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原著

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Original Work

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Clinical Evaluation of Preventive Prosthesis System
Part I. Classification of Preventive Prosthesis System

Wen-Yuen Wu [1,2], Shin-ichi Masumi [1], Shigeki Miyake [1,3], Eri Makihara [1], Toshihiro Kawano [1], Nobuo Oda [1,4] and Yi-Zarn Wang [5]

[1] Division of Occlusion & Maxillofacial Reconstruction, Department of Oral Function, Kyushu Dental University, Kitakyushu, Japan
[2] Chyoda Dental Clinic, Kaohsiung, Taiwan
[3] Aiji Dental Clinic, Hiroshima, Japan
[4] Oda dental Clinic, Fukuoka, Japan
[5] LSU Health Sciences Center School of Medicine, Department of Surgery, USA

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Abstract

We started clinical application of conical telescopic prosthesis since 1987. We could fabricate full mouth rehabilitation with conical telescopic prosthesis from single crown. This simple appliance can combine with implant or magnetic attachment and is able to solve all prosthetic problem. The system is named preventive prosthesis system (PPS). To classify PPS, support areas of dental arch are divided into three types, two anterior main support areas, two posterior main support areas, and one accessory area on both upper and lower arches. To understand the system easily, we introduce a brand new classification. We divide the prosthesis into 3 types, which are extension type (E), pontic type (P), and Crown (Cr). E type is classified into 9 subtypes. P type can be divided into 4 main types and several subdivisions, and Cr type can be divided into 8 subtypes. Although this classification has a disadvantage that there are many subdivisions, the diagnosis, treatment planning and prosthesis fabrication is simplified by this classification.

Key words：preventive prosthesis system / classification / support area / conical telescope crown

Introduction

Current fixed bridge and removable partial denture are systemically different. Their advantage and disadvantage can't compromise with each other and will both eventually fail. The first author started clinical application of conical telescopic prosthesis in Taiwan since 1987, and over 900 cases in his clinic. The co-authors have been working as instructors and advisers since 1981.

The original conical telescopic prosthesis developed in German [1)], and we modify it to apply to all kinds of prosthesis. When set a conventional fixed crown, secondary caries or periodontal disease of the abutment tooth occurs in future, and re-fabrication of the prosthesis is required after dental treatment. But this system is able to easy plaque control and prevents secondary caries or periodontal disease because the system is removable. And if set an inner crown in once, the abutment tooth can use permanently until the tooth is extracted. Furthermore, this system prevents

Table 1　Kennedy's classification

Class Ⅰ	bilateral free ended partially edentulous
Class Ⅱ	unilateral free ended partially edentulous
Class Ⅲ	unilateral bounded partially edentulous
Class Ⅳ	bilateral bounded anterior partially edentulous

the caries of the neighbor teeth. So we form the Preventive Prosthesis System (PPS), which is semi-fixed and semi-removable prosthesis. It has the advantage of both fixed and removable prosthetic but remains almost none of their disadvantage. By this system, we can fabricate prosthesis from single crown to full mouth rehabilitation and can combine implant and magnetic attachment with one simple appliance to solve all prosthetic problems. Clinical and laboratory procedures can save 66.7% of time and budget with the system..

On the other hand, several researchers have conceived classifications for partially edentulous arches in 20th century. However, there is no classification that can be applied on treatment course directly. For example, Kennedy [2] divided the edentulous situations into four different categories (Table 1). But this classification is only for prosthetic defects. Eichner [3] divided them into 3 types (Table 2). But this classification is only for occlusal support. As a result, both classifications are not enough for all prosthesis construction. So we designed a different classification for prosthetic defects, dental and mucosal support according to the PPS.

In this report, we introduce our new classification and prosthesis that matched it.

Classification of PPS

A. Support area

We suggest imagining the arch as a table and the natural teeth roots being the legs of the table. In PPS, we claim that there are two anterior main support areas, two posterior main support areas, and one accessory area on both upper and lower arches. The anterior main support areas are in canine, 1st premolar and 2nd premolar. The posterior main support areas are in 1st molar, 2nd molar and 3rd molar. These 4 areas act as 4 legs of a table during prosthesis for edentulous space. The accessory support area is in central and lateral incisors (Fig. 1). In any prosthesis, 4 support areas are changeable by tooth extraction, adding abutment tooth, adding implant. The dentist can control the state of the same original prosthesis in different cases. Fig. 2 shows the clinical cases of each support areas.

B. Classification of prosthesis

Compromising the current divided removable partial denture and fixed bridge prosthesis, we classified the prosthesis into 3 types, extension type (E), pontic type (P), and Crown (Cr). These 3 types can be interchangeable by taking away or placing abutment tooth and abutment implant.

Table 2　Eichner's classification. The area of occlusal support have been divided into four regions, the premolars and molars on the right and left, where A has contacts on all of the support zones, B does not have contact on all of the support zones, where as C has no contact on any of the support zones.

A-1	A dental arch with 4 support zones without any lacking teeth
A-2	A dental arch with 4 support zones with tooth loss on one side of the jaw
A-3	A dental arch with 4 support zones with tooth loss on both the lower and upper mandibles
B-1	A denture with 3 support zones
B-2	A denture with 2 support zones
B-3	A denture with 1 support zones
B-4	A denture without any support zone and with contact occlusion only at the anterior teeth
C-1	A denture without any support zones with teeth remaining on the lower and upper mandible
C-2	A denture without any support zone with one edentulous jaw
C-3	Both upper and lower jaws are edentulous

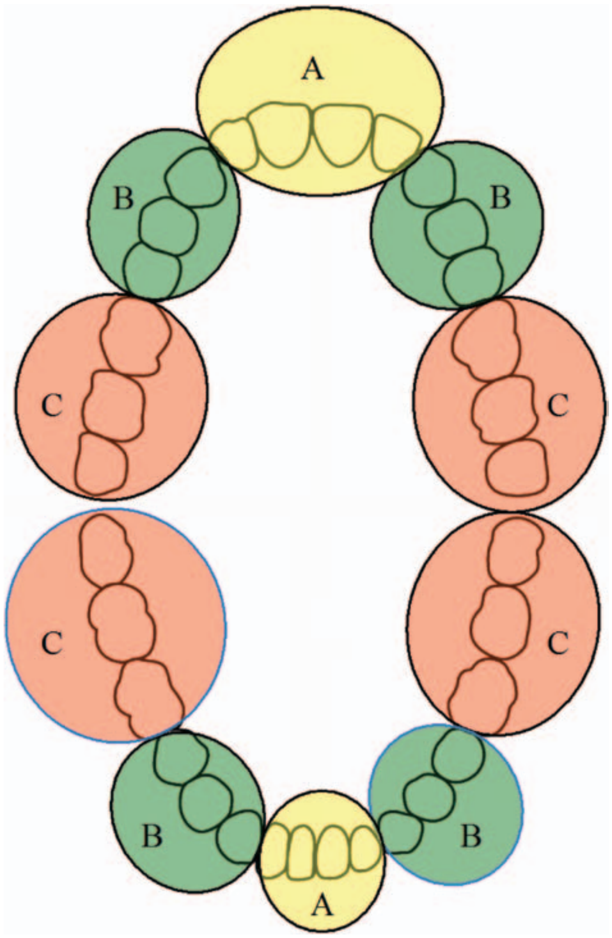

Fig. 1 A scheme of support area
A : accessory support area
B : anterior main support area
C : posterior main support area

1. E type prosthesis

E type is defined the prosthesis with extension lacking the main support areas. E1 type is the E type without anterior support area, while E2 is without posterior support area. There are therefore 9 possible subtypes in E type. In the classification of PPS, we disregard the central and lateral incisors in E type because of the bad occlusal loading on their labial inclination character. Placing implant into any main support area can change the E type prosthesis into the more stable P type. If the added implant failed, P type could also reverse to E type. Table 3 shows classification of E type prosthesis and Fig. 3 shows some clinical cases.

2. P type prosthesis

P type prosthesis is identified with the area rather than the number of missing tooth, which can be within one support area but also can cross another support area. This is different from the current fixed bridge prosthesis. By adding metal rest wing (Re) to current crown or adding pontic metal marginal ridge abutment to the neighbor tooth or prosthesis occlusal surface, we can get an additional support, which is prohibited in current natural enamel surface. For example, in current dentistry, in a first molar missing case, we prepare the second premolar and second molar as abutment and fabricate a fixed bridge with the first molar as the pontic and cement it. In P type, the morphology is almost the same with three supports, but not cemented ; the added Re can be done by either joining to the second premolar outer crown mesial metal and resting onto the first premolar distal occlusal clearance space or joining to the second molar outer crown distal metal and resting onto the third molar mesial occlusal clearance space. We can earn an additional support without injuring these two teeth (Fig. 4). Moreover, if Re is added to both mesial of second premolar and distal of second molar, there will be four supports.

To preventing injury, the additional metal rest wing can be done by joining to the first molar pontic mesial metal without tooth preparation injury of the second premolar. Resting onto the distal occlussal surface earns an additional support for the prepared second molar abutment, and this new type of prosthesis was named anterior cantilever type prosthesis (Ca1), which is the subdivision 1 of P type. There is another subdivision 2 of P type, which the additional metal rest wing can be done by joining to the first molar pontic distal metal without tooth preparation injury of the second molar, and earning an additional support for prepared second premolar abutment by resting onto mesial occlusal surface. This type of prosthesis is named posterior cantilever type prosthesis (Ca2). Each arch has 16 teeth, therefore there are 36 kinds of prosthesis within P type,

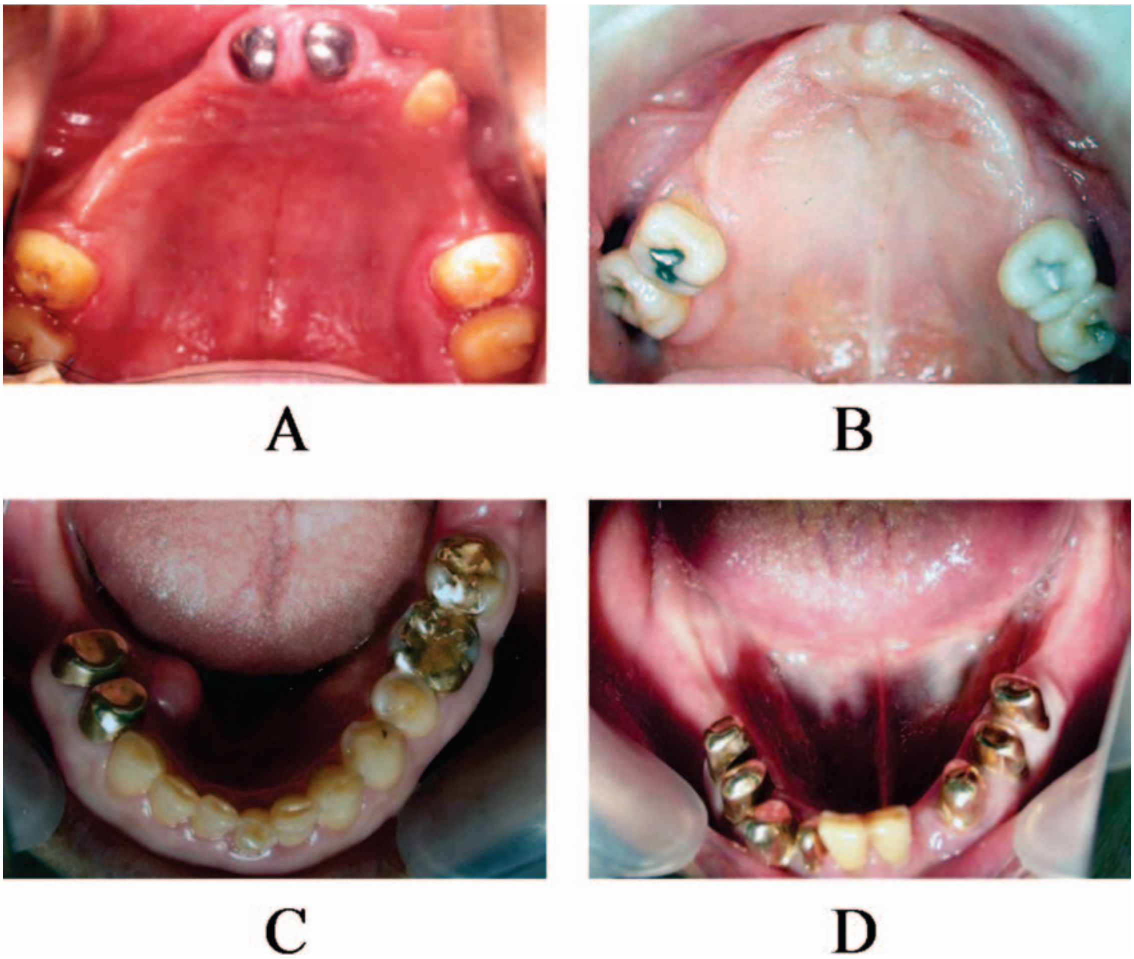

Fig. 2　Clinical cases of each support areas
A. Anterior main support area. Unilateral missing
B. Anterior main support areas. Bilateral missing
C. Posterior main support area. Unilateral missing
D. Posterior main support areas. Bilateral missing

Table 3　Classification of E type

1. E1：E type with 1 anterior edentulous without key support（see Fig. 3-A）
2. E1xII：E type with 2 anterior edentulous without support（see Fig. 3-B）
3. E2：E type with 1 posterior edentulous without support（see Fig. 3-C）
4. E2xII：E type with 1 posterior edentulous without support（see Fig. 3-D）
5. E1. E2：E type with 1 anterior and 1 posterior divided edentulous without support（see Fig. 3-E）
6. E12：E type with 1 anterior and 1 posterior connected edentulous without support（see Fig. 3-F）
7. E12. E1：E type with 1 anterior and 1 posterior connected edentulous and 1 divided anterior edentulous without support（see Fig. 3-G）
8. E12. E2：E type with 1 anterior and 1 posterior connected edentulous and 1 posterior divided edentulous without support（see Fig. 3-H）
9. E1xII. E2xII：E type with 2 anterior and 2 posterior connected edentulous without support（see Fig. 3-I）

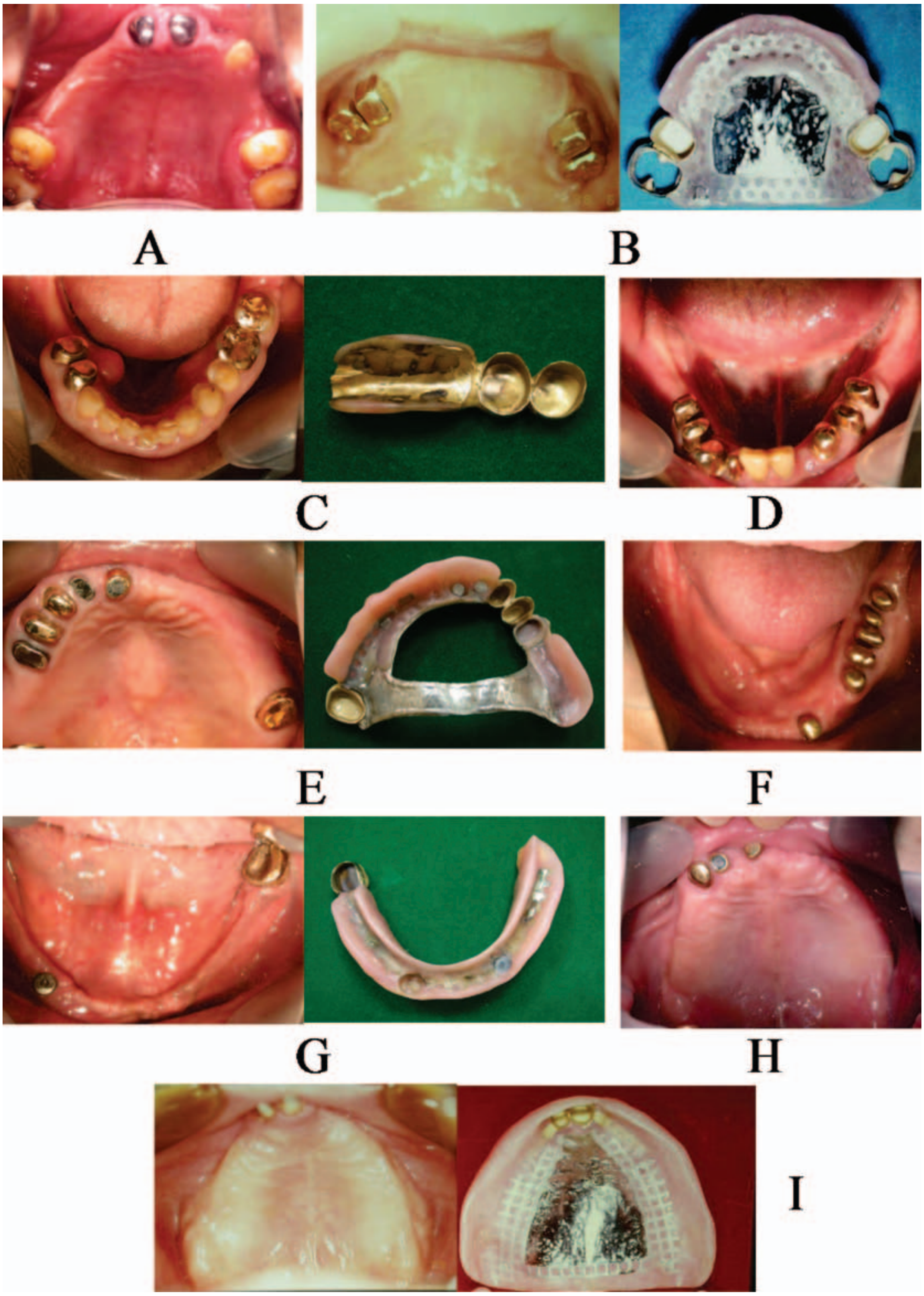

Fig. 3 Sample clinical cases of E type prosthesis
A : E1, B : E1x2, C : E2, D : E2x2, F : E1.E2, F : E12, G : E12.E1, H : E12.E2, I : E1x2.E2x2

including Ca1, Ca2, and with or without Re. Table 5 shows classification of subdivisions of P type (Fig. 4 and Fig. 5).

3. Cr type prosthesis

Teeth treated with crown often breakdown because of caries, periodontal change and etc. To solve the problem, we use the Re, which is beyond

Table 4　Classification of P type

1. P : Prosthesis with anterior and posterior abutments (see Fig. 4-A)
2. P.Re1 : P with anterior rest (see Fig. 4-B)
3. P.Re2 : P with posterior rest (see Fig. 4-C)
4. P.Re1.Re2 : P with anterior and posterior rests (see Fig. 4-D)

Table 5　Classification of subdivisions of P type

A. Ca1 or Ca2
1. Ca1 : Prosthesis with anterior 1 tooth extension (see Fig. 4-E)
2. Ca1.Re1 : Ca1 with anterior rest (see Fig. 4-F)
3. Ca1.Re2 : Ca1 with posterior rest
4. Ca1.Re1.Re2 : Ca1 with anterior and posterior rests (see Fig. 4-G)
5. Ca2 : Prosthesis with posterior 1 tooth extension (see Fig. 4-H)
6. Ca2.Re1 : Ca2 with anterior rest (see Fig. 4-I)
7. Ca2.Re2 : Ca2 with posterior rest (see Fig. 4-J)
8. Ca2.Re1.Re2 : Ca2 with anterior and posterior rests (see Fig. 4-K)
B. Ca1 & Ca2
1. Ca1.Ca2 : Prosthesis with anterior and posterior extension (see Fig. 5-A)
2. Ca1.Ca2.Re1 : Ca1.Ca2 with anterior rest
3. Ca1.Ca2.Re2 : Ca1.Ca2 with posterior rest (see Fig. 5-B)
4. Ca1.Ca2.Re1.Re2 : Ca1.Ca2 with anterior and posterior rests ((see Fig. 5-C))
C. Ca1.P or Ca2.P
1. Ca1.P : Ca1 with extend one anterior tooth
2. Ca1.P.Re1 : Ca1 with extend 1 anterior tooth with anterior rest
3. Ca1.P.Re2 : Ca1 with extend 1 anterior tooth with posterior rest
4. Ca1.P.Re1.Re2 : Ca1 with extend 1 anterior tooth with anterior-posterior rests
5. Ca2.P : Ca2 with extend 1 posterior tooth (see Fig. 5-D)
6. Ca2.P.Re1 : Ca2 with extend 1 posterior tooth with anterior rest (see Fig. 5-E)
7. Ca2.P.Re2 : Ca2 with extend 1 posterior tooth with posterior rest (see Fig. 5-F)
8. Ca2.P.Re1.Re2 : Ca2 with extend 1 posterior tooth with anterior-posterior rests
D. Ca1.P & Ca2.P
1. Ca1.Ca2.P : Ca1.Ca2 with extend 1 anterior tooth and 1posterior tooth
2. Ca1.Ca2.P.Re1 : Ca1.Ca2.P with anterior rest
3. Ca1.Ca2.P.Re2 : Ca1.Ca2.P with posterior rest
4. Ca1.Ca2.P.Re1.Re2 : Ca1.Ca2.P with anterior and posterior rests

the height of contour extension to prevent direct food impaction and further damage. With the morphology change, the prosthesis and neighbor tooth will work coordinately without interruption. With the added Re, current crown and splinting crown could sum up to 8 combinations (Table 6, Fig. 6).

For better understanding and distinguishing, we create the rest wing with cantilever pontic and name it “Cantirest”, which is a new word that combining cantilever and rest. Rest wing with crown and P type, which is currently bridge, is called “Crorest”, which is also a new word that combines crown and rest. We can easily catch rest position and prosthesis type by using cantirest and carorest. We will discuss this in other report.

Discussion and Conclusion

In this report, we introduce our new classification and prosthesis matched to this classification based on PPS.

As we mentioned above that Kennedy’s classification is only for prosthetic defects and Eichner’s classification is only for occlusal support. As a result, both classifications are not enough for all prosthesis construction. So we designed a

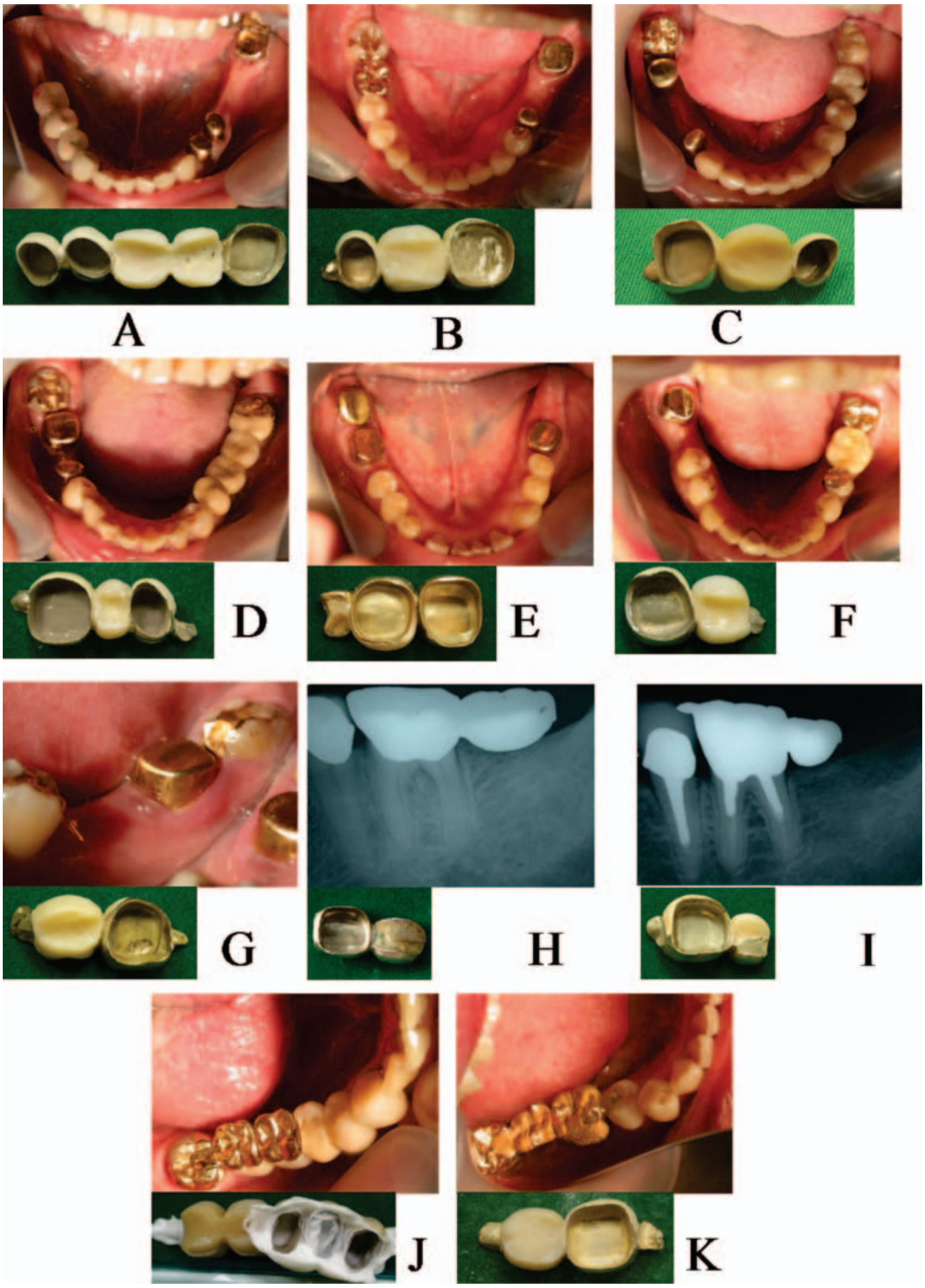

Fig. 4 Sample clinical cases of P type and subdivisions Ca1 and Ca2
A：P, B：P.Re1, C：P.Re2, D：P.Re1.Re2, E：Ca1, F：Ca1.Re1, G：Ca1.Re1.Re2, H：Ca2, I：Ca2.Re1, J：Ca2.Re2, K：Ca2.Re1.Re2

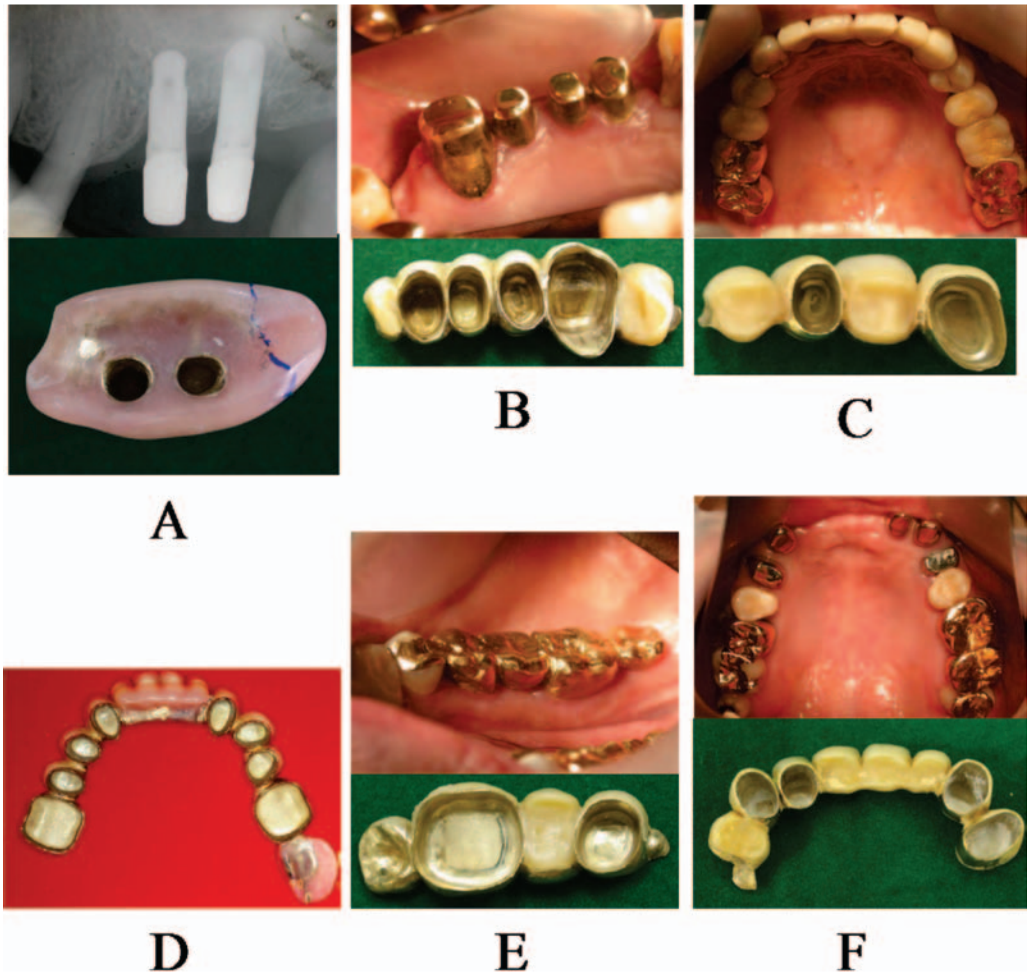

Fig. 5　Sample clinical cases of Ca1 & Ca2 type and Ca1.P or Ca2.P type
A : Ca1.Ca2, B : Ca1.Ca2.Re2 : Ca1, C : Ca1.Ca2.Re1.Re2, D : Ca2.P, E : Ca2.P.Re1, F : Ca2.P.Re2

Table 6　Classification of Cr type

1. Cr : One single double crown (see Fig. 6-A)
2. Cr.Re1 : Cr with anterior rest (see Fig. 6-B)
3. Cr.Re2 : Cr with posterior rest (see Fig. 6-C)
4. Cr.Re1.Re2 : Cr with both anterior and posterior rests (see Fig. 6-D)
5. Sp.Cr : Multiple double crown (see Fig. 6-E)
6. Sp.Cr.Re1 : SpCr with anterior rest
7. Sp.Cr.Re2 : SpCr with posterior rest (see Fig. 6-F)
8. Sp.Cr.Re1.Re2 : SpCr with both anterior and posterior rests

different classification for prosthetic defects, dental and mucosal support according to the PPS. Although this classification has a disadvantage that there are many subdivisions, we consider the edentulous area and supporting element together, thereby simplifying the diagnosis, treatment planning, and prosthesis fabrication to one single appliance with modified conical telescope only.

We will discuss the theory, mechanism, characteristics and clinical considerations of prosthesis of PPS in the next report.

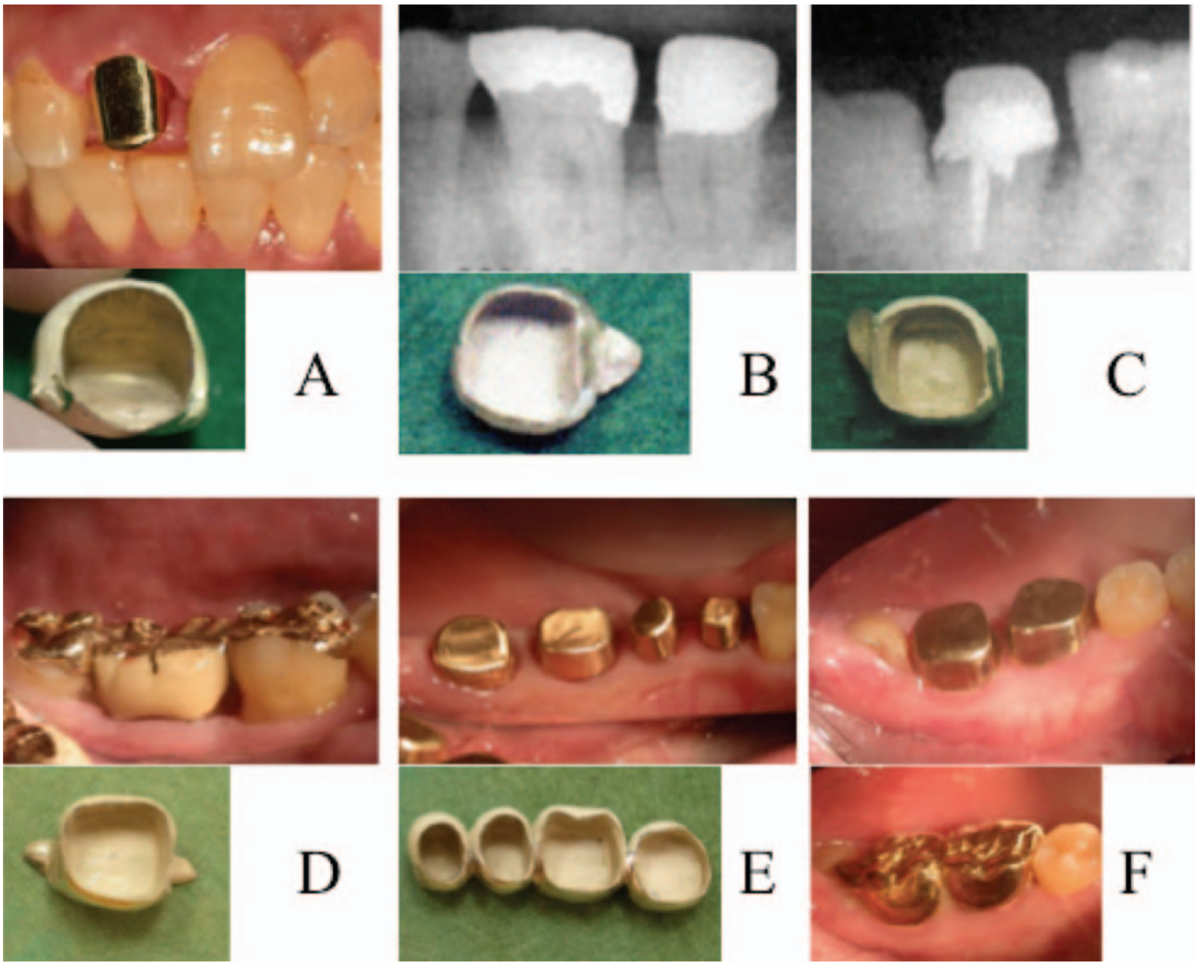

Fig. 6 Sample clinical cases of Cr type
A：Cr, B：Cr.Re1, C：Cr.Re2, D：Cr.Re1.Re2, E：Sp.Cr, F：Sp.Cr.Re2

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予防的補綴システムの臨床評価
パートⅠ．予防的補綴システムの分類

呉　　文元[1,2]・鱒見進一[1]・三宅茂樹[1,3]・槙原絵理[1]
河野稔広[1]・小田展生[1,4]・王　　怡然[5]

[1]九州歯科大学口腔機能学講座顎口腔欠損再構築学分野
[2]呉牙科診所，高雄市，台湾
[3]愛児歯科医院，広島市
[4]おだ歯科医院，福岡市

抄　録

我々は，1987年以降コニカルテレスコープの臨床応用を開始した．　このシステムによって，我々は一個のクラウンからフルマウスリハビリテーションまでコニカルテレスコープによる補綴装置で製作することが可能となった．この単純な装置には，インプラントや磁性アタッチメントを組み込むことができ，すべての補綴の問題を解決することが可能である．我々はこのシステムを予防的補綴システム(PPS)と名付けた. PPSを分類するために，歯列弓の支持領域を３タイプに分け，２つの前方主支持領域，２つの後方主支持領域および１つの補助領域とし，各々上下歯列弓に存在する．　我々はこのシステムを簡単に理解するために新しい分類をデザインし，このレポートで紹介した．また, この分類と合致した若干の補綴装置も提示した．　我々は, 補綴装置を延長タイプ(E), ポンティックタイプ(P)およびクラウンタイプ(Cr)の３つのタイプに分類した. Eタイプは９タイプに分類した. Pタイプは主に４タイプに分類し，細分類がある. Crタイプは８タイプに分類した.

この分類は細分類が多いという欠点はあるが，診断，治療計画および補綴装置の製作は単純化することができた.

キーワード：予防的補綴システム／分類／支持領域／コニカルテレスコープクラウン

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Comparison of preload values of dental implant abutment screws subjected to surface and non-surface treatments

Tsung-han Yang [1], Kai-jen Chuang [2], Shin-ichi Masumi [1], Hong-Wu Lin [1]

[1]Division of Occlusion & Maxillofacial Reconstruction, Department of Oral Function, Kyushu Dental University, Japan

[2]Department of Public Health, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan

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Abstract

Abutment screws of implants can become loose, and loosening can be prevented using several techniques. One technique involves increasing the preload, whereas another easy technique entails reducing the friction coefficient of the screw by applying surface treatment without changing the screw design or material. The purpose of this study was to compare TiN and TiAlCrN surface treatment with non-surface treatment and assess their effects on the preload.

Thirty of dental implant fixture were machined by using Grade 4 titanium and these fixtures were fixed in plastic container. Furthermore, thirty of abutment screws were machined by using Grade 5 titanium alloy and divided into the three groups；Group A (no surface treatment as control), Group B (surface treated with TiN), and Group C (surface treated with TiAlCrN). The fixtures fixed in plastic containers were then fixed on a torque-measuring machine, and the magnitudes of torque, retorque, and untorque were recorded. In the comparisons of preload among Groups A, B, and C, Group C was significantly higher than the values for Groups A ($p<0.01$) and Group B ($p<0.05$). These results suggested that surface treatment with TiAlCrN is very useful for abutment screws in clinical practice to reduce the incidence of screw loosening and associated complications.

Key words：preload / dental implant abutment screw / surface treatments

Introduction

Dental implants cause several complications, often involving more components than the prostheses supporting natural teeth[1]. Dental implant complications primarily involve surgical and prosthetic factors. Surgical complications mainly occur because of surgical techniques or patient medical conditions and can be prevented before surgery or resolved a few weeks after surgery. However, from prostheses delivery to implant failure, prosthetic complications and peri-implantitis are the complications the dental clinicians have to deal with.

According to a review article by Goodcare et. al.(2003)[2], dental implants retained over dentures lead to more complications than those supported by fixed partial dentures (FPDs). Although implants supported by FPDs and crowns lead to fewer complications, those supported by screw-and cement-retained prostheses have 5-year complication rates of approximately 10% and 3%, respectively[3]. Moreover, as per our review of relevant literature[3,4], screw- and cement-retained prostheses have technical and biological complications, respectively. For dentists, treating technical complications (prosthetic repair) is preferred to treating biological complications (peri-implantitis). In addition to porcelain fractures, mechanical complications include abutment screw-related factors. The screw loosening and breakage rates are 3.3% and 0.2%, respectively[5].

Loosening of abutment screws often leads to their breakage[6]. Therefore, prosthetic complications can be partly reduced by reducing the screw-loosening rate. The abutment and implant are held together by a screw, which is tightened with a specific torque by dental clinician. The applied torque elongates the screw, resulting in an elastic recovery force that holds the abutment and implant together ; this force is called the clamping force[7]. Abutment screws can be loosened by the force that separates them and the implant, decreasing the clamping force[8, 9]. Screw loosening can be reduced using two methods[10] : reducing the separating force and increasing clamping force. The first approach can be employed by using prosthetic designs, treatment plans, or occlusal adjustments[6, 11]. The second approach can be employed by increasing the built-in preload[12], which is the force within the screw occurring when it is tightened using torque wrench ; this force has a magnitude equal to that of the clamping force[12]. The preload can be increased by applying more torque[13], changing the screw material[14, 15], increasing the screw diameter[16], and reducing the screw friction[17]. Moreover, applying more torque facilitates increasing the preload, and accordingly, applying a torque of approximately 75% of the screw yield strength, which is more than the magnitude recommended by implant manufacturers, 30–32 N·cm, is suggested[17]. However, a finite analysis revealed that the torque evenly distributes around the implant fixture around the fixture neck and the crest bone around the fixture. The excess torque may interfere with osseointegration and damage the host bone[18, 19].

In addition to the built-in preload magnitude, galvanic corrosion and screw strength are concerns for abutment screws. Considering galvanic corrosion[20, 21], gold screws, which provide more satisfactory preload compared with screws of other metals[13], are an alternative. However, gold prices reduce the clinical applicability of gold screws. Gold screws also have a low physical strength and greater incidence of clinical failure (e.g., screw breakage)[22]. PEEK or carbon fiber screws have no galvanic corrosion-related complications ; however, they have unfavorable physical properties and are not generally preferred compared with titanium alloy screws[23].

Moreover, increasing the implant screw diameter can increase the preload and screw strength[16], subsequently resolving screw-related complications. Increasing the screw diameter changes the fixture design ; increasing the screw width increases the fixture width, which is clinically unfavorable. Considering the economic factors and stock convenience of implant companies and dentists, providing a 1–2 screw size for the complete set of an implant system is favorable. Reducing the screw friction reduces the preload loss during screw tightening[24].

Furthermore, using solid lubrication for reducing screw friction is ideal because the preload within the screw can be increased without increasing the applied force. Solid lubricants conveniently reduce the screw friction[25, 26]. The natural surface of titanium has a high friction coefficient, which reduces the preload ; therefore, titanium surface treatment (solid lubricant) is widely used.

Surface hardness, surface roughness (Ra), and contact area influence the friction coefficient[26]. Surface treatment alters the surface hardness and Ra, thus altering the friction coefficient. The presently available surface treatment technology (using titanium alloy and titanium) is extremely well developed compared with those applied in the 1990s. TiN coating on a dental implant drill reduces erosion and maintains sharpness during implant site preparation. Moreover, a dull drill increases the incidence of bone necrosis because of the heat generated during osteotomy. TiN coating is technically and economically feasible and is widely used on implant abutments for its gold appearance and anti-abrasion property. The gold appearance is aesthetically pleasing when the gingiva over the abutment is thin. Furthermore, the anti-abrasive property is favorable for daily and clinical maintenance. Compared with TiN coating, TiAlCrN coating is a new surface treatment with a higher surface hardness, lower Ra, and stronger adhesion to Titanium alloy[27]. However, TiAlCrN coating is black color, which is not preferred for abutment irrespective of the abutment screw. The black color of TiAlCrN coating abutment will show through gingiva when the gingiva thickness is thin which will lead to esthetic problem.

The purpose of this study was to compare TiN and TiAlCrN surface treatment with non-surface treatment and assess their effects on the preload.

Material and methods

Thirty of dental implant fixture with 11 degree-tapered internal hex without surface treatment were machined by using Grade 4 titanium. Then these fixtures were fixed by using an acrylic resin in plastic container. For reducing experimental errors, all fixtures were fixed at the same location by using a jig. These fixtures were divided into three groups. Furthermore, thirty of abutment screws were machined by using Grade 5 titanium alloy and divided into the three groups. Group A screws were not surface treated as control. Group B screws were surface treated with TiN, and Group C screws were surface treated with TiAlCrN (Fig. 1). The TiAlCrN coating was created by using activation of plasma to ionize the atom of the alloy targets plus nano-composite coating technique to achieve superlattice condition. Thirty straight two-piece abutment and screws were hand torqued by using a screw-driver to the fixtures of all groups. The fixtures fixed in plastic containers were then fixed on a torque-measuring machine (Mark-10 model MTT01-12) (Fig. 2), and

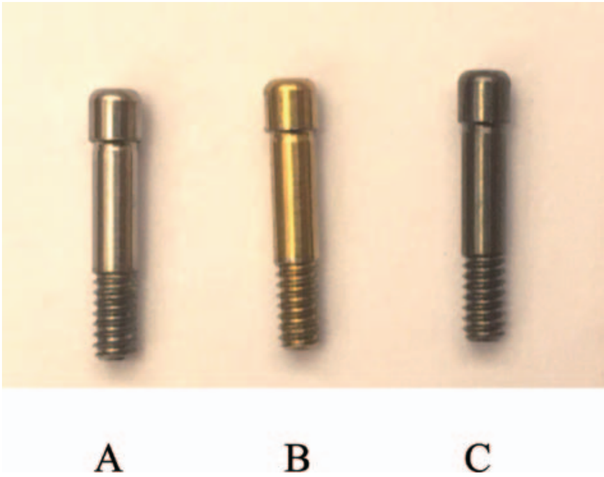

Fig. 1 Test screws. A : no surface treatment, B : TiN surface treatment screw, C : TiAlCrN surface treatment screw

Fig. 2 Torque-measuring machine (Mark-10 model MTT01-12)

a new torque wrench was set to 30 N·cm and operated by the same operator for error reduction. Before the experiment, every sets were torque and untorque once for reducing errors[28]. The experiment began with torquing the screw, followed by a method suggested by most implant manufacturers : torquing and retorquing with 30 N·cm at an interval of 10 minutes. The torque and retorque magnitudes were recorded (Fig. 3). After 10 minutes, the screw was untorqued, and the magnitude was recorded. Each test sample had three data categories : torque, retorque, and untorque. According to previous studies[13, 29], the build-in preload was estimated using equation 1 as follows.

Fig. 3　Sample display of the torque-measuring machine
(a) value of torque force (b) value of untorque force

$$F_{f_s}=\frac{\pi}{\mathrm{P}}(T_{f_s}-T_{f_u})$$

F_{f_s}=estimated preload, T_{f_s}=applied torque, T_{f_u}=removal of torque, and P=thread pitch.

The value of π/P was kept constant in the experiment and this value was 3.14/0.4 in this study. The estimated preload was calculated from the formula of 7.85x{(torque+retorque)/2−untorque}. One-way analysis of variance (ANOVA) with Tukey's honest significant difference test was used for comparing Groups A, B, and C. A p value of <0.05 was considered significant. All statistical analyses were conducted using SPSS software (Version 11.0 ; SPSS Inc., Chicago, IL, USA).

Results

Table 1 shows the values of torque, retorque, and preload in Groups A, B, and C. Mean values (standard deviation) in each group were 31.67 N·cm (4.55) in Group A, 36.31 N·cm (7.65) in Group B, and 47.14 N·cm (13.14) in Group C, respectively.

Fig. 4 shows the comparisons of preload among Groups A, B, and C. Group C was significantly higher than the values for Groups A (p<0.01) and Group B (p<0.05).

Discussion

For reducing the screw-loosening rate, dentists cement prosthesis with permanent cement or use

Table 1　Values of torque, retorque, and preload in Groups A, B, and C.

Group A	torque	retorque	untorque	preload
1	30.2	30.0	26.8	25.91
2	30.7	30.3	26.7	29.83
3	30.2	30.2	25.9	33.76
4	30.1	30.6	25.6	37.29
5	30.1	30.0	25.3	37.29
6	30.1	30.0	26.7	26.30
7	30.4	30.6	26.8	29.05
8	30.1	30.2	26.7	27.08
9	30.1	30.3	25.6	36.11
10	30.1	30.2	25.8	34.15
Mean	30.2	30.2	26.2	31.67
SD	0.2	0.2	0.6	4.55
Group B	**torque**	**retorque**	**untorque**	**preload**
1	34.7	30.6	26.0	52.20
2	30.1	30.0	25.6	34.93
3	30.2	30.1	25.0	40.43
4	30.2	30.5	26.2	32.58
5	30.2	30.2	25.0	40.82
6	30.4	30.3	26.6	29.44
7	30.1	30.3	27.0	25.12
8	30.3	30.4	25.4	38.86
9	30.3	30.2	26.4	30.22
10	30.0	30.0	25.1	38.47
Mean	30.7	30.3	25.8	36.31
SD	1.4	0.2	0.7	7.65
Group C	**torque**	**retorque**	**untorque**	**preload**
1	30.1	30.1	22.7	58.09
2	30.4	30.0	24.4	45.53
3	30.6	30.0	25.5	37.68
4	30.0	29.9	23.1	53.77
5	30.4	29.9	25.3	38.07
6	30.1	30.1	25.8	33.76
7	30.2	30.0	24.7	42.39
8	30.2	30.1	24.9	41.21
9	30.1	30.0	24.6	42.78
10	30.7	30.4	20.6	78.11
Mean	30.3	30.1	24.2	47.14
SD	0.2	0.1	1.6	13.14

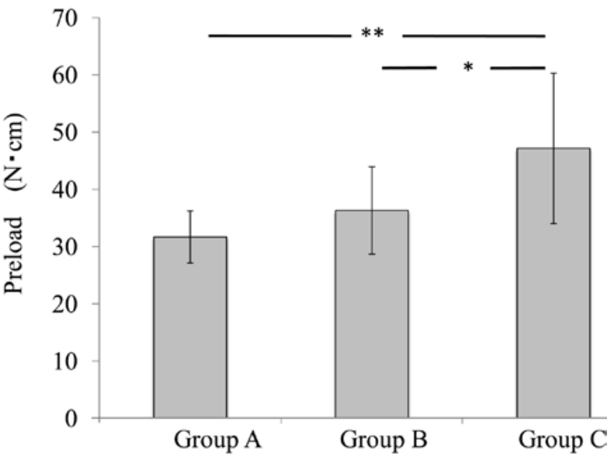

Fig. 4　Comparisons of preload among Groups A, B, and C.
(** : p<0.01, * : p<0.05)

screw-retained prosthesis if prosthesis retention is not ideal. Under both conditions, the clinical time can be reduced by reducing the screw-loosening rate ; increasing the preload reduces the screw loosening rate. Lang et. al. (2003)[17] used finite element analysis for determining the implant preload and suggested that reducing the friction coefficient efficiently increases the preload compared with increasing the tightening torque. Lang also revealed that the friction coefficient should be 0.12 to obtain an optional preload under a 32 N·cm tightening torque. An optimum preload is obtained if the torque reaches 75% of the total yield strength. A gold screw is an alternative that provides a more higher preload[30] because of its high elasticity[31]. However, most dental implant companies do not use gold screws because of their low stiffness, low physical strength[22] and high cost. A Grade 4 titanium fixture is biologically more favorable than a titanium alloy fixture[32]. Because of material-related limitations, the implant fixture is composed of Grade 4 titanium or titanium alloy, and the screw is generally composed of titanium alloy. The friction coefficient between Grade 4 titanium/titanium alloy and titanium/titanium alloy is approximately 0.4–0.5[33]. The friction coefficient for uncoated titanium/titanium alloy can be as high as 0.8–0.9 (unpublished data) ; under this condition, surface treatment (solid lubricant) effectively increases the preload[34]. Jung[35] measured weight loss after repeated torquing and retorquing and revealed that TiN coating reduces the friction coefficient and stabilize the screw joint. Stuker et. al. (2008)[14] compared the preload of Titanium surface and non-surface treatments and revealed that surface treatment provides a more appropriate preload value. Similar results were revealed in several studies[14, 24, 36]. The preload can be examined by measuring the screw elongation after torque application[31], measuring the rotation angle after torque application[37], and measuring the difference between the torque and untorque[29]. Each aforementioned method has advantages and disadvantages. The elongation rate must be precisely measured because the likelihood of error is higher.

The rotation angle measurement technique follows equation 2 as follows.

$$\theta = \frac{2\pi}{\mathrm{P}}\left(\frac{1}{K_b} + \frac{1}{K_c}\right)F_f$$

θ =rotation angle K_b=spring constant of bolt K_c=spring constant of clamping part F_f=clamping force

As equation 2 is not as straightforward as equation 1, we used equation 1 in this study. The preload has been positively correlated with the negative value of torque and untorque in previous studies[13, 14] ; our study yielded identical results. Many factors influence the torque for screw tightening. Simply varying the tightening speed causes considerable differences. Therefore, we set the torque wrench of the machine to 30 N·cm, and the same operator tightened the screw and collected data for measurement. In some studies on torque and untorque, data were collected using digital screw drivers[38, 39]. This approach is different from that used in daily practice by dentists. The tightening procedure of our research is more close to the procedure of clinician daily practice. We observed that TiAlCrN coating is superior to TiN coating and non-surface treatment in increasing the preload. The superior surface hardness of TiAlCrN coating than TiN coating (HV3000 versus HV2300) is one of the reason in better preload result[26]. Surface treatment also might reduced the incidence of screw breakage by increasing the screw strength[40]. Prado et. al. (2014)[40] examined the flexural strength of coated and uncoated screws and revealed that coated screws provide a high value. Higher flexural strength values may reduce the incidence of screw breakage. However, additional studies must evaluate this factor. In addition to increasing the preload in the abutment screw, several methods can be used for reducing the screw loosening rate. These methods involve changing the screw or connection design. Furthermore, changing the abutment materials can

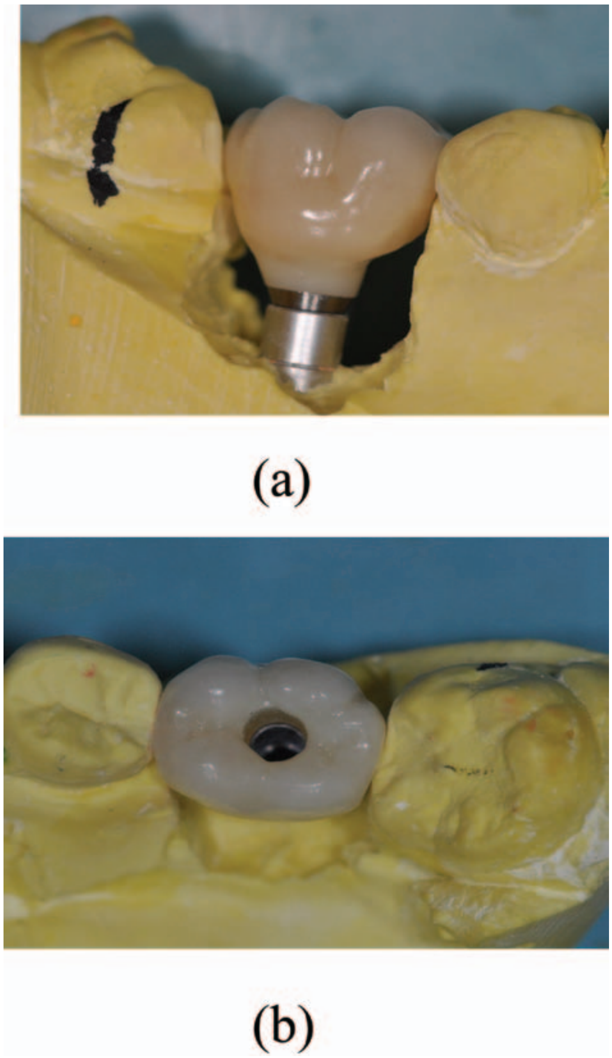

Fig. 5 Sample of hybrid abutment crown.
(a) lateral view (b) occlusal view

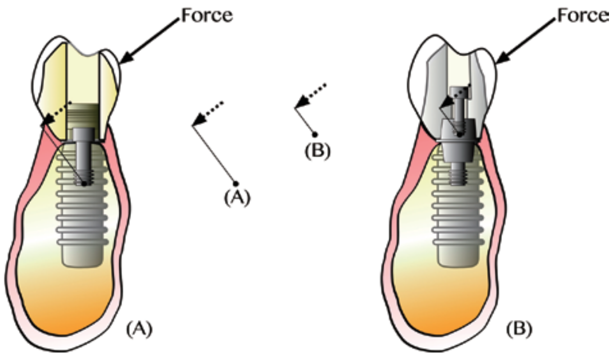

Fig. 6 Scheme of hybrid abutment crown (A) and traditional screw retained implant crown (B). Same oblique force on (A) and (B) prosthesis device and generate different force on the prosthesis screw, the prosthesis screw of the hybrid abutment crown (A) receive more force which lead to more screw loosening rate.

alter the preload[41]; however, this change is outside the scope of our study. CAD/CAM is widely applied in dentistry. CAD/CAM-fabricated custom titanium and zirconia hybrid abutments are replacing the traditional UCLA abutment[38]. A zirconia crown directly cemented to Ti-base and screwed onto the dental implant in one piece (hybrid abutment crown) (Fig. 5) can partly replace a screw-retained crown[42]. The advantages of this type of prosthetic arrangement are an aesthetically pleasing gingiva appearance, biocompatibility, and retrievability. A gingival thickness <2 mm renders a dark appearance to the metal abutment[43]. Zirconia is more biocompatible than titanium, and has lesser bacterial adhesion[44, 45]. Moreover, cementing the crown to Ti-base outside the oral cavity before screwing it onto the implant prevents leaving residual cement, which is a major factor leading to peri-implantitis[46, 47]. However, this type of prosthetic arrangement increases the crown to implant ratio or crown height space and the force on the screw will increase, which will increase screw loosening rate (Fig. 6)[11, 48]. In cement-retained prostheses, cement, particularly provisional cement, act as a buffer, prevents complications[49]. However, for screw-retained prostheses, the force is directly applied on the connection area and screw. Bonfante et. al. (2015)[50] compared cement- and screw-retained crowns under stressed conditions and evaluated the association between the retention type and fixture size, revealing that for screw-retained crowns, failure solely occurs because of the screw and has no association with the implant size. In this study, we revealed the role of the screw in screw-retained prosthesis. In clinical practice, the role of the screw in a hybrid abutment crown cannot be ignored. Therefore, coating the screw for this type of prosthesis can reduce clinical complications. Because of the good adhesion to Titanium alloy[27], the long-term stability of the TiAlCrN coating should be good even after repeated re-torque or clinical loading. However, further clinical research is required to validate these findings.

Conclusion

An abutment screw is an implant component that dentists generally overlook. This screw connects the abutment and the implant through the built-in preload. An appropriate preload is one of the key factors for reducing the incidence of screw loosening- and screw breakage-related complications. We observed that TiAlCrN surface treatment increases the preload when the typical screw tightening torque is applied (30 N·cm). These results suggested that surface treatment with TiAlCrN is very useful for abutment screws in clinical practice to reduce the incidence of screw loosening and associated complications.

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表面処置の違いによるインプラントアバットメントスクリューのプレロード値の比較

楊　宗翰[1]・荘　凱任[2]・鱒見進一[1]・林　鴻吾[2]

[1] 九州歯科大学口腔機能学講座顎口腔欠損再構築学分野
[2] 台北医科大学医学部公衆衛生学講座

抄　録

歯科用インプラントのアバットメントスクリューは緩むことがあり，この緩みは，いくつかの技術を適用することによって防止することができる．１つの方法は，プレロードを増加することである．もう一つの簡単な方法は，スクリューの設計や材料を変えることなく，表面処置を行いスクリューの摩擦係数を減少することである．本研究の目的は，TiNおよびTiAlCrNにより表面処置したアバットメントスクリューと，表面処置していないアバットメントスクリューにおけるプレロードに対する影響を評価することである．

グレード４チタン製歯科用インプラント30個を機械加工して製作し，プラスチック容器内に固定した．さらに，30本のアバットメントスクリューをグレード５チタン合金で機械加工して製作し，グループA（表面処理なし，コントロール），グループB（TiN表面処理），グループC（TiAlCrN表面処理）の３群に分け，トルク測定機を用いてトルク，リトルクおよびアントルクの値を記録した．３群間におけるプレトルクの比較検討を行ったところ，グループCのプレトルクは，グループAおよびグループBより有意に大であることがわかった．これらの結果より，アバットメントスクリューに対するTiAlCrNによる表面処理が，スクリューの緩みやこれに関連する問題の発生率を減少させるために，日常臨床において非常に有用であることが示唆された．

キーワード：プリロード／歯科用インプラントアバットメントスクリュー／表面処理

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Development of the Removable Hygienic Prosthesis System and its Clinical Application

Tai-Wu Lin [1,2], Wen-Yuen Wu [1,3], and Shin-ichi Masumi [1]

[1] Division of Occlusion & Maxillofacial Reconstruction, Department of Oral Function, Kyushu Dental University, Kitakyushu, Japan
[2] Chyoda Dental Clinic, Kaohsiung, Taiwan
[3] Hwa-Tai Dental Clinic, Taipei, Taiwan

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Abstract

Long-term clinical practice has proven that conventional fixed prosthesis tends to destroys the roots of the teeth as well as damaging adjacent teeth. Although a telescopic crown concept has been developed to solve these problems, its fabrication is very difficult. Three types of removable hygienic prosthesis system (RHPS) such as removable double crowns with casting stud attachment and clip (A-type), removable double crowns with casting ball attachment and rubber cap (B-type), and removable pontic with T-post supporting alloy plate (C-type) were designed. Evaluation of the clinical applications of these design types was conducted.

Advantages of the RHPS prosthesis are as follows ;

1. It is designed to be removable for easy access to cleaning.
2. The tension retaining pin, snap-on rubber cap, and T-post supporting alloy plate are all part of a stabilization system of RHPS that allows the patient to retain normal masticatory function.
3. Occlusal rests fabricated at both ends of the crown enable bite pressure distribution to adjacent teeth in order to prevent fragile tooth fracture.

Key words：removable hygienic prosthesis system / rubber cap / tension retaining pin / T-post

Introduction

Long-term clinical practice, has proven that conventional fixed prosthesis damage adjacent teeth and destroy the roots of the every teeth they're affixed to[1]. Dentists are aware that there is a high risk of destroying the tooth along with adjacent teeth when a tooth is restored with a fixed prosthesis[2]. In the aftermath, an adjacent tooth may be damaged so severely that it needs to be root canaled. When a root canaled tooth is severely decayed, resulting in non-restorable carious destruction, extraction becomes the only solution. This is a never-ending costly and unbearable cycle.

From our clinical practices and observations, permanent prosthesis last approximately 4 to 5 years. After approximately 8 to 10 years, swelling, inflammation, severe decay, loose teeth, falling off of crowns, and stench caused by festering pus are all too common[3]. After approximately 10 to 20 years, the conventional cement applied to fix the prosthesis acts like a toxic installation, causing the slow onset of common disease[4~6]. This inadvertently promotes unnecessary teeth extractions and supports the dental implant business. There is usually nothing wrong with the teeth adjacent to the fixed prosthesis. These results suggest that fixed prosthetic restoration after treatment of endodontic or periodontal disease is ineffective and deceiving. These results are also a repeating cycles of the severe decay spreading to adjacent teeth and the foul smell of decayed teeth and prosthesis.

On the other hand, German conical double crown prosthesis has been famous and applied as a removable prosthesis[7]. Removable partial dentures retained by double crowns provide good clinical longevity[8~13]; there are several problems. The connection of inter-surfaces between outer crown and inner crown is sometimes too tight or too loose. It is unable to control bi-furcation and tri-furcation deep pocket effectively and it cannot resolve periodontal disease caused by bi-furcation and tri-furcation completely.

To solve these problems, we designed removable hygienic prosthesis system (RHPS). This system has already received the utility model patents from Taiwan, China, USA, Germany and Japan. The purpose of this study is to introduce the newly developed RHPS and to evaluate its clinical applications. In clinical application, this research is conducted with permission of the Research Ethics Committee of Kyushu Dental University (13-42).

Materials and methods

1. Design and fabrication of RHPS

a. Removable double crowns with casting stud attachment and clip (A-type)

Retention of A-type consists of stud retainers attached to the mesial and distal surfaces of the inner crown and clips attached to the outer crown (Fig. 1). The inner crown with stud retainers is casted with Ni-Cr-Ti alloy (Tilite®, Talladium, U.K.). After testing the inner crown with the material, the outer crown is also made with the same alloy. The outer crown is added to the occlusal rests in the mesial and distal surface for support of the outer crown.

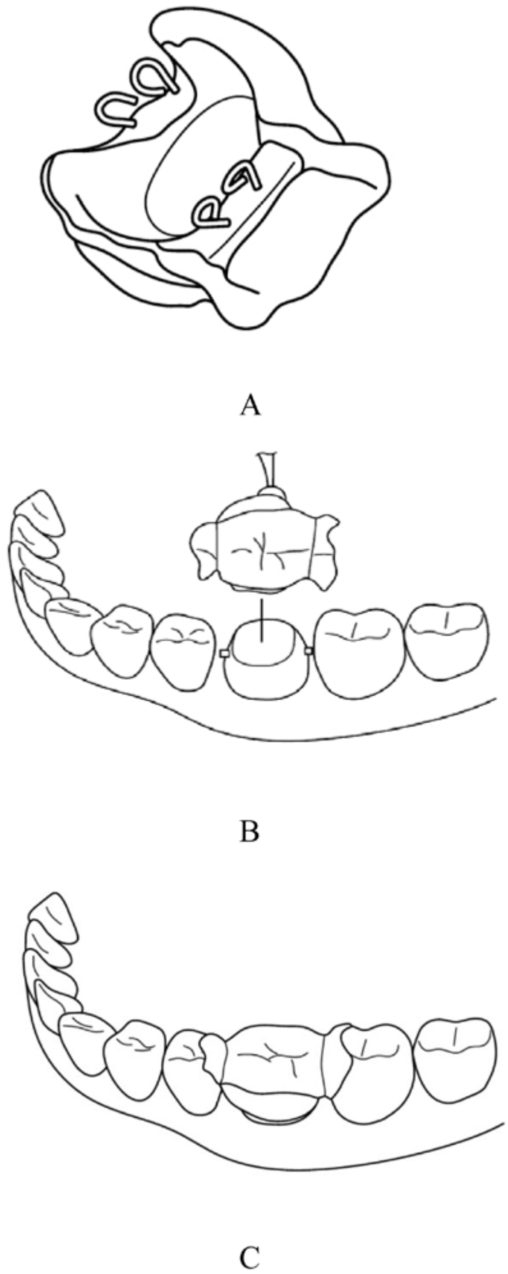


Fig. 1 Scheme of removable double crown with casting stud attachment and clip (A-type)
A : outer crown with clips and occlusal rests
B : inner crown with casting stud attachment
C : after setting

Preparation of rest seat is performed within the enamel as thin as possible and its area is not only occlusal surface but also buccal and lingual surfaces for bearing stress from mastication and preventing food accumulation between teeth gaps.

The two clips for retention are made by bending of a stainless steel wire (diameter : 0.020", A.J.

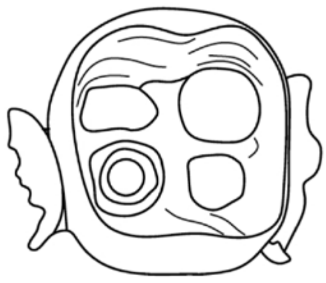
Wilcock, Australia) and the clips are fixed into the outer crown with a self-adhesive resin cement (Maxcem Elite®, Kerr, USA). The inner crown is fixed on the abutment tooth and then the outer crown is set. Retention is adjusted by manipulating the distance between the clips (how much it pinches). This system received the utility model patents from Taiwan (M388923, M453482), USA (8,403,671B2), China (2619675), Germany (202012103278.3) and Japan (3179284).

b. Removable double crowns with casting ball attachment and rubber cap (B-type)

Retention of B-type consists of a ball retainer attached on the inner crown and a rubber cap attached into an outer crown (Fig. 2). The inner crown with ball retainer is casted by the same alloy. After testing and fitting on the inner crown, an outer crown is made. The outer crown is also added the occlusal rests in the mesial and distal surface for support of the outer crown. A rubber cap (Vario-Kugel-Snap®, Dent-line, Canada) is inserted into the outer crown. The inner crown is fixed on the abutment tooth and then the outer crown is set. Retention is adjusted to select a suitable rubber cap from three kinds of rubber caps (green : 4 pounds resistance, yellow : 6 pounds, red : 8 pounds). This system received the utility model patents from Taiwan (M405855, M405856), USA (8,366,444), China (2390002, 2390610) and Japan (5463369).

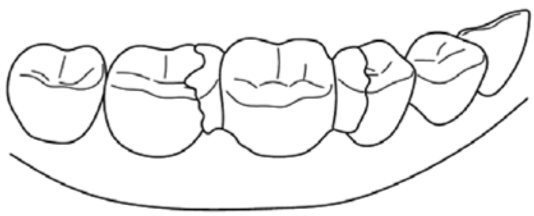
c. Removable pontic with T-post supporting alloy plate (C-type)

C-type crown of RHPS is designed for the patient with intermediary tooth decay of natural teeth. Retention of C-type consists of two T-post supporting alloy plates attached on the distal surface of the mesial tooth and the mesial surface of the distal tooth clips both of which are attached into a pontic (Fig. 3). After preparing of occlusal rest seat, T-post supporting alloy plate with occlusal rest is casted by the same alloy. T-post supporting alloy plates are fixed on the natural teeth with the self-adhesive resin cement, then a pontic is made. The pontic is added to the occlusal rests in the region of mesial and distal surface to support the outer crown. The same stainless steel



A

B



C

Fig. 2 Scheme of removable double crown with casting ball attachment and rubber cap (B-type)
A : outer crown with rubber cap and occlusal rests
B : inner crown with casting ball attachment. Two of the inner crowns are connected by a bar. Their bases are not connected.
C : after setting

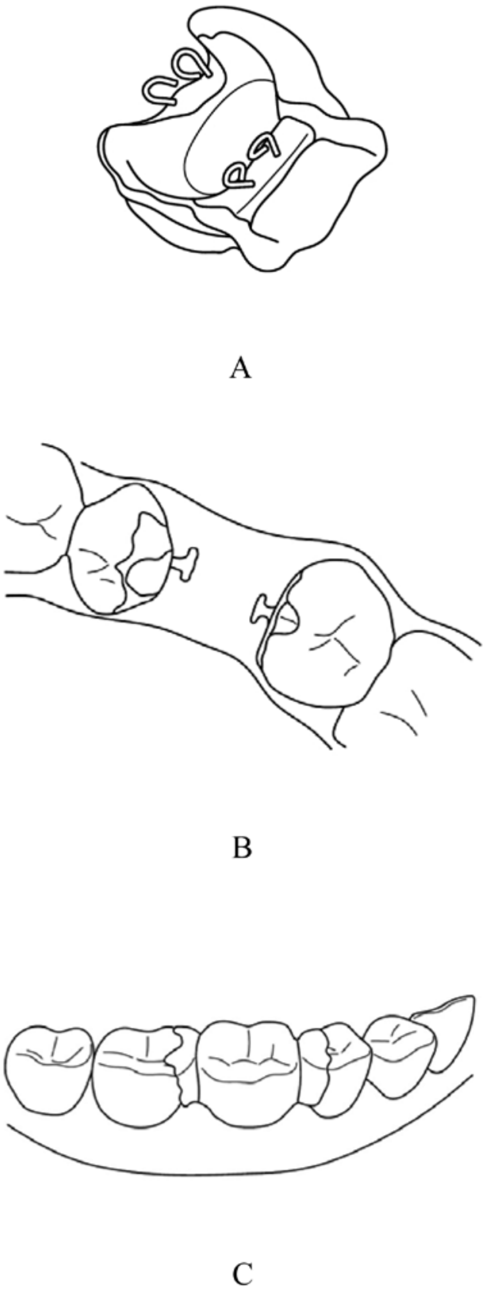


Fig. 3 Scheme of removable pontic with T-post supporting alloy plate (C-type)
A : pontic with clips and occlusal rests
B : T-post supporting alloy plate with occlusal rest
C : after setting

wire mentioned above is bended into clip form and fixed into the pontic with the adhesive resin cement. The pontic is also added to the occlusal rests in the mesial and distal surface for support of the outer crown. Retention is adjustable by manipulating the distance between the clips. This system received the utility model patent from Taiwan (M453483).

Clinical application of RHPS

Although we applied RHPS for lots of patients, we will proceed to introduce typical cases of each type.

a. A-type (Fig. 4)

Patient is a 60-year-old female. She visited our clinic for treatment of her swelling gingiva between the first and second molar on the lower right side January 13, 2012. Bleeding occurred when teeth brushing. Lower right first molar had been fitted with a conventional fixed crown. Gaps between the fixed crown and adjacent teeth were difficult to clean causing inflammation and bleeding.

For treatment, the conventional fixed crown was removed and replaced with an A-type crown of RHPS. With fitted inner and outer crowns, outer crown can be taken off easily. This allows cervical root and gingival area between the root and its adjacent teeth to be cleaned thoroughly with an inter-dental brush. Occlusal rests fabricated on both sides of the restored crown bear stress from mastication and prevents compromised root stump from fracture. Occlusal rests also prevent food accumulation between teeth gaps. This design almost guarantees a lifetime of usage. Only minor repair and maintenance will be needed in the future.

b. B-type (Fig. 5)

Patient is a 45-year-old male. At the first visit on January 13, 2012, a large part of his lower-left-first-molar was severely decayed. The remaining part of the tooth was below the gingival line. Mixed with stench filled pulp tissue, a single touch resulted in profuse bleeding. X-rays showed furcation defect with smelly deep pocket. To remedy this, the root trunk was sectioned, deep pocket eliminated, and decayed tooth was scraped and cleaned up. The remaining sectioned root trunks might be fragile, but at least the periodontal disease was under control. After the gingival was

a

b

c

Fig. 4　Clinical application of an A-type of RHPS in the lower right first molar
a：outer crown with clips and occlusal rests
b：inner crown with casting stud attachment
c：after setting

trimmed, with frequent inter-dental brushing and self-suction (creating vacuum in mouth with suction) to eliminate starchy food accumulation, periodontal disease could be controlled. After one and half months of periodontal disease treatment and root canal procedure, root trunks were strengthened with post filling. Root trunks were then trimmed to the shape of a post. Two inner crowns with a connecting bar were fitted over the root trunk posts. A casting ball on top of each post was used to clip into a rubber cap to grasp ahold of the outer crown. The outer crown was fabricated with occlusal rests on both sides in order to distribute bite pressure and prevent food debris accumulation.

With what we've done thus far, the restored tooth and its surrounding area are in good condition. The stability of the tooth is improved. The compromised root trunks seem to be stronger than the original due to pressure distribution to adjacent teeth. The only function of the compromised root trunks is to secure the outer crown using the rubber cap and casting ball.

c. C-type (Fig. 6)

Patient is a 45-year-old male. His first visit was on April 2012. His upper-left-first molar was already extracted by another dental clinic due to its fracture. After more than 4 months, he came to visit our clinic. He had stipulations and told us he didn't want to be treated with an implant, and didn't want to reduce a large part of his healthy adjacent teeth to fit a dental bridge. He accepted a restoration by a C-type crown of RHPS, which only requires minor filing of adjacent teeth. Adjacent healthy teeth were filed down slightly to fit the upside-down U-shape T-post supporting alloy plates. After a dental technician delivered the restoration parts, T-post supporting alloy plates were glued to the filed down adjacent teeth. Then, an impression was made. The technician fabricated a crown with shoulder rests according to the dental impression. After trying it on, we made a clip from stainless steel wire and positioned it on the T-post. The clip is then glued to the inner part of the crown. Restoration was complete.

This restoration does not damage large parts of healthy adjacent teeth, penetrate gingiva, or drill into maxilla or mandible bone for an implant. Drilling into bone for an implant may lead to bone deterioration in the long run. The restoration does

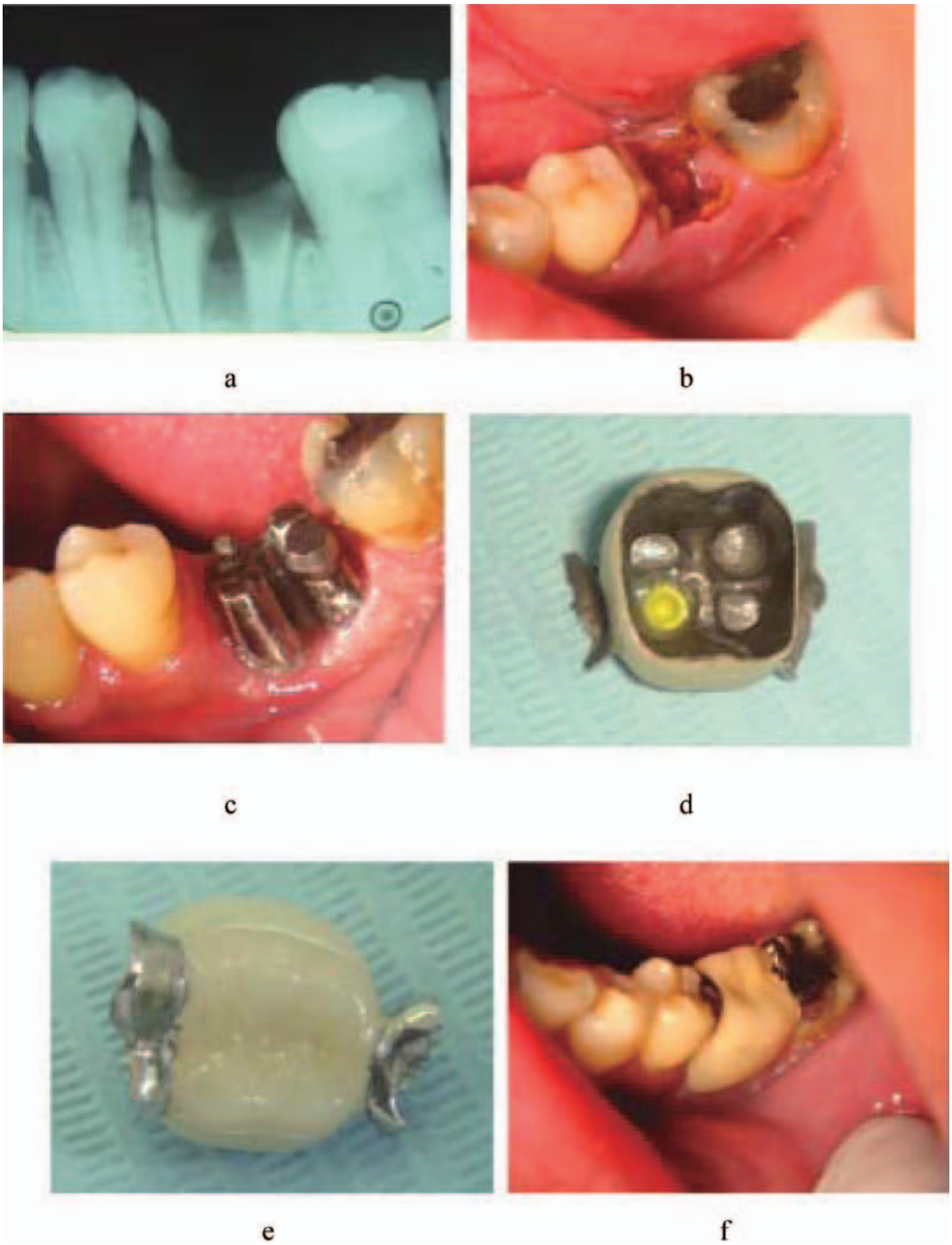


Fig. 5 Clinical application of a B-type of RHPS in the lower left first molar
a : x-ray findings before treatment
b : intraoral findings before treatment
c : inner crown with casting ball attachment.
d : outer crown with rubber cap and occlusal rests
e : outer crown (occlusal view)
f : after setting

not leave open gaps for bacteria toxin to get into blood vessels. Bacteria getting into blood vessels would circulate the body infecting organs with possible diseases such as meningitis, endocarditis, etc.

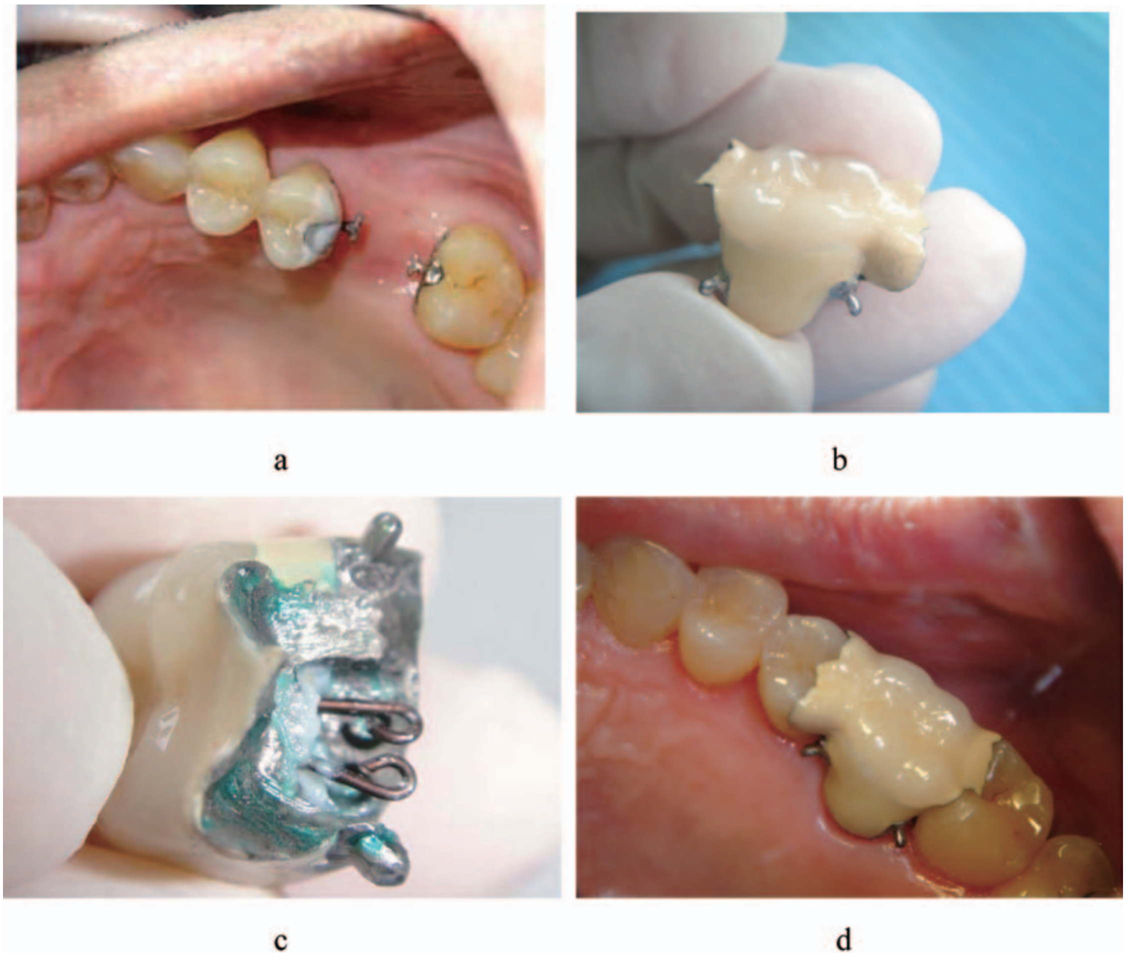


Fig. 6　Clinical application of a C-type of RHPS in the upper left first molar
a：T-post supporting alloy plate with occlusal rest
b：pontic（occlusal view）
c：pontic with clips and occlusal rests
d：after setting

d. Clinical statistis

We applied these prosthesis to 382 patients so far. Table 1 shows the result of clinical statistics about 256 patients followed up more than five years. In 256 patents, male patients were158 and female were 98.

A-type was applied to 78 patients（male 48, female 30）and mean age was 45.1+/−11.8 year. Success rate of A-type was 82.1%. All of 14 failure cases were extracted of the abutment teeth by severe periodontitis. It was thought that the detachment of the clips by the aging of self-adhesive resin cement, but there is no such case currently.

B-type was applied to 112 patients（male 78, female 34）and mean age was 47.8+/−11.8 year. Success rate of A-type was 83.9%. All of 18 failure cases were also extracted of the abutment teeth by severe periodontitis.

C-type was applied to 66 patients（male 32, female 34）and mean age was 35.7+/−6.8 year. Success rate of A-type was 80.3%. All of 13 failure cases were change to the implant prosthesis by patients’ requirements.

Discussion

It is a well-known fact among dentists that inappropriate dental crowns will not protect the patient from developing periodontal disease. Bridgework on healthy natural teeth is destructive

Table 1 Clinical statistics of RHPS

Type of RHPS	N (Male:Female)	Mean age	Success	Failure	Success rate (%)
A	78(48:30)	45.1+/−11.8	64	14	82.1
B	112(78:34)	47.8+/−11.8	94	18	83.9
C	66(32:34)	35.7+/−6.78	53	13	80.3
Total	256(158:98)	43.9+/−11.8	211	45	82.4

and tends to replace after several years. Over preparation of these teeth eventually lead them to decay or fall out. Bridgework causes patients to lose more teeth[1~6].

To solve these problems, a telescopic crown concept has been developed[7] and applied in clinics[8~13]. Wu et al (2016)[13] described the treatment methods used by the Preventive Prosthesis System. This system is based on the modified conical telescopic prosthesis and the semi-fixed and semi-removable prosthesis. Although the telescopic crown system is very useful, it is thought that the technical procedure used to fabricate the prosthesis is very difficult. Wadhwa et al (2014)[12] described that fabrication of a telescopic denture was a technique sensitive procedure but it offered advantages such as bilateral splinting effect in long span partially edentulous arches, reduced effective crown-root ratio, maintenance of proprioception, and transfer of forces along the long axis of the abutments. Although the management was complex, it improved patient's esthetics, oral function and social confidence. How the inner and outer crown piece together is the most important part in this system ; to maintain retention is very difficult.

Regarding the maintenance of this system is only usual tooth-blushing after detaching the prosthesis when after eating and before going to bed. Periodical recall is performed and checked the patients' oral condition.

The RHPS is the answer to all the previously cited problems. It manages to fix conventional crown and bridgework flaws while also saving a severely decayed tooth from extraction thus avoiding an implant.

In the RHPS, bite pressure is supported by occlusal rests which lie on adjacent stable and structure-sound teeth. If adjacent teeth are weak and fragile, then an implant is considered as a last resort. If there are concrete conditions of adjacent teeth (mobility, status of periodontal condition, etc.), then a removable pontic with T-post supporting alloy plate (C-type) is considered. After the implant, applying of the RHPS allows for easy cleaning and thus prevents damage to surrounding tissue and bone as seen in the conventional restoration method. Stable adjacent teeth can share occlusal force. An ulcerous furcation deep pocket is eliminated with sectioning of the teeth roots. The RHPS allows for maximum level of cleanliness. It is important to prevent young patients (aged 20 to 30) with early stages of furcation development, from further deterioration causing need for extractions or a dental implant that will affect them for the rest of their lives. This can be accomplished with the following actions. The occlusal rest alleviates and distributes bite pressure. It also prevents food from getting stuck between teeth. When sectioning of the roots is completed along with the application of RHPS, the ulcerous furcation pocket will no longer rot, leaving the gingiva and surrounding area clean and healthy.

The RHPS is also useful for the disabled, bed-ridden, and wheel chair bound patients as it allows them all to maintain good oral hygiene. Caretakers can clean their teeth with a sonic brush easily, thus preventing dental problems. Furthermore, both old and new removable prosthesis by the RHPS can be fused together whereas a conventional fixed prosthesis must be replaced with a new one when removed. The only disadvantage of this system is not readily applicable to anterior teeth because it is esthetically disadvantageous.

Conclusion

In this study, we described the introduction of the newly developed RHPS and the evaluation of its clinical applications.

Advantages of the RHPS prosthesis are as follows；

1. It is designed to be removable for ease of cleaning. Patient can brush and clean easily at the cervical gingival area, the area where most decay problems come from.
2. Tension retaining pin, snap-on rubber cap, and T-post supporting alloy plate are locking systems of RHPS which allows the patient to retain stable and normal masticatory function.
3. Occlusal rests fabricated at both ends of the crown enable bite pressure distribution to adjacent teeth in order to prevent fragile tooth fracture.

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衛生的な可撤式補綴システムの開発と臨床応用

林　泰　武[1,2]・呉　文　元[1,3]・鱒　見　進　一[1]

[1]九州歯科大学口腔機能学講座顎口腔欠損再構築学分野
[2]華泰牙醫診所，台北市，台湾
[3]呉牙科診所，高雄市，台湾

抄　録

長期の臨床経験から，従来の固定性補綴装置は，隣接歯に損傷を与えるだけでなく，修復した歯の歯根も破壊するということが明らかになった．これらの問題を解決するために，テレスコープクラウンの概念が発展したが，その製作は非常に困難である．そこで我々は, 根面アタッチメントとクリップによる可撤性二重冠(A-タイプ), ボールアタッチメントとラバーキャップによる可撤性二重冠(B-タイプ)，およびT-ポスト合金プレートで支持する可撤性ポンティック(C-タイプ)の３種の衛生的可撤式補綴システム(RHPS)を開発し，台湾，中国，日本，米国，ドイツにおける特許を取得した．今回，これら３種の特徴について論文として紹介するとともに，臨床応用について検討した．

本システムの長所は以下のとおりである．

1．本システムは容易に清掃が行えるよう設計されている．
2．根面アタッチメントとクリップ，ボールアタッチメントとラバーキャップおよびT-ポスト合金プレートにより，患者は安定した通常の咀嚼機能が行える．
3．クラウンの両端に設置したオクルーザルレストは，脆弱な歯の破折を防止し，隣接歯への咬合圧分配を可能にする．

キーワード：衛生的な可撤式補綴システム／クリップ/ラバーキャップ／ T-ポスト

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九州歯科大学内
TEL・FAX　093−571−9555
E-mail: kds@y7.dion.ne.jp
URL http://www.ac.auone-net.jp/~kds/
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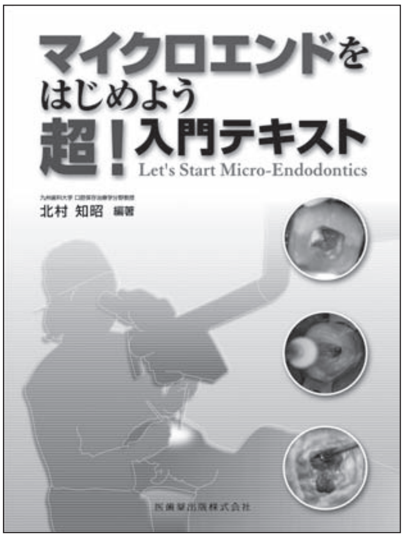

マイクロエンドをはじめよう 超！入門テキスト

北村知昭　編著

マイクロスコープは，もはや「特別」じゃない！
「特別な道具」ではなく「便利な道具」であるマイクロスコープを臨床に取り入れる際の絶好の手引き書

◆本書では，マイクロエンド初心者がつまづいてしまいそうな点にフォーカスをあて，マイクロエンドのトレーニングをするうえで押さえておきたいポイントやコツを写真や図を多用してビジュアルに解説.
◆歯内治療をマイクロエンドに移行することで日々の臨床レベルが上がることを実感してください.

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