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Proceedings of the 21th International Conference on Magnetic Applications in Dentistry

The Japanese Society of Magnetic Applications in Dentistry

The 21th International Conference on Magnetic Applications in Dentistry

The 21th International Conference on The Japanese Society of Magnetic Applications in Dentistry organized by JSMAD was held on the Internet as follows;

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Monday, February 21 to Monday, March 7, 2022

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Researches and developments related to dentistry and magnetism such as:

- Magnetic attachments for dentures
- Orthodontic appliances using magnets
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Contents

The study of attractive force occurred in parallel installation of keepers on the coping. -The influence of the distance between two keepers-

M. Yoshida, S. Nakabayashi, H. Yasuda, Y. Nakamura, N. Higuchi, T. Ohyama, and N. Tsukimura

Department of Partial Denture Prosthodontics, Nihon University School of Dentistry

Introduction

In a choice of magnetic keeper, a shape of root is an important factor in deciding the size. Especially when a root cross section is flat, two small size of keepers arranged in parallel are applied to improve its retention. In the past study of this course, the attractive force of magnetic attachments arranged in a row has been examined, and the study shows that a parallel installation of keepers makes its attractive force much stronger than a single attachment does. This study shows that how the difference of each keepers' distance affects its attraction.

Objective

This study simulates the case that a root cross section of maxillary first premolar is flat and clarifies how the distance between the two keepers affects its attractive force as they are arranged in parallel to improve retention of a denture.

Materials and Methods

Table.1 Details of materials and machine

Materials and Machines			Manufacturer	Abbreviation
GIGAUSS	C300		GC	C3
FIXPEED		lot No.180726	GC	
Aron alpha (an adhesive)		lot No.8Y27Z	TOAGOSEI CO.,LTD	
Universal testing machine	EZ-Test		Shimadzu Corp.	EZ-Test
ISO tensile test jig				

Experimental methods

The distance between the each keepers: 0mm,1mm,2mm
From now on they are written as 0mm=0,1mm=1, and 2mm=2
3different experiment stands are made along with the distance of keepers
(Fig.1) (Fig.2)
Data processing methods

The attractive force of C300 was measured 5 times, and a standard value is based on the average. A theoretical value is 2 times of the standard value. Measurements were held 5 times in each experimental method, and an experimental value is based on the average. The obtained experimental value was statistically processed with statistical analysis software GraphPad Prism, and a significant level is 5% in both one-way ANOVA and Tukey's multiple comparison tests.

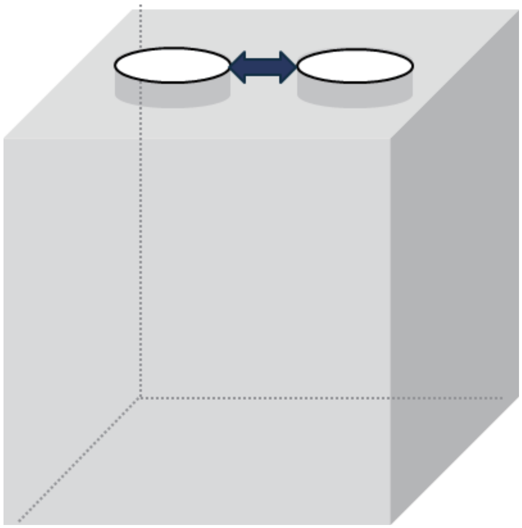

Fig.1 Sample image

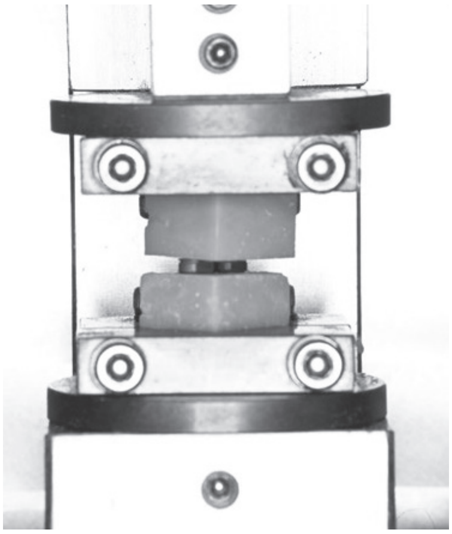

Fig.2 Universal testing machine with ISO tensile test jig

Results

The standard value of C300: 265gf
The theoretical value of C300: 530gf (two times of a standard value)
The average value of 0: 462gf The average value of 1: 387gf The average value of 2 :403gf (Table.2)

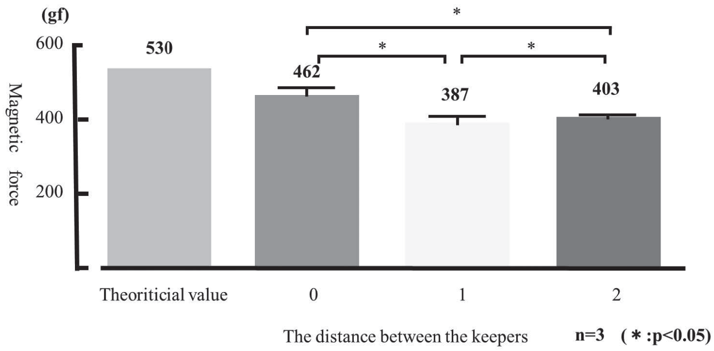

Table.2 The magnetic force of the two parallel installed keepers

Conclusions

The attractive force changes by the difference of the distance between the keepers. In the case of arranging keepers in contact, compared to the case of arranging them separately, the rate of decline of its attraction is small against the standard value.

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1. Nakabayashi. S , Higuchi. N, Nagai. E, Sanada. j, Ootani. K, Ohyama. T, Yasuda. H, Tsukimura. N. A study of the attractive force of magnetic attachments on keepers mounted in parallel in a coping, J J Mag Dent 28(1):71-75, 2019.

Resistance force of magnetic attachments against external lateral displacement

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Abstract

The purpose of this study is to demonstrate the resistance force of magnetic attachments against external forces that displace it laterally along the mating face. The resistance and attractive forces during lateral displacement between a magnetic assembly or neodymium magnet and its keeper were measured. The maximum friction force of the Physio Magnet 5213 magnetic attachment was 1.78 N whereas that of neodymium keeper was 0.39 N. It was demonstrated that besides frictional force, the magnetic attraction force contributes towards the overall resistance against external forces that laterally displace the magnetic assembly from its keeper. The magnetic attachment had a smaller attraction force than the maximum static friction. Contrastingly, neodymium magnet combined with the same keeper, upon significant displacement, generated an attraction force that exceeded the maximum static friction force. This is because the magnet's open circuit system generated an attraction force that restored the magnet to its keeper. Further understanding and utilization of this phenomenon, is significant for development of a new magnetic attachment with a stronger bracing function.

Introduction

Support, retention, and bracing or resistances against lateral forces are the three fundamental aspects required for stability of dentures during function[1)]. Elements of a denture such as abutments, proximal plate, connectors, occlusal rests, clasps, reciprocators and base plate, contribute towards stability solely or in combination. Dental magnetic attachments are devices incorporated into the abutments to offer retention and support with minimal bracing (horizontal stability)[2)]. These characteristics are absent in other abutment devices. The use of magnetic attachments eliminates most of the rotational and lateral forces which are detrimental to the longevity of a tooth's root[3)]. Use of magnetic attachments also allows for a decrease in abutment teeth loading forces which is an advantage, but a compromise in terms of denture functionality. However, it is possible to actively increase force generated by bracing components using magnetic attachments of improved root cap shape or using MT crown[2)].

Dental magnetic attachments are associated with weak bracing force because only frictional force of the mating face provides resistance to external forces acting in the horizontal direction. The magnets attractive force is not directly involved[2)]. Generally, when force is exerted on an object placed on a horizontal surface in an attempt to slide it laterally, static friction provides a counter force. Static friction force shows the greatest magnitude just before the object starts to move. It is termed as the maximum static friction. Maximum static friction Fs is proportional to the normal force N acting perpendicularly through the object to the contact surface. The proportionality constant μ_s at that point is called the coefficient of static friction, whose relationship is represented by the following equation (1).

$$F_s=\mu_s N \tag{1}$$

When the force applied to move the object becomes greater than F_s, the object starts to slide, and kinetic friction begins to act on the object instead of static friction. Kinetic friction is a smaller force than maximum static friction. It has been proven experimentally that kinetic friction F_k is proportional to normal force N. The proportionality constant μ_k is called coefficient of kinetic friction, and the following equation (2) describes the relationship.

$$F_k =\mu_k N \tag{2}$$

The values represented by μ_s and μ_k are constants which are determined by properties of the contact surface, such as surface roughness, surface energy. The contact surface area and velocity of the moving object have no direct influence on the constants. The normal force N in most scenarios is the force of gravity acting on the object. Magnetic attachments possess a very small gravity due to their minute mass. Therefore it is the attractive force of a magnet that predominantly acts as the normal force N. The bracing force of a magnetic attachment which is its resistance to forces that try to shift the magnetic assembly laterally from its keeper, is majorly dependent on the attractive force. Out of the few studies that investigated the friction force of magnetic attachments, only one study reported a magnetic attachment with a friction force of 70~90 g. It is a well-known that dental magnetic attachments are gentle on the roots of the abutment teeth but the mechanism needs to be understood well by studying resistance force and its behavior against forces that cause lateral displacement.

Objective

The purpose of this study was to demonstrate the resistance forces of a magnetic attachment against lateral displacement. The resistance and attractive forces of magnetic assembly and magnet against its keeper during lateral displacement were examined.

Materials and Methods

Dental magnetic attachment and magnet

A dental magnetic attachment, Physio Magnet 5213 (magnetic assembly: 5.2 mm in diameter and 1.3 mm in height, with keeper: 5.2 mm in diameter and 0.8 mm in height, Morita) was used in this study. The set is subsequently referred to as magnetic attachment. A magnet, cylindrical neodymium magnet (Nd-Fe-B: 5.0 mm in diameter and 1.5 mm in height, Trusco) was used. The cylindrical neodymium magnet was combined with the Physio Magnet keeper. The set is hereinafter referred to as magnet. In order to have the magnet and keeper in a position whereby their centers match, the magnets diameter must be smaller than the keepers[4]. Therefore the magnet selected for use in this study had a slightly smaller diameter than the keeper's.

Experimental device

The retentive force measuring device used in this study matches the basic description in ISO 13017:2020[5]. It was connected to a digital force gauge (ZPS, Imada). The device was installed in a universal testing machine (AGS-5kNG, Shimadzu) which controlled the crosshead speed.

Measurement of resistance force of a magnetic attachment or magnet and keeper against external forces that cause lateral displacement

As shown in the Figure 1, aluminum jigs were fixed with their long axis in a vertical plane. One jig was fixed to the lower table of the measuring device whereas the other was fixed onto the upper table. A magnetic assembly and magnet combined with keeper were fixed onto the jigs using cyanoacrylate adhesive with the long axis in a vertical plane as shown in Fig 1. The magnetic assembly or magnet was pulled upwards so that the mating faces slide against each other at the crosshead speed of 1mm/min, and the resistance force measured by the force gauge. Recording of measurements was done at a sampling rate of 1 kHz until the magnetic assembly or magnet completely separated from the keeper. After the measurement, the time values were converted to distance to generate a displacement distance-resistance curve.

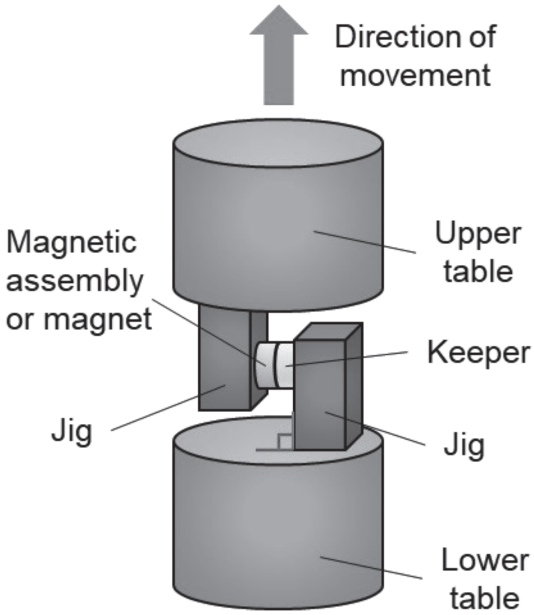

Fig. 1Set up of the sample mounted on device to measure resistance forces

Measurement of attractive force during lateral displacement

The measuring device, magnetic attachment and magnet were set up in accordance with the test method of ISO 13017[5)], and retentive force (attractive force) was measured at crosshead speed of 2 mm/min. The measurements started when the magnetic assembly or magnet had its center aligned to that of the keeper. Attractive force measurements were done at intervals of 100 µm horizontal displacement of keeper. The experiment was run until the magnetic assembly or magnet completely separated from its keeper.

Results

1. Resistance force of magnetic attachment or magnet and keeper against external forces that cause lateral displacement along the mating face

The displacement -resistance force curve of the magnetic attachment is shown in Figure 2. The horizontal axis shows the distance of horizontal shift (displacement) by the magnetic assembly away from the keeper whereas the vertical axis shows the resistance force measured. The resistance force just before the magnetic assembly started to move (maximum static friction force) was 1.78N. Once the assembly started to move, the force dropped drastically to 1.34 N. Afterwards, the resistance force increased as the distance approached 0.25 mm, then decreased with increasing distance. The curve had several inflection points. Beyond 5.2 mm, the resistance dropped to zero.

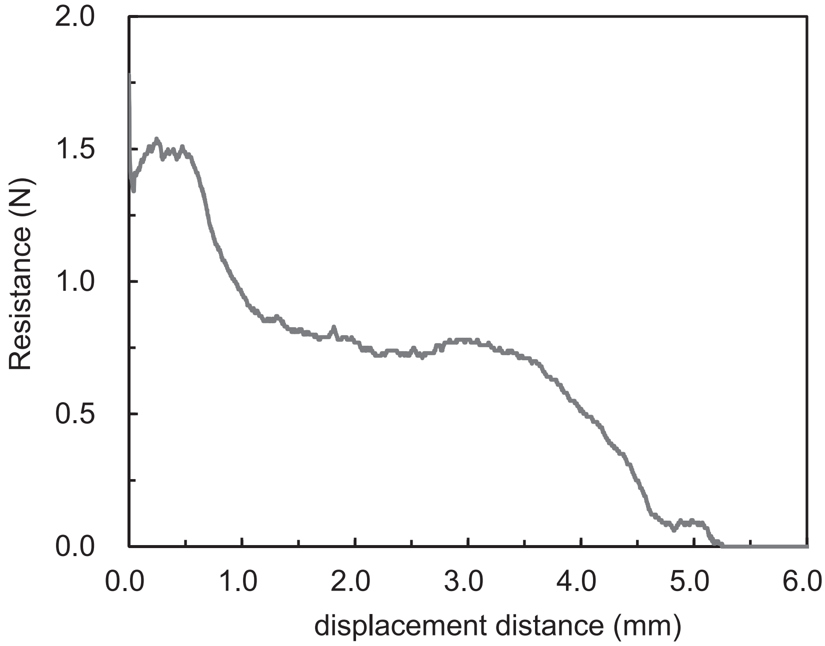

Fig. 2 The displacement distance-resistance force curve of the Physio magnetic attachment

The displacement distance-resistance force curve of the neodymium magnet -keeper is shown in Figure 3. The resistance force just before the initial movement of the magnet (maximum static friction force) was 0.39 N. Afterwards, the force dropped to 0.37 N then showed a transient rise and fall at 0.54 mm. Beyond that, the force increased monotonically with the increase in distance. As the distance exceeded 4.5 mm, the resistance force decreased to reach zero at 6.4 mm. The decline in resistance force to zero from 5.1 mm distance point, showed a smooth convex shape.

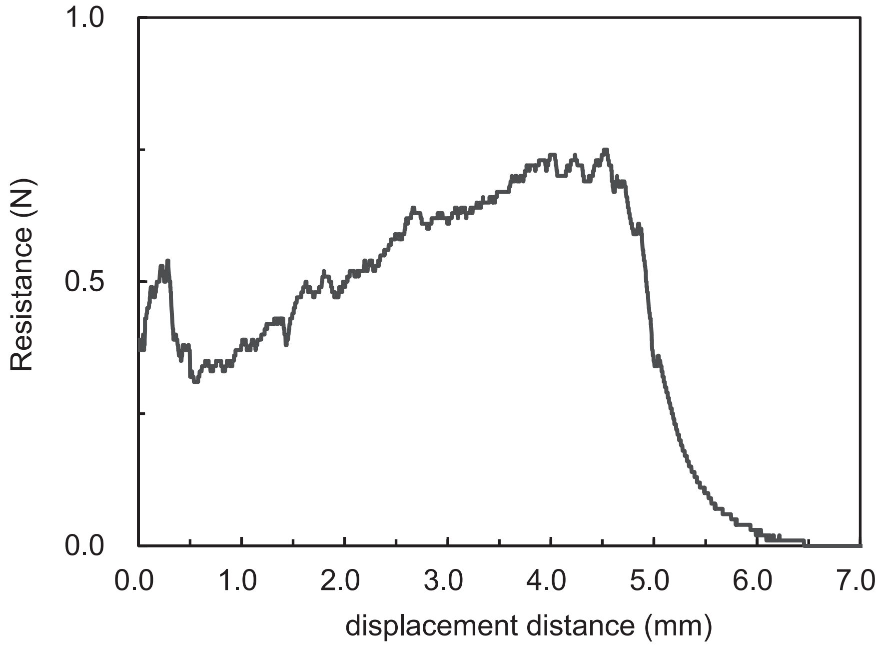

Fig. 3The displacement distance-resistance curve of neodymium magnet-keeper

2. Horizontal displacement and magnetic attractive force

The relationship between horizontal displacement and the attractive force of magnetic attachment and neodymium magnet are shown in Figure 4 and Figure 5 respectively. In both cases, the attractive forces decreased with increasing displacement and showed multiple inflections.

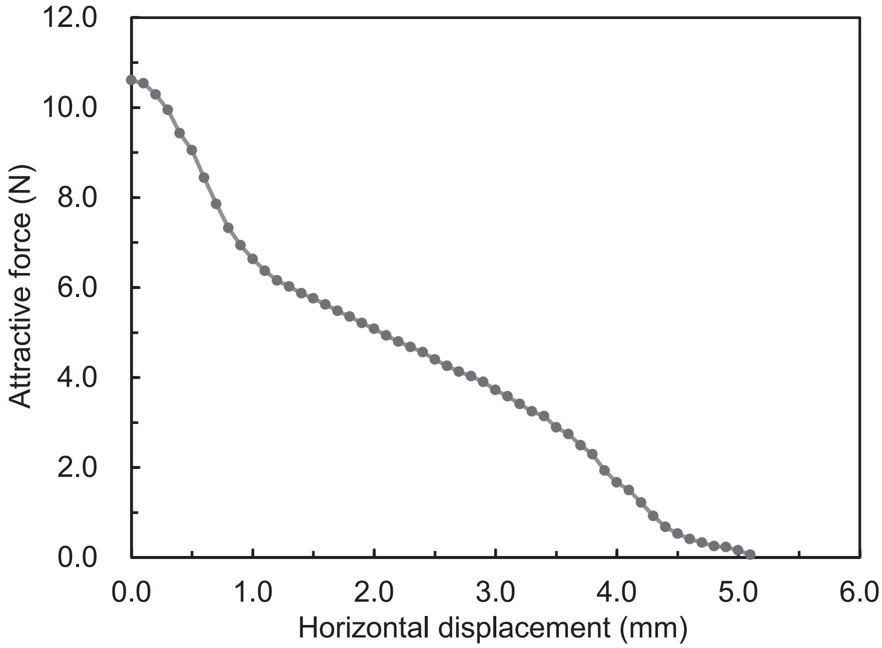

Fig. 4The attractive force against horizontal displacement in magnetic attachment

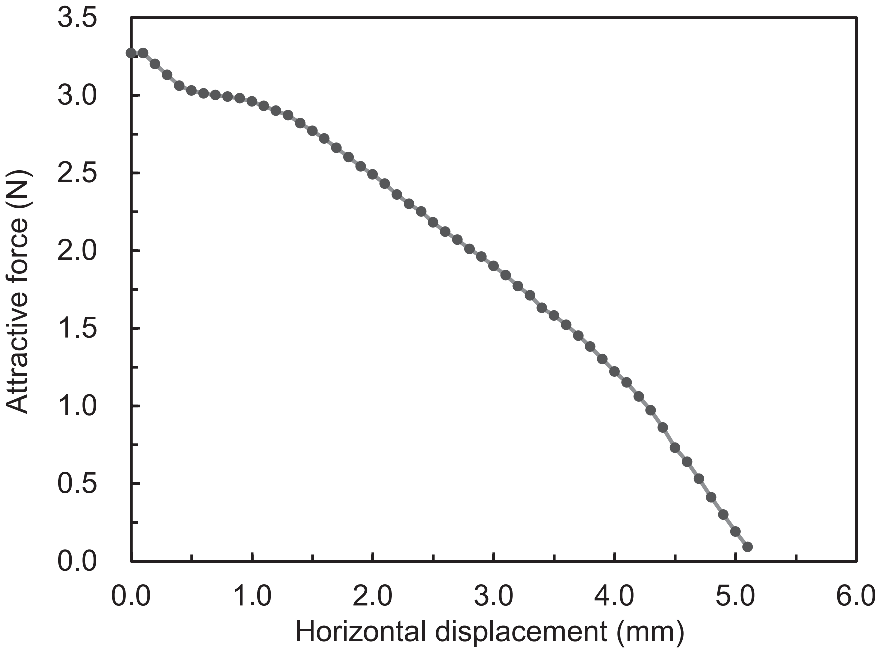

Fig. 5 The attractive force against horizontal displacement of neodymium magnet and keeper

Discussion

1. Resistance force of magnetic attachment against external forces that cause lateral displacement along the mating face

In this study, the mating face of the magnetic attachment was fixed onto the measuring device with the long axis parallel to the vertical plane so that only the attractive force of the magnet affects the normal force which in turn relates to friction force. The maximum static friction was determined from the resistance displacement curve. Normal force N is the attractive force at zero displacement. The coefficient of static friction was calculated using equation (1). The kinetic friction which is active soon after the magnetic assembly or magnet starts to move, was derived from the resistance displacement curve. The coefficient of kinetic friction was calculated using equation (2). The calculated coefficients of static friction and of kinetic friction for the magnetic attachment 5213 were equal to 0.17 and 0.13 respectively. The values reinforced a well-known concept of, coefficient of static friction being greater that of kinetic friction. Ishihata et al. in a previous study[3)] reported that the frictional force of a magnetic attachment was about 1/3 its attractive force. The coefficient of friction in that study was about 0.33. The large difference between the two studies is that the material of the magnetic attachments used was different. The magnetic attachment in Ishihata et al.'s study was made of stainless steel and experimental magnetic alloy E[6)], while the magnetic attachment used in this study was made of magnetic stainless steel. The coefficient of friction exhibited by a pair of contacting surfaces is highly dependent on the different material deformation characteristics and the surface roughness.

Friction force is proportional to the normal force but independent of the contact surface area (Amontons' law). Therefore, kinetic friction force was calculated at different positions of displacement using Equation (2), after acquisition of coefficient of kinetic friction and data on attractive forces at different positions. The results are shown in Figure 6 alongside the resistance force. If kinetic friction is the only force that resists the external forces responsible for lateral displacement of magnetic attachments, then the two sets of values would be identical and the two curves superimposed onto each other. However, in this case, the resistance force was larger than the kinetic friction force calculated. This implies that the resistance force measured includes laterally attraction force related to the magnetic attachments. The magnetic assembly creates a magnetic circuit on the mating face when in contact with the keeper which generates a strong attractive force. Even when the magnetic assembly has been displaced until it is no longer in contact with the keeper, a small attraction force towards the keeper persists. The small attraction force attempts to restore the magnetic assembly back in contact with the keeper. Therefore, the measured resistance force is the sum of kinetic friction force acting along the mating face and the attraction force due to the magnetic fields.

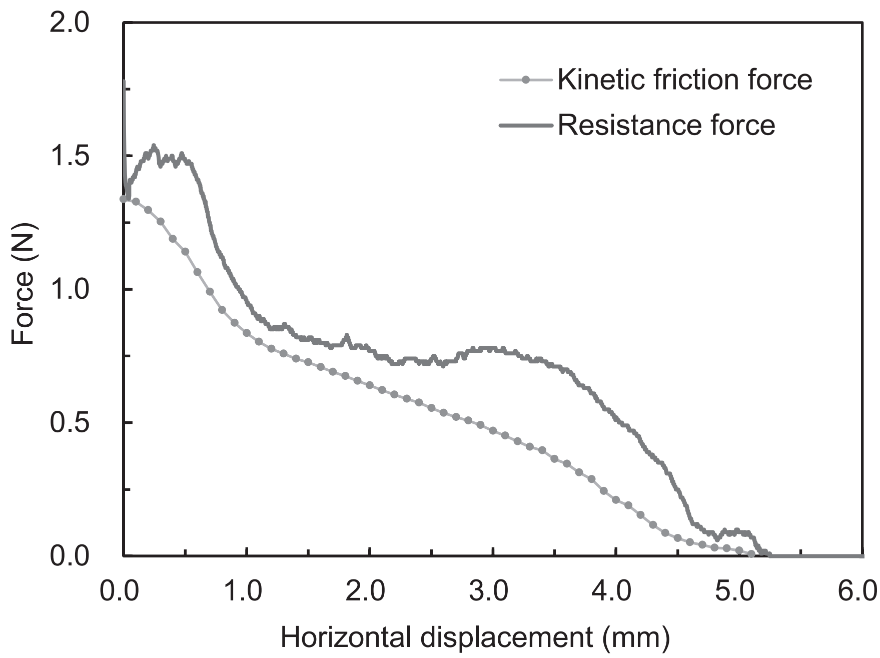

Fig. 6 Kinetic friction force and resistance force corresponding to different positions of horizontal displacement of magnetic attachment

The difference between the resistance force and the kinetic friction force was calculated to obtain the attraction force of the magnetic attachments in each position. Using the coefficient of static friction and attractive force values at each position, the maximum static friction force exerted at each position of lateral displacement was obtained using formula (1). The results are shown in the Figure 7. As demonstrated on this figure, the attraction force that attempts to restore the magnetic assembly into congruence with the keeper is generally smaller than the maximum static friction force. Therefore, the attraction force does not automatically get an already displaced magnetic attachment back to its original position with keeper or move further.

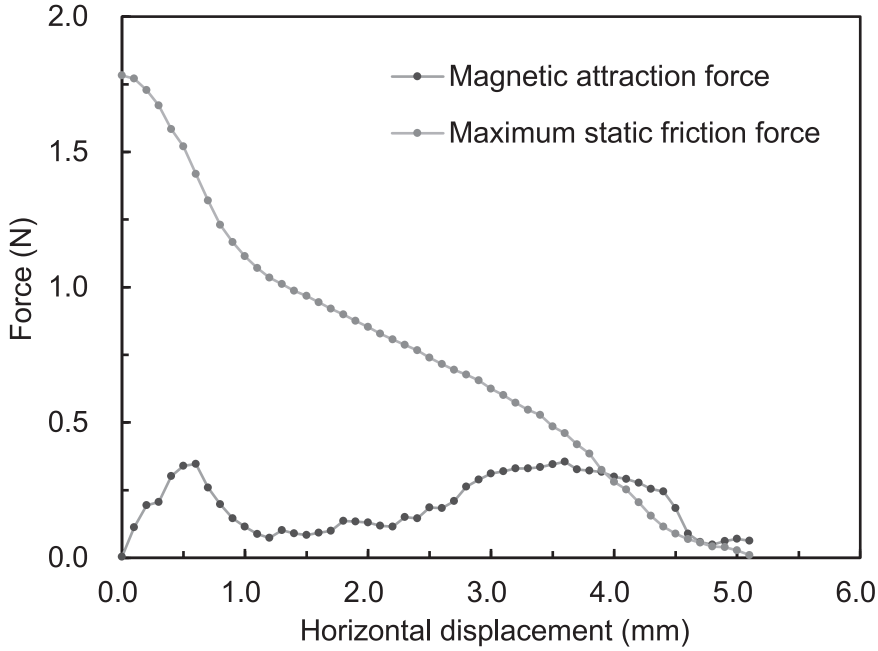

Fig. 7 Magnetic attraction force and maximum static friction force at each displaced position of magnetic attachment

2. Resistance force of neodymium magnet against forces that cause lateral displacement along the mating face

The coefficients of static and kinetic friction while using neodymium magnet were determined in a similar manner to that of magnetic attachment. The attained coefficients of static and kinetic friction were 0.12 and 0.11. Coefficient of static friction was larger than that of kinetic friction. Kinetic friction force at each position of lateral displacement was calculated in a manner similar to that of magnetic attachment. The data of kinetic force along with the resistance force are represented in a graph shown as in figure 8. Similar to the case of magnetic attachment, the resistance force was larger than the kinetic friction. This is because the attraction force between magnet and keeper even in their displaced condition is incorporated into the measured resistance force. The measured resistance force is the sum of the kinetic friction force at the mating face and the attraction force due to the magnetic force. Since neodymium magnets are characterized by open magnetic circuit, the magnetic fields from the bottom side (opposite to mating face) of the magnet and the exposed surface of the keeper generate an attraction force. This attraction force pulls the magnet back towards the fixed keeper. Contrary to the case of the magnetic attachment in which the resistance force quickly dropped to zero when the magnetic assembly completely separated from the keeper, the attraction force in this case persisted even after the separation point (distance of 5.1 mm). The above finding is a feature of open magnetic circuit, whose magnetic force after separation is inversely proportional to the square of the distance (inverse square law) causing the magnetic force to decrease slowly in a convex shape. On the other hand, the Physio magnetic attachment used in this study has a closed magnetic circuit in which the two poles close to each other undergo little magnetic flux leaks causing quick decay of magnetic force.

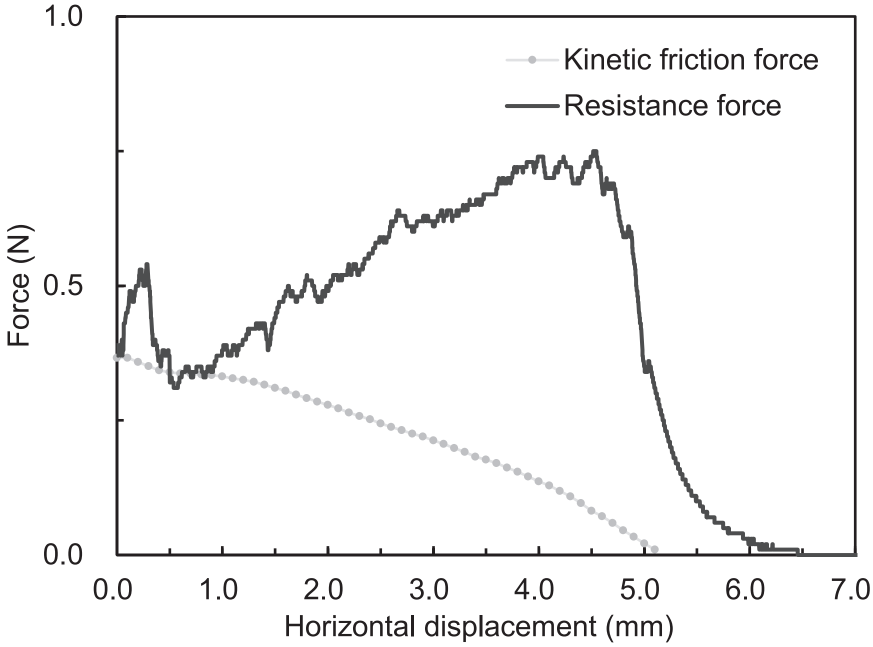

Fig. 8Kinetic friction force and resistance force corresponding to positions of lateral displacement of the neodymium magnet

The neodymium magnet's laterally attraction force and the maximum static friction force at each position of lateral displacement were determined in the same method as the magnetic attachment. The results are shown in the Figure 9. Unlike the magnetic attachment scenario, the magnets attraction force exceeded the maximum static friction force when the magnet was displaced significantly by more than 2.5 mm. The resultant force can restore the magnet to coincide with its keeper. The restoring force generated in the magnet combination used in this study was small, but it may be possible to increase it through use of certain selective combination of magnets. Although magnetic attachments are gentle on the tooth root, they act as weak bracing components. Clinical application of the restoring forces, would simplify alignment of the keeper to magnetic assembly. It may also be possible to develop a new magnetic attachment with enhanced bracing function using the information on the phenomenon of restoring forces.

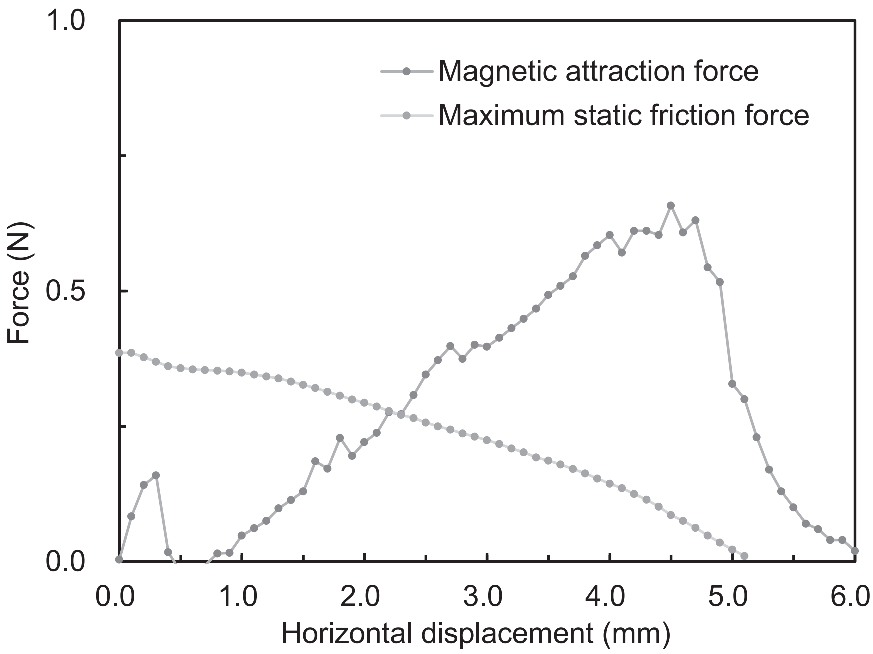

Fig. 9 Magnetic attraction force and maximum static friction at each position of the neodymium magnet

Conclusion

The maximum friction force of the Physio Magnet 5213 recorded was 1.78 N. It was clearly demonstrated that besides frictional force, magnetic attraction force also influences the overall resistance force that stops displacement and restores a magnetic assembly to its keeper.

Acknowledgments

The authors greatly acknowledge KEDC Co., Ltd. for providing the Physio Magnet 5213.

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Long-term follow-up cases of magnetic attachment denture with different prosthetic designs

H. Kumano, Y. Nakamura, H. Nakamura, R. Kanbara, T. Masuda, W. Fujinami, S. Ozawa and J. Takebe.
Department of Removable Prosthodontics, School of Dentistry, Aichi Gakuin University

Introduction

The magnetic attachments can be small and powerful attractive force by using a neodymium magnet which is one of rare earth magnets. This system can be used as abutment teeth by decreasing the lateral force even if crow-root ratio is poor. Therefore, the clinical efficacies of a magnetic attachment have been widely demonstrated[1,2]. The most important advantage of the magnetic attachment is that it can be used in the root cap type or MT (Magno telescopic) crown type according to the clinical conditions of the abutment tooth. As a result, it is possible to preserve abutment teeth with maximized support ability by using either type of them, which is considered to have great clinical advantage. This report is a case study of partial denture prosthesis designed with magnetic attachments of the MT (Magno telescopic) crown type for the maxilla and the root cap type for the mandible, which are followed in good condition for a long time.

Summary of the case

Patient is a 71-year-old woman. The chief complaint was to look better, worry about the bite, and not be able to bite things.

Medical history was hypothyroidism. History of present illness was stained teeth, misalignment of the bite, difficulty in biting, and pain in TMJ. After splint treatment at the previous doctor, the TMJ problem was improved. However, in May 2007, the patient requested mastication and aesthetic treatment and thus consulted the department.

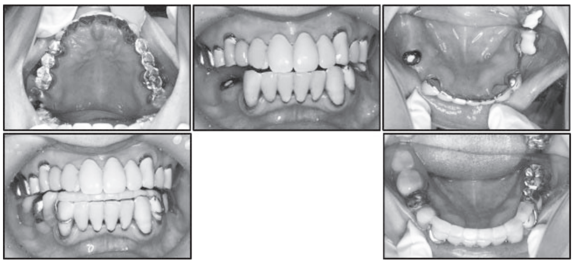

Fig.1 Intraoral views and mandibular removable partial denture at the time of initial examination

In the present illness, many restorations set on the remaining teeth in the maxilla and gingival recession at the margin was observed. In the mandible, as well as in the maxilla, all remaining teeth except for the residual root were set with restorations. 35 of the intermediate defect was set with the fixed partial denture incorporating a bar-type retainer.45 was a residual root and 46,47 was distal extension missing. The facing of restorations that had been set was discolored. Mandibular tours was found on the lingual of the mandible. In addition, when the removable partial denture was set, it was observed the bite raising (Fig.1).

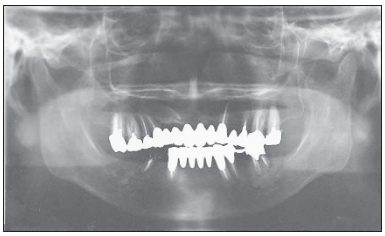

Fig.2 Panoramic radiographs at the time of initial examination

From panoramic radiographs at the time of initial examination, radiolucency at the apex was observed in 25, 27 and 36, and poor root canal filling was observed in 16 and 26. Poor crown-root ratio was observed in the mandibular anterior teeth region. In addition, incompatibility of the restorations in the maxillary and mandibular molars was observed (Fig.2).

Based on the above findings, it was diagnosed as masticatory disorder due to mandibular molar defect and esthetic disorder due to discoloration of the facing of the maxillary and mandibular fixed partial dentures.

Treatment and progress

Using the occlusal vertical dimension of the old denture as a reference, the study cast was mounted on a semi adjustable articulator and examined. The presence of the vomiting reflex was found in the maxilla during the taking of preliminary impression.

Imaging examination using panoramic radiographs showed a poor crown-root ratio in the remaining mandibular teeth. Then, it was decided to remove all prosthesis for remaining teeth of the mandible and to make treatment denture of overdenture type. Before making the treatment denture, we had to remove the mandibular torus that was thought to cause pain when wearing the denture. Next, the poor prosthesis for the remaining mandibular teeth were removed and treatment denture was set. The maxilla, as well as the mandible, were also set with a provisional bridge after the poor prosthesis were removed. While adjusting the interim prosthesis set on the maxilla and mandible, re-root canal treatment was performed for 15,16,26,27,36,45. 36 of the distal root was treated with hemi section because of poor prognosis.

After re-root canal treatment, the definitive prosthesis was designed (Fig.3). The design of the definitive prosthesis for the maxilla was a removable dental prosthesis with MT (Magno telescopic) crown type using magnetic attachments for the retainer, because the clinical condition of the abutment teeth was good. The reason for making it a removable dental prosthesis was to consider how to deal with 13 defects and the vomiting reflex. In the mandible, considering the clinical condition of the abutment teeth and the crown-root ratio, the overdenture was made with a root cap with keeper as the retainer.

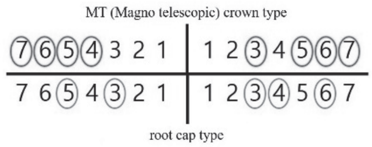

Fig.3 The design of the definitive prosthesis

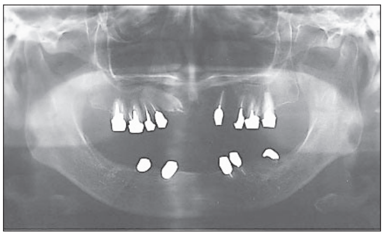

Fig.4 Panoramic radiographs of the inner crown of the MT crown and root cap with keeper (2011.8)

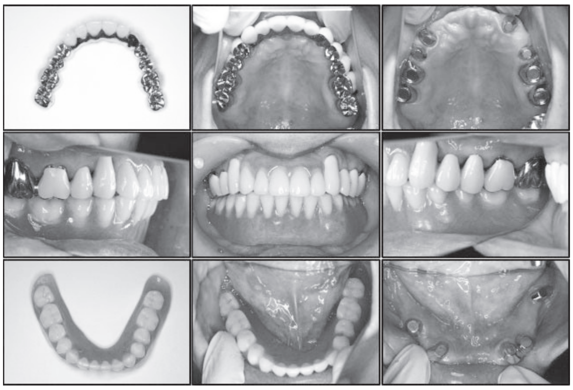

Fig.5 Intraoral view of the definitive prosthesis and placement (2011.8)

After taking precise impression of the maxillary and mandibular abutment teeth, the inner crown of the MT crown and the root cap with keeper were made. After making the inner crown of the MT crown in the maxilla, pickup impression was taken and the outer crown of the MT crown was made. Then, according to the conventional method, the maxillary and maxillary definitive prosthesis was made (Fig.4,5). In the maxilla, the magnet assembly was set at the time of placement of the definitive prosthesis. In the mandible, one month after the definitive prosthesis was set in place, a magnetic assembly was set on the abutment tooth after checking that there was no pain in the mandibular residual mucous membrane. The fit of the definitive prosthesis was good, and the patient was satisfied both functionally and aesthetically. After that, it was recalled once every three months.

However, one year and three months after the definitive prosthesis was set in place, mobility of teeth 45 and 36, which were of uncertain prognosis, increased. Therefore, it was diagnosed that it was difficult to preserve them, and the teeth were extracted. After healing of the extraction socket, metal plate denture with the two-piece artificial resin tooth was made to improve the rigidity of the denture and to maintain the stable occlusal relationship (Fig.6). To obtain an occlusal surface in harmony with jaw movement, the two-piece artificial resin tooth was used for about two months. Then, the occlusal surface was replaced with lithium disilicate glass ceramics.

After the metal plate denture was set in the mandible, it was recalled regularly every six months. The purpose of the recall is to manage the periodontal disease of the remaining teeth and to check and adjust the occlusal changes of the denture and remaining teeth. At present, the dentures and remaining teeth are in good condition (Fig.7,8,9,10).

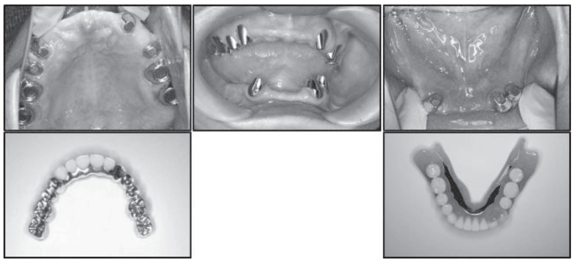

Fig.6 Intraoral view and the prosthesis for maxilla and mandible (2013.7)

Fig.7 Periodontal conditions

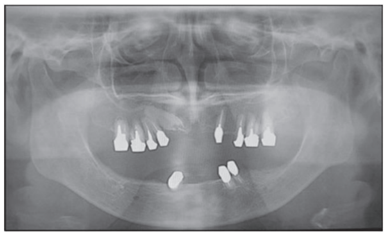

Fig.8 Panoramic radiographs of the current condition (2021.12)

Fig.9 Intraoral view of the prosthesis for maxilla and mandible and placement (2017.6)

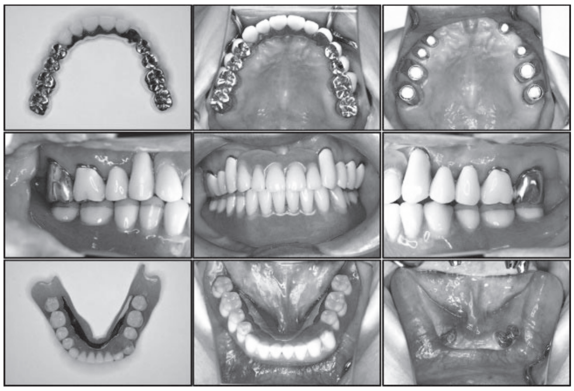

Fig.10 Intraoral view of the prosthesis for maxilla and mandible and placement (2021.6)

Conclusions

This time, MT (Magno telescopic) crown type was selected for the retainer in the maxilla, where the clinical conditions of the abutment teeth were relatively good. Since the clinical conditions of the abutment teeth were poor, a root cap type was selected for the retainer in the mandible. Finally, the partial denture prosthesis was designed using different methods of magnetic attachments in the maxilla and mandible.

The most important advantage of the magnetic attachment is that it can be used in the root cap type or MT crown type according to the clinical conditions of the abutment tooth. As a result, it is possible to preserve abutment teeth with maximized support ability by using either type of them, which is considered to have great clinical advantage. Therefore, it is considered that this case had a good long-term, functional and aesthetic follow-up. The maintenance of the dentures and remaining teeth will be continued with the main purpose of checking and adjusting the occlusal changes.

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Denture repair by applying a magnetic attachment after extracting the abutment tooth of a cone crown telescope: A case report

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Abstract

In this case report, a denture was repaired by applying a magnetic attachment after extracting the abutment tooth of a cone crown telescope. The patient was a 76-year-old female. She wore a denture with a cone crown telescope for three missing teeth: the left central incisor, the lateral incisor, and the canine. The second premolar on the left side of the maxilla, one of the abutment teeth, was extracted due to root fracture. Subsequently, a full metal crown with an extracoronal magnetic attachment was affixed to the maxillary left first molar behind the defect. Denture repair was performed by adding a magnetic attachment to the inner surface of the outer crown of the second premolar on the left side of the maxilla to match the keeper of the extracoronal magnetic attachment. The patient was satisfied with using the repaired denture. In addition, by adopting an extra-crown attachment, it was possible to reduce the burden on the abutment tooth.

Introduction

In recent years, dental magnetic attachments have become easier to handle in general clinical practice due to their miniaturization, retentive force, improved corrosion resistance, and the fact that they can also be applied to extracoronal magnetic attachments. Another advantage is that, with a little ingenuity, there are various ways to use them.

In this case, one of the abutment teeth of the removable partial denture was extracted. The full metal crown of the existing tooth at the extraction site was made into a full metal crown equipped with an extracoronal magnetic attachment, and the denture was repaired by affixing a magnetic attachment to the inner surface of the denture so as to fit the keeper.

Outline of the case

The condition of the prosthetic device in the oral cavity at this patient's first visit was shown in the previous report, [1] but the basics are given below.

The patient was a 77-year-old female. On June 12, 2020, she came to the hospital complaining of upper left pain during occlusion. Intraoral views and the denture are shown in Figure 1. As a general medical history, the patient was being treated for hypertension.

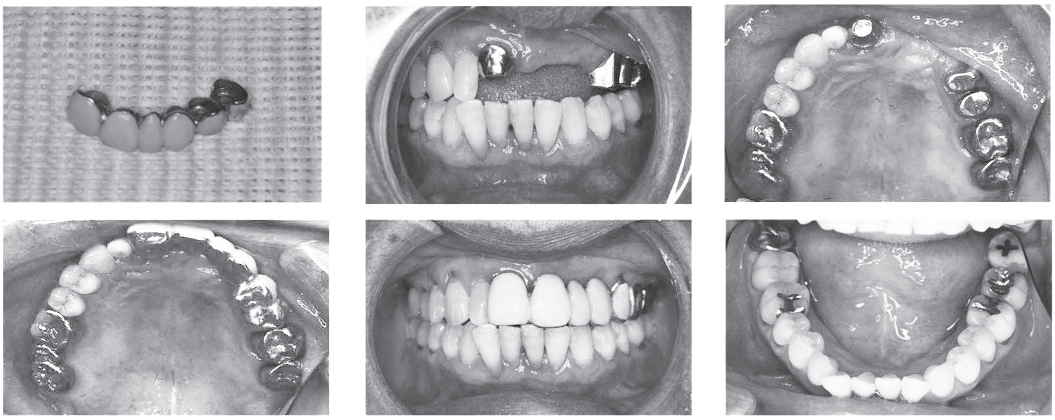


Fig.1 Intraoral views and the denture at the beginning of prosthetic treatment

Her current dental history is as follows. In December 2000, inner crowns of the cone crown telescope on the maxillary right central incisor, left first premolar, and left second premolar were produced for three tooth defects. A removable partial denture equipped with outer crowns conforming to those inner crowns was then set. In November 2014, the inner crown of the maxillary right central incisor, one of the abutment teeth, was removed for root canal treatment due to acute apical periodontitis. In July 2015, after endodontic treatment, the maxillary right central incisor was repaired by fitting a magnotelescopic crown (MT crown) with a magnetic attachment to fit the existing outer crown.

The current disease is as follows. The second premolar on the left side of the maxilla, which was the focus of the main complaint, had occlusal pain for about 3 weeks; additionally, red swelling was observed in the buccal gingiva, the tooth mobility was second grade, and the periodontal pocket depth was 9 mm at the deepest point. A dental photograph of the second premolar on the left side of the maxilla is shown in Figure 2. A root fracture extending to the apex was found, and the tooth was judged to be unsavable, so it was extracted on June 30.

Fig. 2. Dental radiograph

Clinical procedure

In planning the prosthetic treatment, the following factors were considered: The denture had been used for a long time, but the fit of the denture was good, and the patient could use the denture comfortably. Therefore, the prosthetic treatment plan after tooth extraction was shown as follows and was accepted by the patient:

(1) Fabricate a provisional crown with an extracoronal attachment after removing the full metal crown of the maxillary left first molar.

(2) Produce a full metal crown with an extracoronal magnetic attachment keeper after the residual ridge being stable.

(3) Mount the magnetic assembly on the inner surface of the outer crown of the second premolar on the left side of the maxilla.

(4) Maintain and recall.

Treatments were performed as follows.

A provisional crown with extracoronal attachment to the maxillary left first molar was made by applying a bent ready-made rest wire to the outside of the crown. The extracoronal attachment was fitted to the inner surface of the outer crown of the second premolar on the left side of the maxilla (Fig.3).

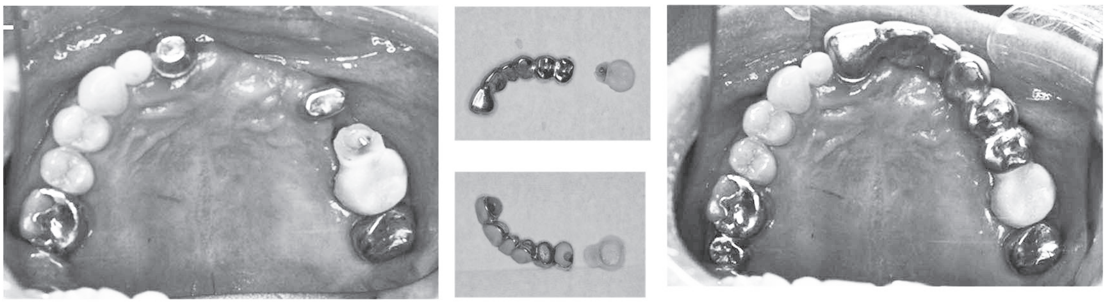
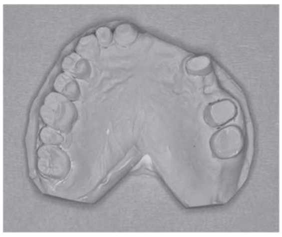


Fig. 3. Intraoral views, the denture and the provisional crown

Working casts without the denture (Fig.4①) and with the denture (Fig.4②) were prepared for the production of a full metal crown with the extracoronal attachment. In this case, since it was used on the inner surface of the outer crown of the second premolar on the left side of the maxilla, GIGAUSS C400® (GC, Japan) was used as the magnetic attachment, and the extracoronal attachment was manufactured by the keeper bonding method.

The crown morphology was waxed up in consideration of the following points (Fig.4③). The mesial surface was adapted to the distal surface of the second premolar on the left side of the maxilla of the model with denture. The part of the extracoronal attachment in contact with the mucosal surface was fitted with a dentureless model. For the pedestal to which the keeper of the extracoronal attachment is affixed, a model with denture was used, and wax-up was performed on the model in which the occlusal surface was ground, leaving the axial surface of the second premolar on the left side of the maxilla. The wax pattern was buried and cast according to the conventional method, and then the cast body was adjusted and polished (Fig.4④).



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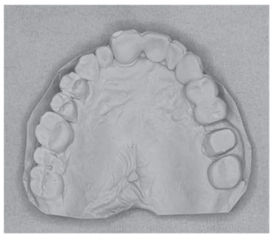

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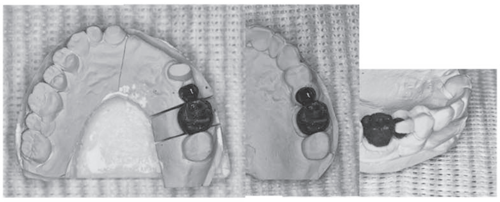

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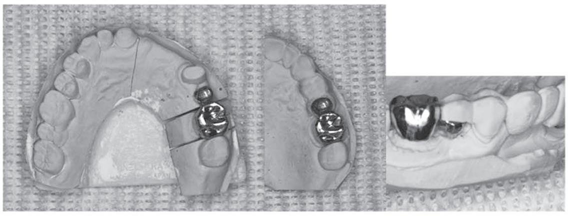

④

Fig. 4. Fabrication process from the wax-up of the first molar tooth to the completion of the full metal crown with an extracoronal magnetic attachment

The full metal crown with an extracoronal attachment was set in the oral cavity. At the next visit, a magnetic attachment was fitted to the inner surface of the outer crown of the second premolar on the left side of the maxilla (Fig.5).

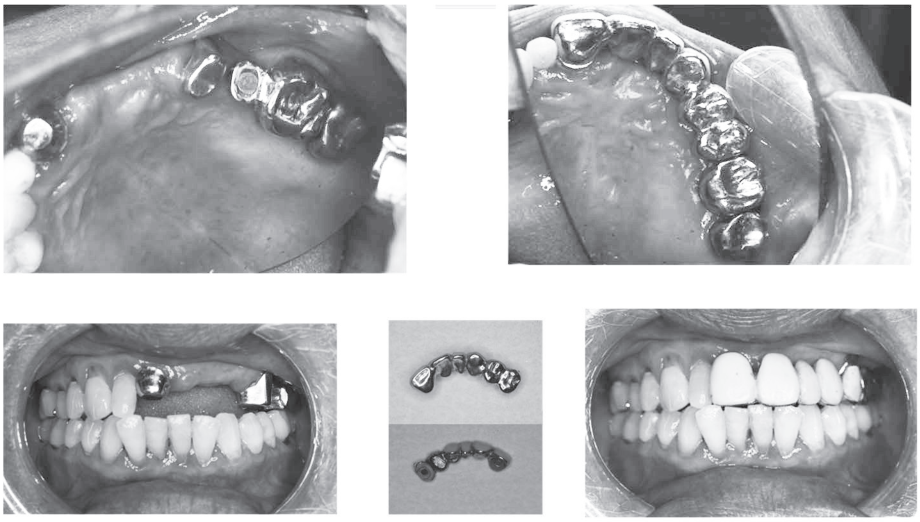

Fig. 5. Intraoral views and the denture at the wearing of the magnetic attachment

Discussion

In this case, by extracting the second premolar on the left side of the maxilla, the Kennedy classification is type 1 of Class III, and the Eichner classification is B-1. Including the maxillary right second molar that had already been missing, 5 teeth were missing. Since there was no defect in the mandible, the number of teeth decreased from 24 to 23, and the number of occlusal supports decreased from 10 to 9. In Miyachi's occlusal triangle, the area changed from the first area to the second.[2)] However, the patient had 9 occlusal supports and 23 teeth, had no tooth loss for the past 21 years, and she had more teeth and occlusal supports than other people of her generation. As a result of considering these factors, it was judged that the minimum prosthetic treatment was possible in this case.

Regarding the maxillary left first molar, the periodontium was generally good, and the pocket depth was about 3 mm, although the margins of the full metal crown were incompatible.

The patient was using the denture well and strongly hoped to continue using it. Therefore, she was relatively reluctant to make new dentures. In this case, the purpose of prosthetic treatment was to use the existing denture as much as possible while not placing an excessive burden on the abutment teeth. When she was presented a treatment plan using a full metal crown with an extracoronal attachment, she gave her consent to the treatment plan. [3)]

Conclusions

As a prosthetic treatment after tooth extraction, the existing full metal crown of the existing tooth was remade into a full metal crown with an extracoronal attachment. The existing denture was repaired by setting a magnetic attachment on the inner surface of the outer crown of the denture to fit the keeper. By using the existing denture, we enabled the patient to use the repaired denture without discomfort and with high satisfaction. In addition, the use of a magnetic attachment could reduce the burden on the abutment teeth.

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A case report of a removable denture using magnetic attachment and circumferential clasp followed up for 9 years

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Abstract

To reconstruct a harmonious craniofacial system, it is essential to maintain an appropriate occlusal vertical dimension (OVD). This clinical report describes the prognosis of a magnetic attachment denture that improved an immediate denture to maintain an appropriate OVD and the optimum mandibular position. As a definitive prosthesis, a removable maxillary overlay denture was fabricated that included a coping type of magnetic attachment, copings, and circumferential clasps.

Nine years after the denture setting, the definitive prosthesis has been used without serious problems, and the magnetic attachment has no clinically significant loss of retention.

Introduction

To reconstruct a harmonious craniofacial system, it is essential to maintain an appropriate occlusal vertical dimension(OVD). This clinical report describes the prognosis of a magnetic attachment denture that improved an immediate denture to maintain an appropriate OVD and the optimum mandibular position.

Clinical History

The patient, a 63-year-old female, complained of masticatory dysfunction. The patient had received a maxillary fixed bridge from tooth #3 to tooth #11 in 1989; however, the restoration failed, having a marginal discrepancy and damage by caries (Fig.1). We did not diagnose infraocclusion by analysis of the OVD. Finally, we suggested fabricating a removable maxillary overlay denture with a coping type of magnetic attachment as a definitive prosthesis by use of an immediate denture to maintain the optimum

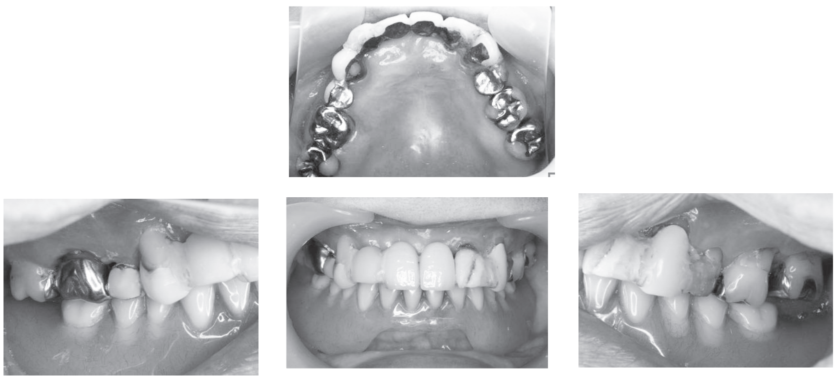

Fig.1 Intraoral view at the initial examination

mandibular position, which the patient found acceptable.

Treatment Procedure

As the first therapy, the incompatible fixed bridge in a marginal portion was removed, and tooth #3 was extracted. Then an immediate maxillary denture was set on a portion of the missing teeth. With the immediate denture, the patient obtained an adequate occlusal relationship and maintained the optimum mandibular position (Fig.2).

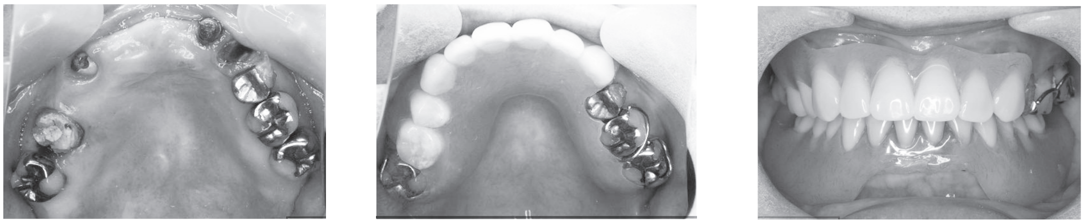

Fig.2 Intraoral view with immediate denture

As a definitive prosthesis, the reinforcement structure of the framework for preventing denture base fracture was made to cover about three quarters of the circumference of the magnetic attachment, and protrusion of the labial side was avoided (Fig.3). GIGAUSS C600® (GC, Japan), the magnetic attachment in this case report, was applied to tooth #6. The keeper of the magnetic attachment and magnetic assembly were fixed with adhesive resin cement (Multilink® Automix, Ivoclar Vivadent, Liechtenstein) (Fig.4).

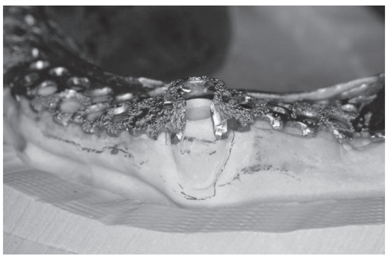

Fig.3 Reinforcement structure of framework

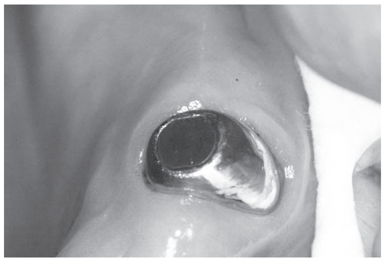

Fig.4 Keeper of the magnetic attachment

A removable maxillary overlay denture was fabricated and included a coping type of magnetic attachment,

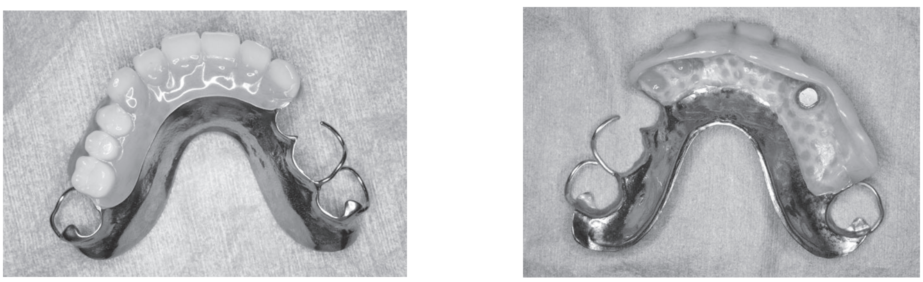

Fig.5 Removable maxillary overlay denture

circumferential clasps (wire type), and a horseshoe plate as the major connector. This denture was fabricated with the existing occlusal height and the optimum mandibular position (Fig.5). Figure 6 is an intraoral view of the definitive prosthesis.

Fig.6 Intraoral view with definitive prostheses

Outcome of Treatment

Presently, 9 years and 7 months have passed since the definitive prosthesis was set (Fig.7). Maintenance was initially performed every month, but since the prognosis was good, it has been changed to every 3 to 4 months after the first year. In addition to PMTC, maintenance included cleaning and cleaning guidance by various cleaning tools such as Taft brushes, disinfection around the branch teeth by chlorhexidine hydrochloride, and the application of plaque dye in the oral cavity and denture every 6 months. At that time, TBI was always performed for #6 (Fig.8). After about 8 years, there was no problem with #6, but secondary caries was observed in #10. There may have been an effect that the maintenance interval became a little longer due to the situation of COVID-19, but it is also possible that too much attention was focused only on cleaning the coping type of magnetic attachment (#6) (Fig.9). In this case, many fulcrum lines could be set because the front, back, left, and right of the abutment teeth could be arranged. In addition, molar abutment teeth with crown morphology have an excellent bracing function as compared to abutment teeth with crown morphology in the form of the root surface, and it seems that the burden of the coping type of magnetic attachment for #6 was reduced (Fig.10).

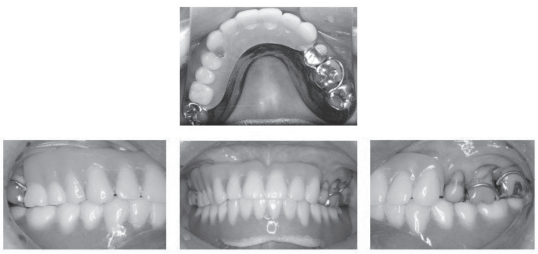

Fig. 7 Intraoral view with definitive prosthesis at 9 years after treatment

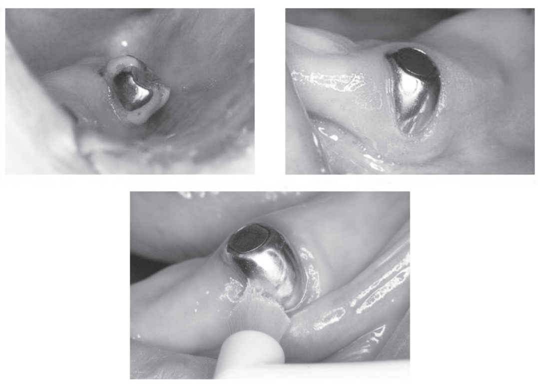

Fig.8 Maintenance

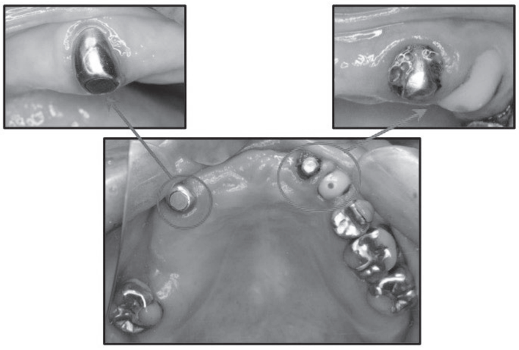

Fig.9 Intraoral view with definitive prosthesis at 8 years after treatment

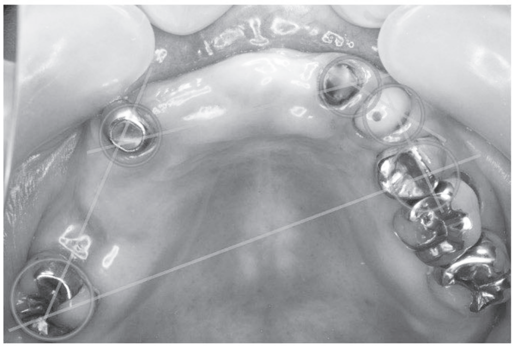

Fig.10 The fulcrum line

Conclusions

A magnetic attachment could be provided as a useful retentive appliance for alleviating patient complaints regarding aesthetics and function. It is difficult to maintain an ideal combination of aesthetics and functionality because the design of a final prosthesis is complex. Therefore, continuous follow-up is necessary with occlusal adjustment and relining of the denture base to prevent any reduction of the OVD.

A clinical case of implant overdenture with magnetic attachment using CAD/CAM technology

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Abstract

【Objective】

In recent years, digital dentistry based on computer-aided design and computer-aided manufacturing (CAD/CAM) has become increasingly popular, and the workflow for the fabrication of removable dentures has changed dramatically. This case was used CAD/CAM technology for maxillary conventional overdenture and mandibular implant overdenture (IOD) with magnetic attachments.

【Method】

CAD/CAM dentures were fabricated using DENTCA system (DENTCA Inc., Mitsui Chemical Inc.). On the initial visit, exclusive plastic trays (DENTCA tray, DENTCA Inc.) were used for making definitive impression, determination of vertical dimension, and recording of the centric relation with gothic-arch tracing. On the second visit, 3D printed try-in dentures were placed in the patient's mouth, occlusion, retention, stability, and esthetics were checked and corrected. On the final visit, CAD/CAM dentures were delivered in the patient's mouth.

【Results, Discussion】

Maxillary conventional overdenture and mandibular IOD with magnetic attachments can be fabricated using CAD/CAM technology **for** high strength and accuracy prosthesis.

Introduction

Computer-aided design and computer-aided manufacturing (CAD/CAM) technology has been applied to removable denture fabrication. CAD/CAM dentures can be fabricated with high precision by reducing because polymerization distortion is eliminated. This case was used CAD/CAM technology for maxillary conventional overdenture and mandibular implant overdenture (IOD) with magnetic attachments.

Patient's characteristics

The patient was a 65-years old female with partially edentulous maxillary jaw including dental root fractures #23 and #26 and fully edentulous mandibular jaw including dental implant fractures #47 (Fig. 1, 2). Maxillary and mandibular acrylic partial denture was worn for five years. Her chief complaints were unstable and difficulties of mastication using existing dentures. There was no significant medical history.

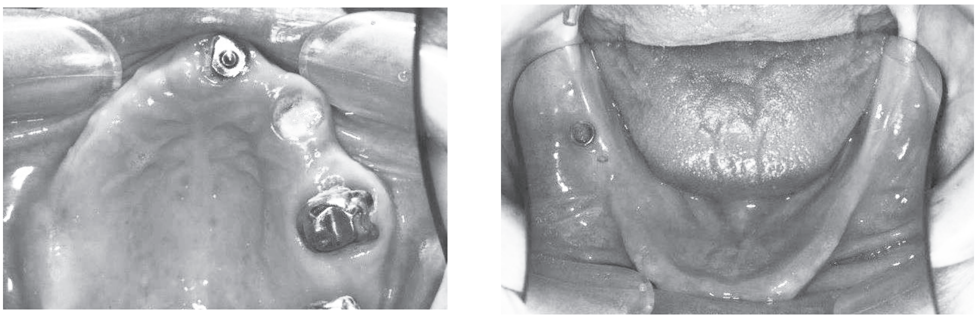


Fig. 1 Intraoral photograph at the first visit

Treatment progresses

2017/ February ・First visits

April ・Extraction of #23, #26 teeth, and remove of #47 implant.

July ・Two implants (Magfit MIP fixture, PLATON, Japan) were placed in the regions of # 33 and # 43

November ・Definitive impressions of both maxilla and mandibular jaws were made and the maxillomandibular relationship was recorded.

・3D printed try-in dentures were placed in the patient's mouth, occlusion, retention, stability, and esthetics were checked.

・CAD/CAM dentures were delivered to the patient's mouth.

・Magnetic attachments (Magfit MIP, PLATON, Japan) were set on the CAD/CAM denture.

Implant placement

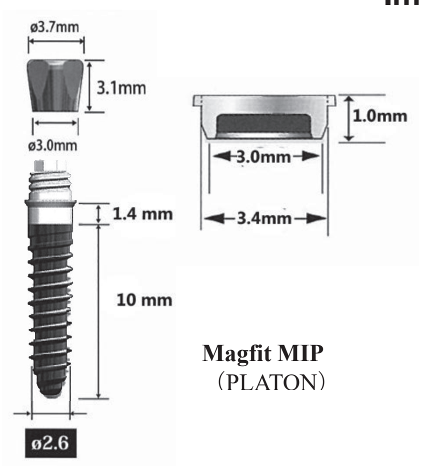


Fig. 2 Shema of Mini implant and magnetic attachment

Mini dental implant has been applied as a convenient treatment option for edentulous patients in cases where standard-sized Implants cannot be placed for economical and/or anatomical reasons

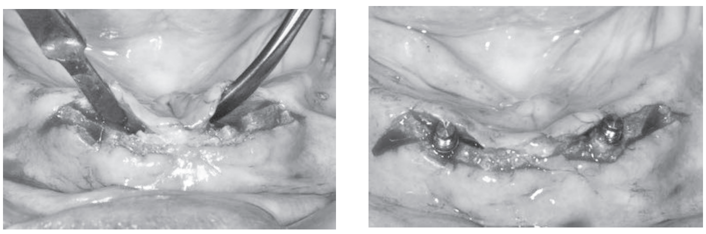
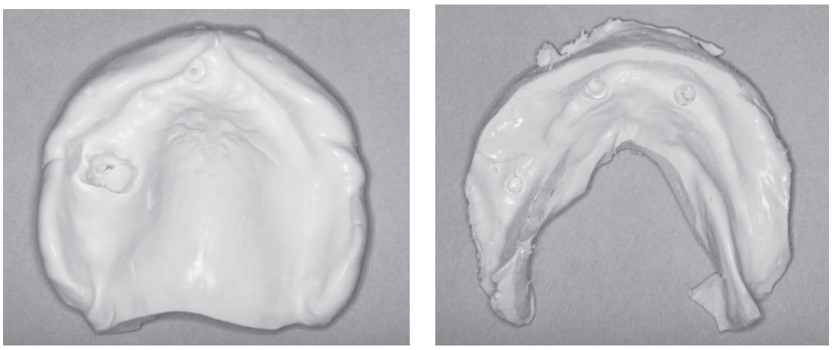


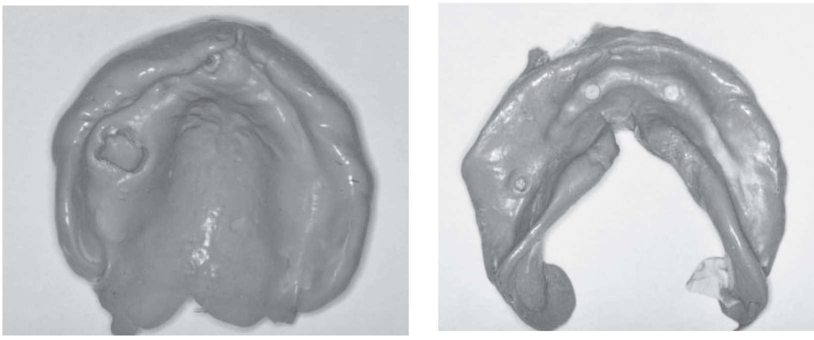
Fig. 3 Two mini implants were placed at canine regions.

Fig. 4 Magnetic attachment keepers (Magfit MIP flat keeper, PLATON) were set on the implants.

CAD/CAM dentures were fabricated using DENTCA system



a: Use hard flow polyvinyl siloxane impression material for first impression



b: Apply medium flow polyvinyl siloxane for wash impression. Seat and border mold to capture anatomical landmarks.

Fig. 5 a,b Definitive impressions of both the maxilla and mandible were made with a double impression technique using polyvinyl siloxane impression materials (Exafine, hard and medium flow types; GC Corp) with custom trays (DENTCA tray, Size M; DENTCA Inc).

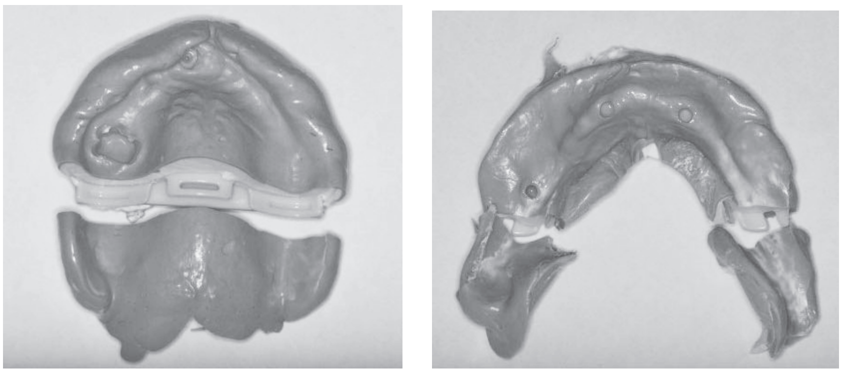


Fig. 6 Both impressions were sectioned and separated anteroposteriorly

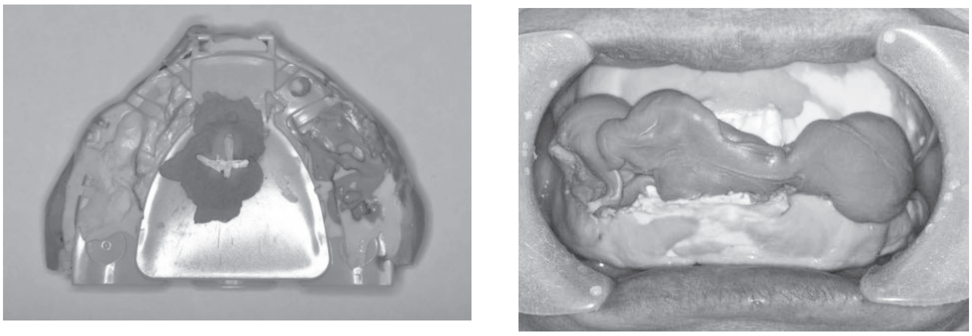


Fig. 7 Gothic arch was traced, and the maxillomandibular relationship was registered using the anterior portions of the impressions.

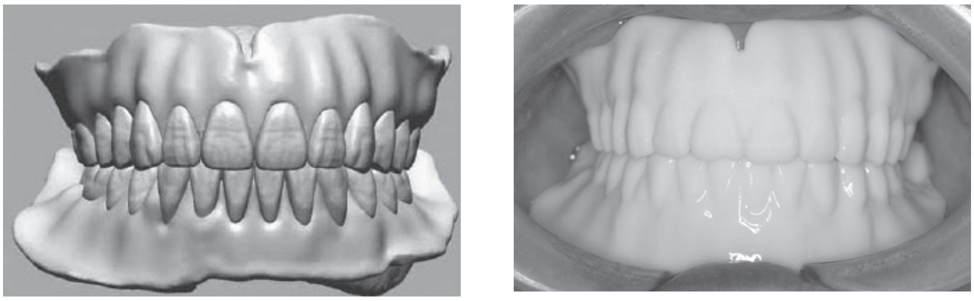


Fig. 8 Virtual teeth were automatically arranged according to average positions of anatomical landmark using a digital design system (PreForm v1.9.1 CAD software; DENTCA Inc). 3D printed try-in dentures were placed in the patient’s mouth, occlusion, retention, stability, and esthetics were checked and corrected.

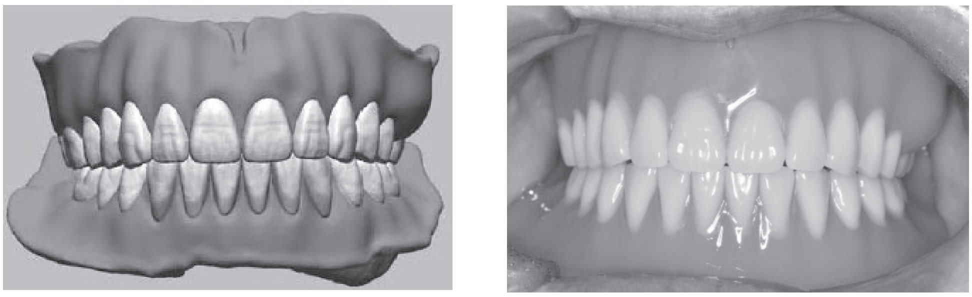


Fig. 9 Maxillary and mandibular complete dentures was milled from acrylic resin block and commercially available denture teeth were bonded with resin adhesive.

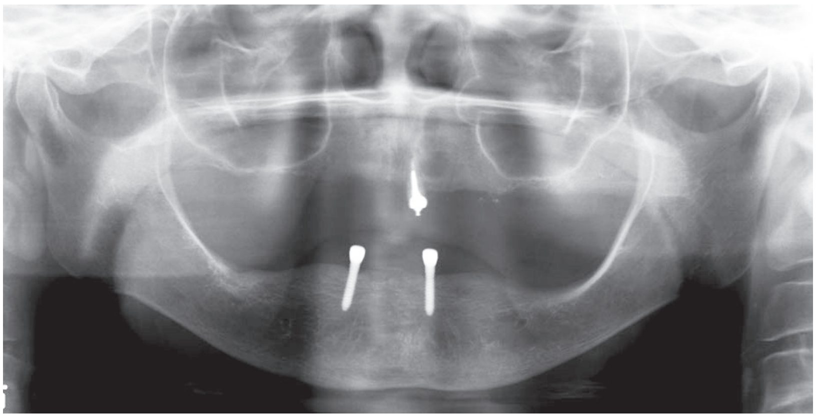


Fig. 10 Panorama radiograph at the postoperative visit

Results and Discussion

Maxillary conventional overdenture and mandibular IOD with magnetic attachments can be fabricated using CAD/CAM technology for high strength and accuracy prosthesis. Sufficient retention and stability could be provided by the magnetic attachments, and satisfactory aesthetic and function could be achieved using the DENTCA system.

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