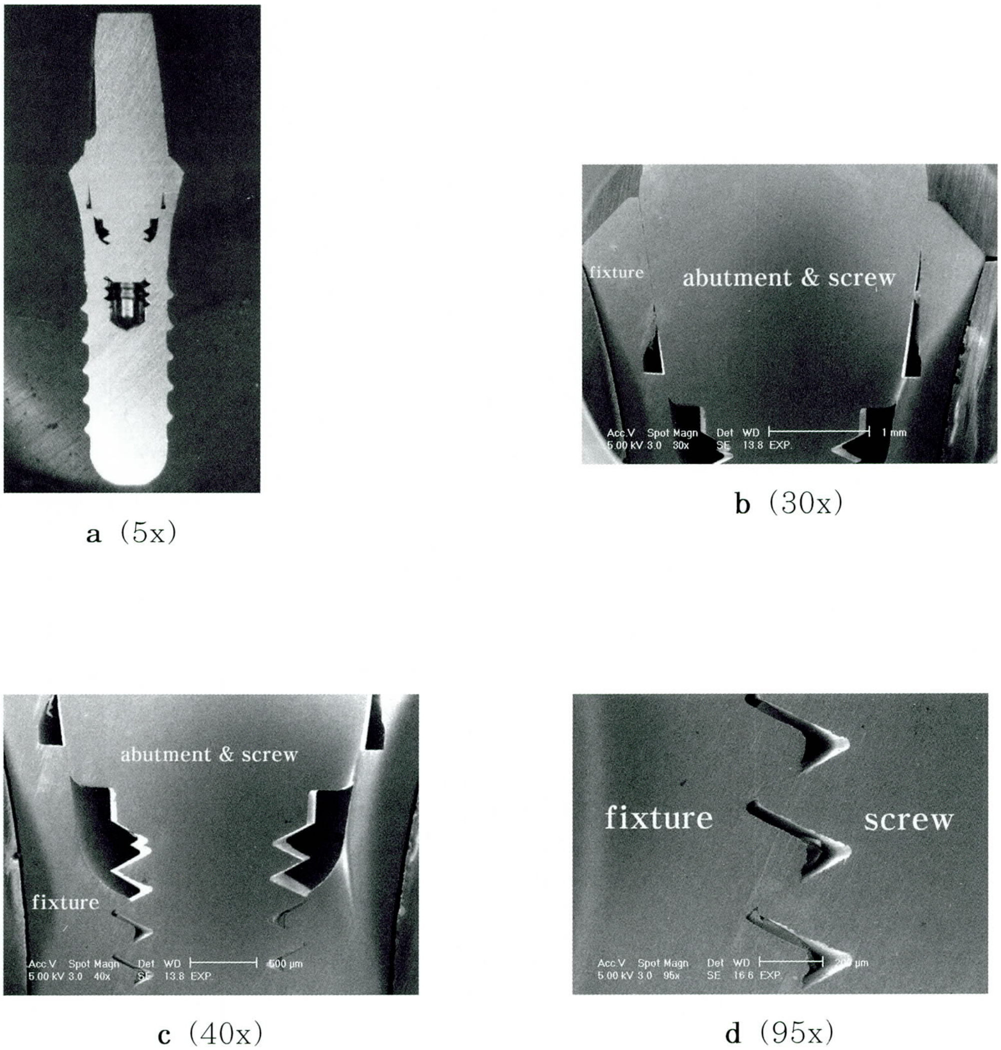
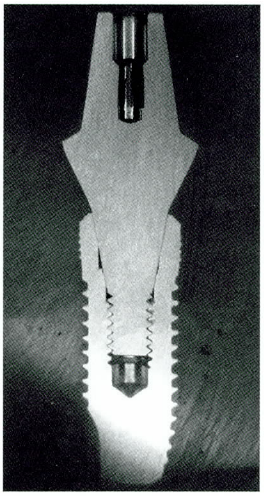
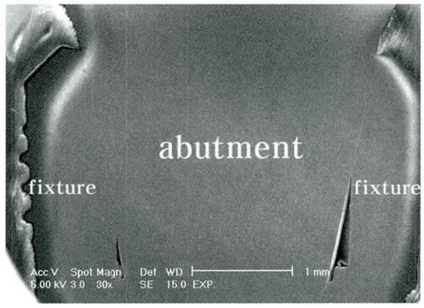


Fig. 11. Optical cross-section micrograph (a) and SEM (b,c,d) of joint connection in **Neoplant (1 piece)** implant system.



a (5x)



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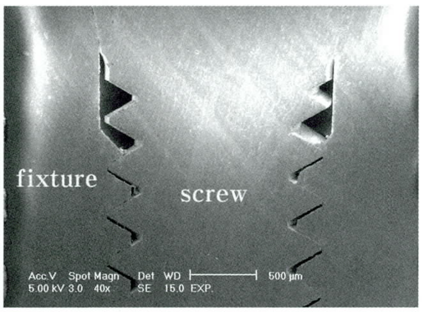
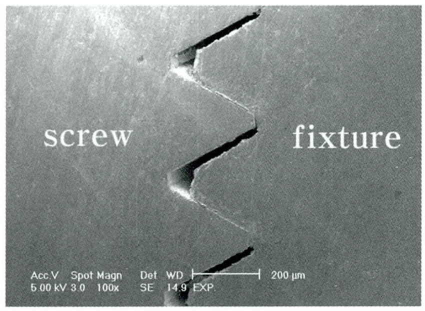
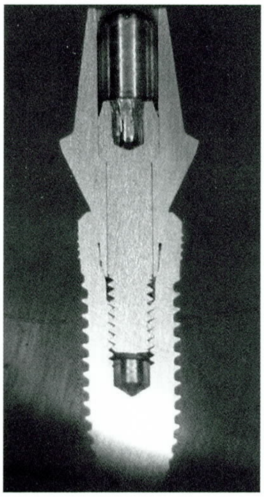


c (40x)

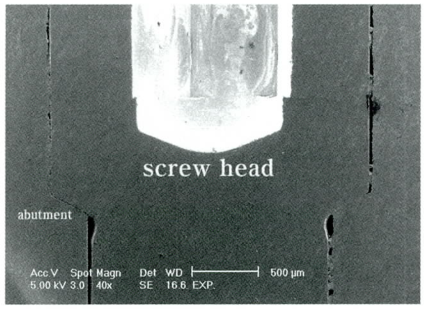


d (100x)

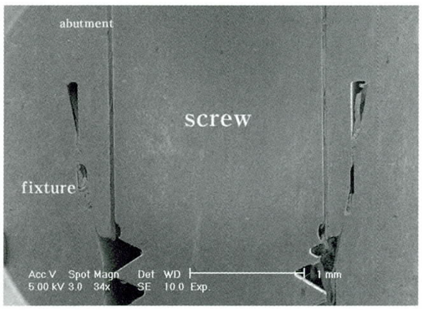
Fig.12. Optical cross-section micrograph (a) and SEM (b,c,d) of joint connection in **Implantium (1 piece)** implant system.



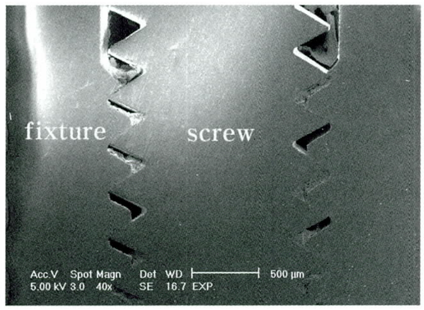
a (5x)



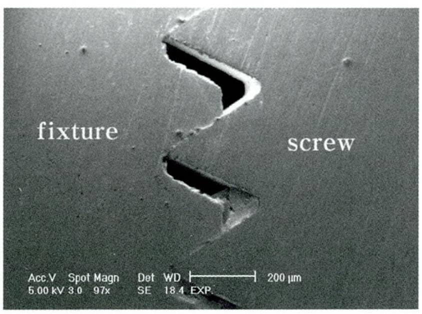
b (40x)



c (34x)



d (40x)



e (97x)

Fig.13. Optical cross-section micrograph (a) and SEM (b,c,d,e) of joint connection in **Implantium (2 piece)** implant system.

Ⅳ. DISCUSSION

In internal connection of home-made implant systems, the component joint interfaces were in good condition. And the results of the above study showed that materials and mechanical properties and quality of milling differed depending on their manufacturing companies. Binon[8] reported that while the products by each manufactured company had a good degree of precision and accuracy, each system was revealed a system's difference between them in accuracy of inter-components.

The Fit of the abutment/screw interface

The abutment/screw interfaces existed in two piece type connection. Joint connection state in all systems was in good condition at lower border of screw head. But variable gap exited in another area except this area. Persson et, al.[38] reported that presence of bacteria was the result in a contamination of the fixture and abutment components during the 1st and/or 2nd stage of implant installation, a transmission of microorganisms from the oral environment during function subsequent to bridge installation. Ericsson et, al.[19] reported that the colonization of bacteria inside the implant system and the penetration of bacteria or their products via the microgap-between the fixture and the abutment-might constitute a risk for soft tissue inflammation and loss of supporting bone. Like this reason, despite the fact that the microgap inevitably exists in all system, it is better to strive to reduce the possibility of having microgap.

The Fit of the abutment/implant fixture interface

In this study, Only Implantium system had 11 degree morse taper and other systems had 8 degree morse taper. Sutter et, al.[47] proposed an 8 degree taper connection, referred to in the literature as the ITI Morse taper, between implant and abutment as an optimal combination of predictable vertical positioning and self locking characteristics.

Generally, two piece type connection was superior to one piece type connection in this study. Because fixtures of all systems were synOcta implant fixture. SynOcta fixture had index at implant level and positioning notch for prosthetic convenience. Although one piece type abutment also used this fixture. Two piece type abutment was developed privite use at synOcta fixture. So joint interface between this fixture and original one piece abutment had reduced total joint interface to 31 % compared with that between original one piece abutment and original fixture. Squier et, al.[46] reported that reduced connected surface didn't have an influence on screw joint stability. This reduction was that one piece abutment was partially connection with inner surface of synOctra fixture. For this reason, Dio, Implantium, Neoplant system didn't have bilateral mirror image in geometric condition. If original fixture used in this study, the result had reverse effects. Among the products of several companies, Especially AVANA, Dio, Implantium systems had broad and very close connection in one piece type joint interface.

The Fit of the implant fixture/screw interface

Generally, two piece type connection was superior to one piece type connection. This reason is that one piece type connection gains joint stability from friction force at morse taper and preload by screw. Most of this stability is gained friction force at morse taper. Preload by screw doesn't mainly take part in joint stability. But in two piece connection, most of joint stability is gained from the preload by screw, when it is connected.[2,33,34,37,44,46,47] For this reason, if one piece system is acquired the more accuracy at lower screw/fixture joint interface, the more stability is gained.

Although two piece type was superior to one piece type, Neoplant and Implantium system showed good quality at lower part of the screw/fixture interface.

In the process of making test specimens, the loss of preload or loss of integrity between components might occur. The joints of the structural components might be loosened due to a loss of the preload during procedure of the grinder-polisher. This phenomenon, which had been observed in a few experiments, was confirmed to be a failure of specimens. This was more obvious in a lower grid carbide paper, but this was lesser observed in the higher grid carbide paper.

The loss of preload might also occur during the ultrasonic cleaning process aimed for probation of the structural joints. This loss had occurred in some test specimens and it was considered that the longer the cleaning was the higher the rate of loss was. In order to minimize the occurrence of the above these errors, grind-polisher was carefully used throughout multi grid levels, and The procedure of ultrasonic cleaning was shortened and the steam-spray was used for long time.

In addition, the specimens were probed with a optical scanning microscope. The test specimens used in the experiment were only those that had been found in good condition in the implant fixture/abutment joint patterns in case of the one piece types which had invariably a sensitive joint area, and the screw/fixture joint patterns in case of the two piece types. However, it was difficult to conclude that the above potential problems were completely avoided in an experiment.

This experiment was a pre-test for the acceptability assessment of home-made internal implant system after and under the load. The above errors may act as a big obstacle to alter the pre-set preload of the specimen during the process of making specimens, thereby seriously effecting the conclusion of such an experiment.

Therefore, in a future additional experiment, the development of a different method of making test specimens is needed.

V. CONCLUSIONS

The data obtained from the implant fixture/abutment/screw interfaces using Stereoscopic Zoom microscope and FE-SEM supported the following conclusions:

1. Implant fixture/abutment/screw connection interfaces of internal connection systems made in Korea were in good condition.
   1) The abutment/screw interface was that joint connection in all systems were in good condition at lower border of the screw head.
   2) The abutment/fixture interface was that generally, two piece type connection was superior to one piece type connection in this study.
   3) The screw/fixture interface was that generally, two piece type connection was superior to one piece type connection in this study.

2. The results of the above study showed that materials and mechanical properties and quality of milling differed depending on their manufacturing companies.

Conclusively although mechanical geometry was different, each system showed good connection interfaces. But it was difficult to come to a conclusion from these facts. Because the specimens of each type were just two. and it was inevitable to have potential errors in experiment. Although joint interfaces were in good condition in this study, more study related to load distribution in contact interfaces and change of joint stability and fit by long term load is needed.

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