

日 磁 齒 誌

J J Mag Dent

ISSN 0918-9629

2025

Volume 34. Number 2

JJMD

日本磁気歯科学会雑誌

The Journal of the Japanese Society
of Magnetic Applications in Dentistry

Volume 34, Number 2

The Japanese Society of Magnetic Applications in Dentistry

日本磁気歯科学会

J J Mag Dent vol. 34 No. 2 2025

The Journal of the Japanese Society of Magnetic Applications in Dentistry

Volume 34, Number 2



*Proceedings of the 24th International Conference
on Magnetic Applications in Dentistry*

The Japanese Society of Magnetic Applications in Dentistry

The 24th International Conference on Magnetic Applications in Dentistry

The 24th International Conference on The Japanese Society of Magnetic Applications in Dentistry organized by JSMAD was held on the Internet as follows;

Meeting Dates:

Monday, February 24 to Friday, March 14, 2025

Location:

JSMAD web site

<http://jsmad.jp/international/24/>

General Chair:

Dr. Kazuhiko Okamoto, Meikai University

Subjects:

Researches and developments related to dentistry and magnetism such as:

- Magnetic attachments for dentures
- Orthodontic appliances using magnets
- Measurement of jaw movement using magnetic sensors
- Biological effects of magnetic fields
- Dental applications of MRI
- Others



Conference Committee

The Japanese Society of Magnetic applications in Dentistry

President of the Japanese Society of Magnetic applications in Dentistry

Dr. Jun Takebe, Aichi-Gakuin University

Vice-President of the Japanese Society of Magnetic applications in Dentistry

Dr. Kazuhiko Okamoto, Meikai University

Conference Secretary

Dr. Daikei Matsumoto, Meikai University

Conference Organizing Committee

Dr. Hideki Aita, Health Science University of Hokkaido

Dr. Masatake Akutagawa, The University of Tokushima

Dr. Yuji Honda, Honda Shika Daiichi Shinryoujo

Dr. Yuichi Ishida, The University of Tokushima

Dr. Masayasu Ito, Nihon University

Dr. Tetsuo Ohyama, Nihon University

Dr. Chikahiro Ohkubo, Tsurumi University

Dr. Manabu Kanazawa, Insutitute of Science Tokyo

Dr. Takuya Kobayashi, Iwate Medical University

Dr. Hisashi Koshino, Health Science University of Hokkaido

Dr. Yoshihiro Kotsubo, Kotsubo Dental Clinic

Dr. Hirokazu Kumano, Aichi-Gakuin University

Dr. Kenji Maekawa, Osaka Dental University

Dr. Eri Makihara, Kyusyu Dental University

Dr. Kazuo Nakamura, Sanno Hospital

Dr. Kazuhiro Nagata, Nagaoka Dental Clinic

Dr. Ichiro Ogura, Nippon Dental University

Dr. Kiwamu Sakaguchi, Hokkaido University

Dr. Mineyo Sone, Meikai University

Dr. Yasunori Suzuki, Tsurumi University

Dr. Masatoshi Takahashi, Health Science University of Hokkaido

Dr. Joji Tanaka, Tanaka Dental Clinic

Dr. Fujio Tsuchida, Mami's Dental Office
Dr. Takashi Tsuzuki, Fukuoka Dental College
Dr. Takayuki Ueda, Tokyo Dental University
Dr. Junichiro Wada, Insutitute of Science Tokyo
Dr. Noriyuki Wakabayashi, Insutitute of Science Tokyo
Dr. Megumi Watanabe, The University of Tokushima
Dr. Nobuhiro Yoda, Tohoku University

Conference Arrangements Committee

Dr. Manabu Kanazawa, Insutitute of Science Tokyo
Dr. Masatake Akutagawa, The University of Tokushima
Dr. Shogo Ozawa, Aichi-Gakuin University
Dr. Hisashi Koshino, Health Science University of Hokkaido
Dr. Takuya Kobayashi, Iwate Medical University

Proceeding Committee

Dr. Mineyo Sone, Meikai University
Dr. Hideki Aita, Health Sciences University of Hokkaido
Dr. Masatake Akutagawa, The University of Tokushima
Dr. Hirokazu Kumano, Aichi-gakuin University
Dr. Masatoshi Takahashi, Tohoku University
Dr. Eri Makihara, Kyusyu Dental University
Dr. Kenji Maekawa, Osaka Dental University

Published by the Japanese Society of Magnetic applications in Dentistry

c/o K-Convention Co., Ltd.
Address: 1-24-7-313, Shinjuku Shinjuku-ku, Tokyo, 160-0022, Japan

Copyright (c) 2023 The Japanese Society of Magnetic Applications in Dentistry

All right reserved. No part of this publication may reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher.

B&W: Ryuwa print
223-5, Fukawa, Kawagoe, Saitama 350-0831 JAPAN

The 25th International Conference on Magnetic Applications in Dentistry General Information

General Information

The Japanese Society of Magnetic Applications in Dentistry (President: Jun Takebe, Aichi Gakuin University) is a scientific association founded in 1991 and is devoted to furthering the application of magnetism in dentistry. The 25th International Conference on Magnetic Applications in Dentistry organized by JSMAD will take place on the Internet as follows.

Meeting Dates:

Monday, February 23 to Friday, March 13, 2026

Location:

JSMAD web site:

<http://jsmad.jp/international/25/>

General Chair:

Prof. Takashi Tsuzuki, Fukuoka Dental College

Executive Committee Chair:

Lecturer. Ippei Hamanaka, Fukuoka Dental College

Subjects:

Researches and developments related to dentistry and magnetism such as:

- Magnetic attachments for dentures
- Orthodontic appliances using magnets
- Measurement of jaw movement using magnetic sensors
- Biological effects of magnetic fields
- Dental applications of MRI
- Others

Registration Information

Registration:

Send e-mail titled "Registration for 25th international conference" with your Name, University or Institution, Postal address, Phone, Fax and E-mail address to conference secretariat.

Registration Fees:

No registration fees. Anyone who is interested in magnetic applications in dentistry can participate in the conference via the Internet. Publishing Charge for Proceedings:

After the conference, the proceeding will be published. The publishing charge is 10,000 yen per page. (No charge for invited paper.)

Guidelines for Presentation

Deadlines:

Entry: January 23, 2026

Poster submission: February 9, 2026

Entry:

Send Title and Abstract within 200 words with your Registration.

Paper submission:

Please send papers in Microsoft Word format to the conference secretariat by E-mail. All contents should be written in English. No multi-byte character, such as Japanese Kanji, should be contained. A template file can be obtained from the conference web site. Web presentations for the conference will be produced by the secretariat from the paper. The secretariat will not make any correction of the paper even miss-spelling, grammatical errors etc. Alternative format files are acceptable. Please contact to the secretariat for more detailed information.

Discussion:

Discussions will be done using a bulletin board on JSMAD Web Site via the Internet. The authors should check the board frequently during the meeting dates. If questions or comments on your presentation are posted, please answer them as soon as possible.

Notice to Contributors:

Freely-given informed consent from the subjects or patients must be obtained. Waivers must be obtained for photographs showing persons.

Note:

Copyright of all posters published on the conference will be property of the Japanese Society of Magnetic Applications in Dentistry. Copies of the posters will be made and transferred to JSMAD web site for continuous presentation after the meeting dates. For further information. send e-mail to conference secretariat.

Conference Secretariat

E-mail: jsmad35@fdnet.ac.jp

Contents

Session 1 (The 24th International Conference)

Chair: Kazuhiko OKAMOTO (Meikai University School of Dentistry)

1. A case of functional recovery in a patient with rheumatoid arthritis using magnetic attachment overdentures
Takashi Tsuzuki, Munehisa Maeshiba, Ipppei Hamanaka 1
2. Troubleshooting implant dentures with magnetic attachments
Kichizo Kikuta, Syugi Ji, Yuta Takahashi, Mayu Yamazaki, Shohgo Shibata, Mitsuki Masumoto,
Daisuke Kurihara, Yasunori Suzuki, Chikahiro Ohkubo 4
3. Skill up the magnetic attachment hands-on seminar — Three-year report —
Mayu Yamazaki, Syugi Ji, Yuta Takahashi, Kichizo Kikuta, Shogo Shibata, Mitsuki Masumoto,
Hidemasa Shimpo, Daisuke Kurihara, Yasunori Suzuki, Chikahiro Ohkubo 11

Session 2 (The 24th International Conference)

Chair: Masatake AKUTAGAWA (Tokushima University)

4. Retentive force of experimental nickel-free cup-yoke-type dental magnetic attachments
M. Takahashi, Y. Takada, A. Kikuchi, T. Nezu 16
5. Basic research on the fitting accuracy of titanium root caps manufactured by intraoral scanner
Mineyo SONE, Daikei MATSUMOTO, Yuki TANIUCHI, Kenji AOKI, Mie NUMAZAWA,
Fumiko NARUMI, Natsumi KOYAMA, and Kazuhiko OKAMOTO 22

Session 3 (The 23th International Conference)

Chair: Eri MAKIHARA (Kyushu Dental University)

6. A Case of Single Implant Overdenture with Magnetic Attachment
Mitsuki Masumoto, Yasunori Suzuki, Keisuke Kohri, Ryouji Muto, Chikahiro Ohkubo 26

A case of functional recovery in a patient with rheumatoid arthritis using magnetic attachment overdentures

Takashi Tsuzuki, Munehisa Maeshiba, Ippei Hamanaka

Section of Removable Prosthodontics, Department of Oral Rehabilitation, Fukuoka Dental College

Abstract:

【Introduction】

Magnetic attachment is a type of stud attachment that offer the advantage of easy attachment and detachment without directional restrictions. We report a case in which magnetic attachments were applied to an elderly patient with rheumatoid arthritis and reduced finger dexterity, resulting in a high level of patient satisfaction.

【Case report】

The patient is an 82-year-old woman who visited the clinic with the chief complaint of difficulty eating due to the mobility of her maxillary bridge. The fixed bridge in the maxillary anterior region showed mobility in the abutment teeth, which also caused instability in the clasp denture fitted for the missing molar area. The patient complained of difficulty in putting on and taking off dentures due to rheumatoid arthritis. The anterior bridge was removed, and an overdenture was provided to achieve occlusal balance. Additionally, a magnetic attachment was employed, ensuring strong retention and easy handling.

【Discussion/conclusion】

For patients with rheumatoid arthritis who have difficulty inserting and removing dentures, magnetic attachments have proven to be a treatment method that achieves high patient satisfaction.

I. Introduction

Patients with rheumatoid arthritis or hemorrhagic cerebrovascular disorders often experience reduced manual dexterity, making denture attachment and removal difficult¹⁾. Therefore, careful consideration is required in denture design. Magnetic attachments have no directional constraints during insertion and removal, allowing easy handling even for elderly individuals with diminished manual dexterity²⁾. In this study, we report a case in which the application of magnetic attachments improved the oral health-related quality of life (QOL) in a completely edentulous maxillary patient with rheumatoid arthritis.

II. Case report

1 Patient information

The patient was a 82-year-old woman who visited our clinic with the chief complaint of mobility in her maxillary anterior teeth. She reported that a hard resin veneered splinted crown had been placed

on her maxillary anterior teeth approximately 10 years ago. A clasp denture was in place in the maxillary molar region (Fig. 1-3). In the mandible, an overdenture with magnetic attachments was fitted, using teeth #43 and #33 as abutments.

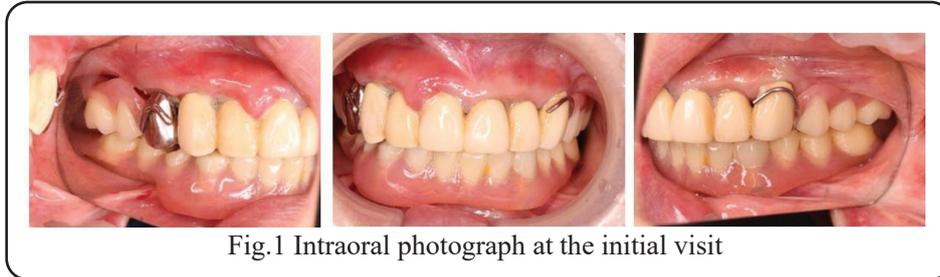


Fig.1 Intraoral photograph at the initial visit

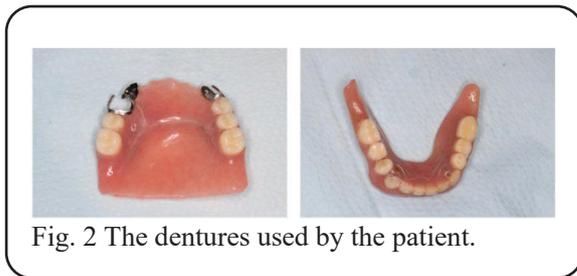


Fig. 2 The dentures used by the patient.

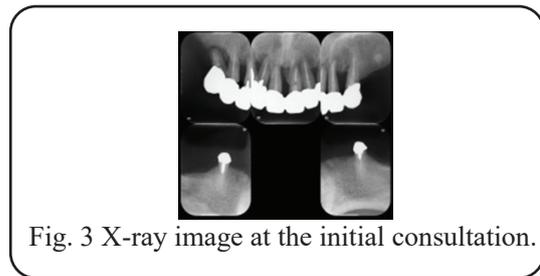


Fig. 3 X-ray image at the initial consultation.

Her medical history included rheumatoid arthritis, which had led to reduced manual dexterity, making it difficult for her to attach and remove her dentures (Fig. 4). The total score for her oral health-related quality of life (QOL) was 32. According to the questionnaire on consumable foods, she was generally able to eat well.

2 Treatment Procedure

In April 2024, teeth 14, 12, 11, and 22 were deemed non-restorable and extracted. Simultaneously, additional artificial teeth were placed. Although magnetic attachments were initially planned for teeth 13 and 23, the prognosis of tooth 23 was uncertain. Therefore, magnetic attachments were placed using teeth 13 and 21 as abutments instead.

Following standard procedures, a denture was fabricated, and in October 2024, a maxillary overdenture was delivered. After a two-week settling period, magnetic components were incorporated into the denture (Fig. 5-6).

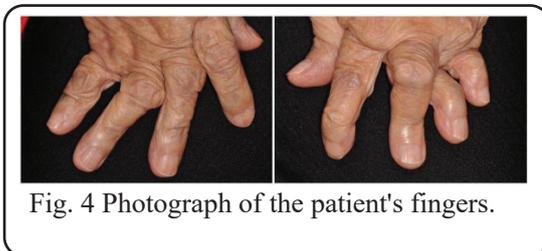


Fig. 4 Photograph of the patient's fingers.



Fig. 5 Definitive denture



Fig. 6 Intraoral view with definitive denture

III. Results

Three months after denture placement, the oral health-related QOL score improved to 15. The patient reported that denture attachment and removal had become easier.

Improvements were observed in all categories of the oral health-related QOL assessment, with particularly notable enhancements in "Physical pain," "Psychological discomfort," "Social disability," and "Handicap."

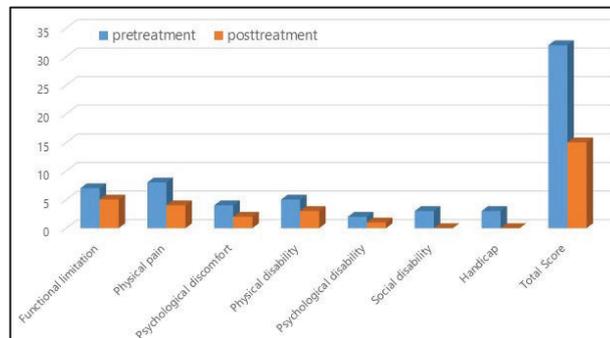


Fig. 7 Result of Oral Health Impact Profile for Edentulous

IV. Discussions/ Conclusions

The questionnaire on consumable foods showed no significant changes. However, in the "Physical disability" category of the oral health-related QOL assessment, the response improved from "occasionally" to "rarely," suggesting a significant improvement in eating-related issues.

Furthermore, the adoption of an overdenture resolved both aesthetic concerns and the difficulty of denture attachment and removal, which likely contributed to maintaining good relationships with those around the patient. This case suggests that using magnetic attachments to address denture attachment and removal difficulties may also have a positive impact on social relationships.

References

- 1) M. Hattori, M. Haraguchi, Semper-Hogg, W, Ralf J. Kohal, Y. Sumita: Prosthodontic rehabilitation on a patient with limited mouth opening related to rheumatoid arthritis: A clinical report, *Int J Maxillofac Prosthetics*, 5(1), 18-21, 2022.
- 2) C. Ohkubo, I. Watanabe, Y. Tanaka, T. Hosoi. Application of cast iron-platinum keeper to a collapsible denture for a patient with constricted oral opening: a clinical report, *J Prosthet Dent*, 90(1):6-9, 2003.

Troubleshooting implant dentures with magnetic attachments

Kichizo Kikuta, Syugi Ji, Yuta Takahashi, Mayu Yamazaki, Shohgo Shibata, Mitsuki Masumoto,
Daisuke Kurihara, Yasunori Suzuki, Chikahiro Ohkubo

Department of Oral Rehabilitation and Prosthodontics, Tsurumi University School of Dental Medicine

Abstract

【Objective】

Two cases of postoperative complications of implant overdenture (IOD) and implant removal partial denture (IRPD) were improved by the use of magnetic attachments.

【Summary of the case】

Case 1: 76-year-old man. After an IRPD was placed in the maxilla at a private dental clinic, the patient came to our clinic with a complaint of dislocation of the artificial tooth; the IRPD had been repaired many times. Increased vertical dimension, new Co-Cr IRPD with magnetic attachments was delivered.

Case 2: 73-year-old man. A maxillary IOD with locator attachments was worn, but he requested remake due to mastication disorder and denture fracture. Existing implants were placed without parallelism, so an IOD with a bar attachment and a magnetic attachment was fabricated.

【Results and Discussion】

In order for IODs and IRPDs to achieve good results for long term period, the characteristics of the attachments must be exactly understood and the IOD should be carefully designed and fabricated.

I. Introduction

Implant over denture (IOD) and implant removal partial denture (IRPD) are highly effective, even with a small number of implants, and have excellent treatment effectiveness. Therefore, their demand in Japan, a super-aged society, is increasing.

II. Objective

Two cases of postoperative complications of IOD and IRPD were greatly improved by changing the implant superstructure design.

Case report

Case1

1 Patient Information

The patient was a 76-year-old man who presented to our university hospital with a chief complaint of broken dentures and difficulty chewing. At the family dental clinic, four implants were placed in the maxilla, and an IRPD was delivered (Fig. 1). At the first consultation, in 2014, the artificial tooth had detached from the IRPD, and the denture base showed evidence of repeated repairs (Figs. 2, 3). There were no special notes on his general history.

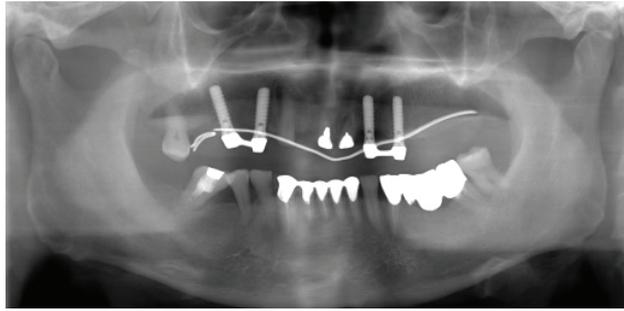


Fig 1. Panoramic radiograph at the first examination



Fig 2. Intraoral views at the first examination



Fig 3. Intraoral photographs without IRPD at the first examination

2 Treatment Procedures

The occlusal vertical dimension of the existing denture was decreased. Therefore, bite raising was first performed using a treatment denture and then an IRPD was fabricated as a definitive denture. For implant attachments, a combination of magnetic and locator attachments was chosen based on comprehensive consideration of the denture space, cleanability, implant placement direction, and retentive force.

- 1) Since the vertical space on the bar attachment was insufficient, the healing abutment (2 mm height) was replaced (Fig. 4). An acrylic denture with a cast clasp on the maxillary right third molar was delivered as the treatment denture, and 3 mm of the vertical dimension was increased (Fig. 5).



Fig 4. The bar attachment was replaced with a healing abutment.



Fig 5. Vertical dimension of 3 mm was increased using a treatment denture.

- 2) Using the treatment denture, no symptoms of occlusal discomfort or disharmony were observed in the remaining teeth or temporomandibular joints. Thus, the increased occlusal vertical dimension was deemed adequate. To fabricate the definitive denture, impressions were made using a custom tray and impression copings, followed by recording the maxillomandibular relationship, and try-in of the wax denture. Additionally, a functional generated path (FGP) was recorded (Fig. 6).



Fig 6. a. Screwed impression copings, b. Wax denture try-in, c. FGP

- 3) For the definitive denture, a Co–Cr alloy framework with a metal backing was designed so the anterior region would enhance the denture's strength and rigidity. The denture base was designed as a horseshoe shape to minimize the foreign body sensation. As for the retainers, an Aker's clasp was designed for #18, and magnetic attachments were placed on #14 and #23. Locator attachments were selected for #15 and #24 (Fig. 7).



Fig 7. Definitive denture

3 Results

After using the new denture (Fig. 8), there was no pain, and the adaptation of the denture base to the mucosa was favorable. Furthermore, fully bilateral balanced occlusion was provided to suppress denture movement and prevent lateral forces. In the occlusal force examination using Dental Prescale (GC, Tokyo), improved masticatory performance was confirmed (Fig. 9).



Fig 8. Intraoral photograph with denture in situ

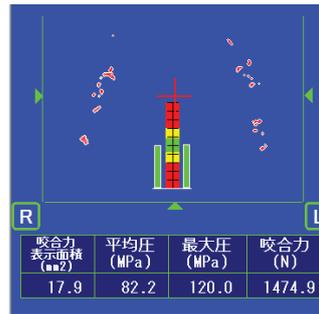


Fig 9. Postoperative Dental Prescale results

Case2

4 Patient Information

The patient was a 73-year-old edentulous man. He had received three implants in the maxilla and two in the mandible at another dental clinic, and IODs were placed (Figs. 10, 11). Subsequently, he experienced ease of removal of the maxillary denture and pain in the mucosa under the mandibular denture. At his first visit, there was evidence of multiple repairs to the maxillary IOD, and the attachment females were detached (Fig. 12). The mandibular denture caused pain in the molar region. His medical history includes a vomiting reflex.

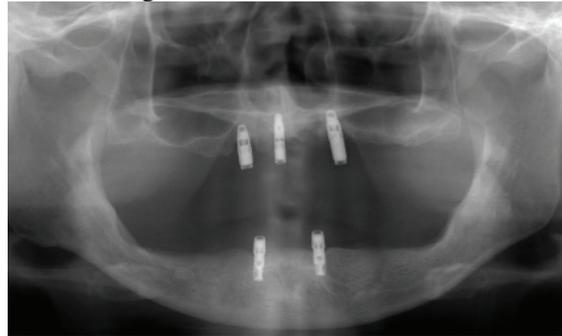


Fig 10. Panoramic radiograph at the first examination



Fig 11. Intraoral views at the first examination



Fig 12. Existing denture with multiple repairs

5 Treatment Procedures

It was determined that the lack of parallelism in the placement of the maxillary implants contributed to the reduced retention of the attachments and dislodgement of the denture. To improve the survival rate of the implants, it was necessary to distribute the load on them. However, the patient declined additional implant placement. Therefore, the implants were connected using a milling bar to reduce the load on each individual implant. On the other hand, a design using both milling bar and attachments would result in insufficient vertical space. Therefore, magnetic attachments were selected on the bar. As both maxillary and mandibular dentures lacked a reinforcing structure directly above the implants, metal-structured dentures with Ti alloy frameworks were fabricated.

- 1) Initially, a metal verification jig was fabricated on the definitive cast to confirm the accurate positional relationship of the implants (Fig. 13). For impression taking, impression copings and a custom tray were prepared, and an impression was taken using a silicone rubber impression. For the maxillomandibular relationship record, the occlusal vertical dimension was increased by 4 mm, and a wax denture was fabricated and tried in.

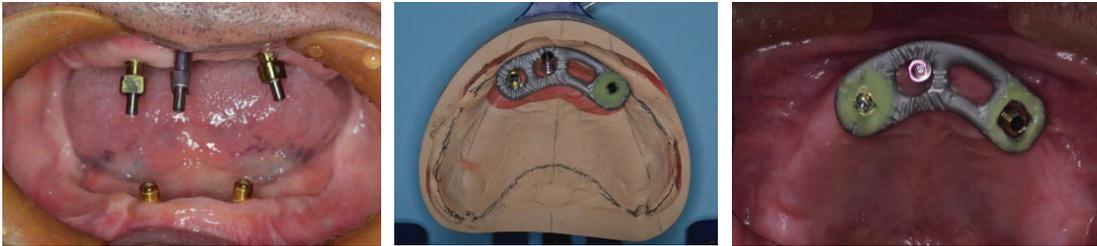


Fig 13. a. Placement of impression copings, b. Verification jig, c. Jig fixed to coping

- 2) Following the wax denture try-in, 3D data of the wax denture and definitive cast were acquired using a laboratory scanner. The bar was designed on CAD software, while the amount of denture space available was confirmed (Fig. 14). Based on the obtained STL data, the bar was milled from a Ti-6Al-4V alloy disk. The incorporation of magnetic attachments into the milling bar achieved both the distribution of occlusal forces and an improvement in retention. Locator attachments were selected for the mandible (Fig. 15).

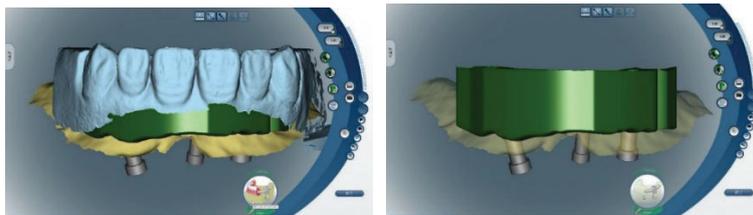


Fig 14. Design of the maxillary milling bar



Fig 15. Intraoral view after milling bar placement

- 3) Following milling bar placement, the framework was fabricated. The cast with the bar attachments was scanned on the lab scanner, and the framework was designed using CAD software. The metal framework was fabricated using additive manufacturing with selective laser melting

(SLM) of Ti-6Al-4V alloy powder using the 3D data (Fig. 16). After the resin pattern for the mandibular framework was fabricated using additive manufacturing, the pattern was cast using a Co-Cr alloy (Fig. 17).

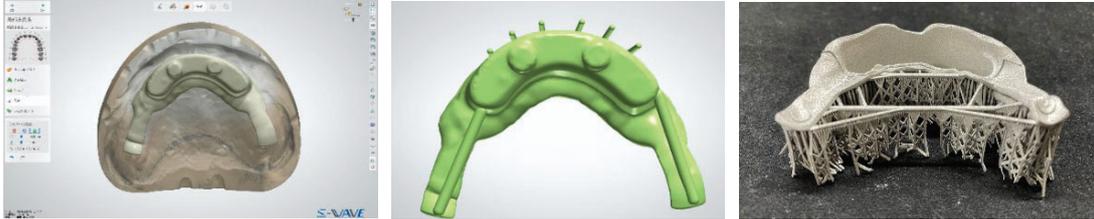


Fig 16. Maxillary framework fabricated using CAD/CAM (additive manufacturing)



Fig 17. Mandibular Co-Cr framework cast by resin pattern using CAD/CAM (additive manufacturing)

- 4) The precise fit between the CAD/CAM-fabricated bar attachments and the framework provided robust support and retention. Furthermore, retention was reinforced with magnet attachments. The posterior border of the maxillary denture was shortened to minimize the vomiting reflex. For the mandible denture, the framework was designed to be covered on the attachments with housings to prevent denture fracture (Fig. 18).

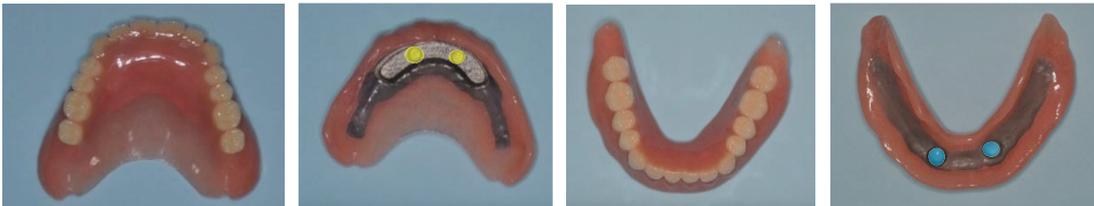


Fig 18. Definitive denture

● : Magnet attachments
● : Locator attachments

6 Results

As compared to the previous dentures, the overjet and overbite relationships were improved, and the esthetic was significantly improved as well. The patient's chief complaints of maxillary denture removal and mandibular denture pain were also resolved. Results of the adaptation and occlusion examinations revealed no areas of discomfort, and excellent adaptation of the denture base to the mucosa was observed (Fig. 19). Dental Prescale examination results showed an approximately five-fold increase in the occlusal contact area and an approximately 6-fold increase in the occlusal force as compared to the existing denture, indicating an improvement in masticatory performance (Fig. 20). Patient satisfaction also improved.

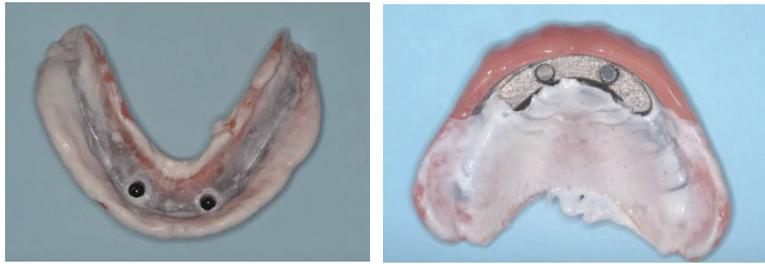


Fig 19. Evaluation of denture fitness using Fit Checker

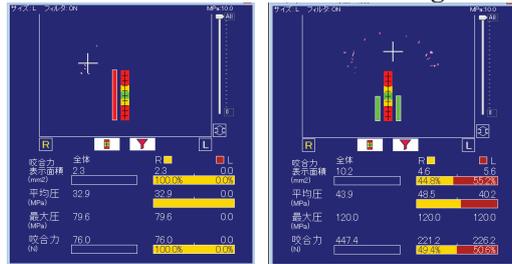


Fig 20. Dental Prescale results (left: preoperative; right: postoperative)



Fig 21. Intraoral view of new maxillary and mandibular IODs

III. Discussions

Maxillary IODs and IRPDs can achieve high treatment effectiveness with a small number of implants. Furthermore, in Japan, which is a super-aging society, the demand for these treatments is expected to increase, as they can adapt to changes even if a patient's independence declines.

However, complications are likely to occur, and additional treatment is required after dentures are delivered. Therefore, although the initial cost of IODs and IRPDs is low, the total treatment cost may be high.

IV. Conclusions

In both cases, no complications—such as implant loss, decreased attachment retention, or denture fracture—have occurred since the delivery of the new dentures. To achieve a favorable long-term prognosis for IODs and IRPDs, it is essential to have a thorough understanding of the characteristics of the attachments and to design highly rigid dentures.

Skill up the magnetic attachment hands-on seminar —Three-year report—

Mayu Yamazaki, Syugi Ji, Yuta Takahashi, Kichizo Kikuta, Shogo Shibata, Mitsuki Masumoto, Hidemasa Shimpo, Daisuke Kurihara, Yasunori Suzuki, Chikahiro Ohkubo
Department of Oral Rehabilitation and Prosthodontics, Tsurumi University School of Dental Medicine

Abstract

【Objective】

For magnetic attachments, it is important to accurately position and fix the magnetic assembly and the keeper. This report provides an overview of a hands-on seminar, titled “How to use the magnetic attachments: laboratory and clinical procedures,” which was held at the 131st through 133rd Annual Meetings of the Japanese Prosthetic Society.

【Methods】

The hands-on seminars consisted of a lecture on the features of magnetic attachments and how to proceed with treatment, and hands-on practice using a jaw model and overdenture replica to fix a magnetic structure to a denture.

【Results and Discussion】

The hands-on seminars received 40 applicants each year and were held six times in total, divided into two sessions of 20 participants each. Problems that occurred during installation each time included detachment of the magnetic assembly from the denture and lack of attractive force. The problems with detachment were thought to be due to the non-use of metal primer or the removal of the denture before the self-curing resin had completely polymerized. Insufficient attractive force may be due to misalignment of the magnetic assembly, such as resin intrusion onto the keeper surface or existing air gap.

Introduction

Unlike conventional mechanical force-application mechanisms, magnetic attachments use attractive force and have many advantages, such as their small size, their simple shape, and their use of a less harmful lateral force. For clinical success with magnetic attachments, accurate positioning of the magnetic assembly on the keeper and its connection are very important, as inadequate attachment causes a gap between the keeper and the contact surface as well as a significant reduction in retentive force. In order to acquire the needed skills, a hands-on seminar, titled “How to use the magnetic attachments: laboratory and clinical procedures,” was held at the 131st through 133rd Annual Meetings of the Japanese Prosthetic Society. In this paper, we report on these seminars.

Objective

In each seminar, a 40-minute lecture on the characteristics of magnetic attachments and how to proceed with treatment, their application, design, treatment procedures, and possible problems was given. After the lecture, 50 minutes was allowed for practice using a simulation model and overdenture replica and for training in the clinical procedure of fixing the magnetic assembly to the denture base using autopolymerized resin.

Lecture

1. Explanation of points to note when placing magnetic attachments

(1) Causes of significant decrease in retention

Failures in the attachment procedures include misalignment of the magnetic assembly, namely, air gaps due to the intrusion of the resin onto the keeper surface or polymerization shrinkage.

As for the misalignment of the magnetic assembly and the keeper, it has been reported that the

attractive force decreased by about 1/3 when an air gap of 0.1 mm was vertically created and by about 2/3 when the magnetic assembly was horizontally displaced by 0.5 mm (Figs. 1, 2).¹⁾

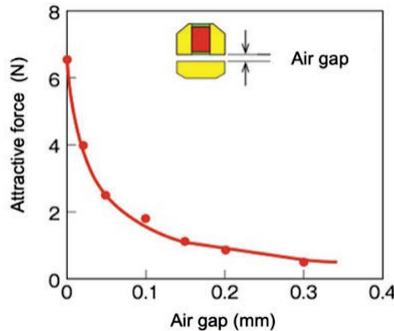


Fig. 1 Effect of vertical gaps between the magnetic assembly and the keeper on attraction force¹⁾

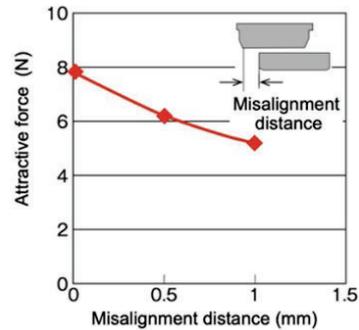


Fig. 2 Effect of horizontal displacement of the magnetic assembly on the keeper on the attractive force¹⁾

(2) Polymerization shrinkage of autopolymerized resins

- (i) As the amount of autopolymerized resin used when fixing the magnetic assembly was increased, the shrinkage of the autopolymerized resins also increased, and the air gap grew.
- (ii) The brush-on technique showed lower polymerization shrinkage and better dimensional accuracy as compared to the mixing technique (Fig. 3).²⁾
- (iii) The brush-on technique can control the amount of resin on the inner surface of the denture base by the placement of a spillway. The results include the prevention of ill-fitting dentures and dentures that are difficult to remove due to resin that has penetrated into the undercut around the keeper coping (Fig. 4).
- (iv) Holding the denture until the resin is polymerized and the timing of denture removal are also important.

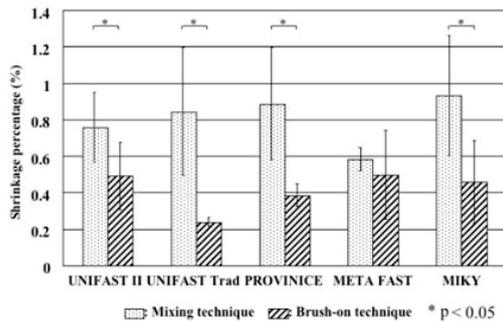


Fig. 3 Polymerization shrinkage of autopolymerized resin using brush-on and mixing techniques²⁾



Fig. 4 Spillway provided to the denture base

(3) Placement of the magnetic assembly. The magnetic assembly should be placed after the denture is settled, considering the minimum shrinkage of the autopolymerized resin.

2. Movie explaining the clinical procedure of magnetic attachments (Fig. 5)



Fig. 5 Clinical procedures for applying the magnetic attachment

Practice

Placement of magnetic attachments (magnetic assembly) (Figs. 6-9)



Fig. 6 Jaw model of a partially edentulous mandible with left and right remaining canines, overdenture replica, and magnetic attachments (Physio Magnet, Kedika Corporation) used in the seminar.



Fig. 7 A space for magnetic attachments was created on the denture. The denture was placed on the jaw model, and a spillway was provided.



Fig. 8 After applying Vaseline to the keeper coping and the residual ridge, the magnetic assembly was placed on the keeper. Using the brush-on technique, the magnetic assembly was fixed with autopolymerized resin using light pressure.



Fig. 9 After the resin was polymerized, the denture was removed and polished

Results

The hands-on seminars received 40 applicants each year and were held six times in total, divided into two sessions of 20 participants each.

The breakdown for the three years from the 131st through the 133rd Annual Meeting was 99 participants with university affiliations and 21 with non-university affiliations, with 33 participants with university affiliations and 7 with non-university affiliations at each session (Figs. 10, 11).

Difficulties such as the detachment of the magnetic assembly and lack of attractive force were observed during the fixing procedures. Questionnaire results from participants were provided by the Japanese Society of Prosthetic Dentistry only for the 131st Congress, but results for the 132nd and 133rd Congresses were not available. Participants' years of experience at the 131st meeting are shown in Fig. 12. In addition, evaluations of the seminar by the participants showed that many of them answered that they were satisfied with the seminar. The results of the post-seminar questionnaire are shown in Fig. 13.

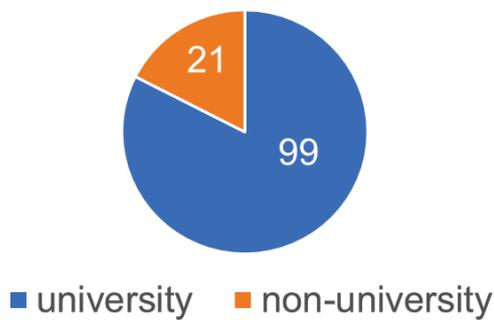


Fig.10 Workplaces of participants (3 years)

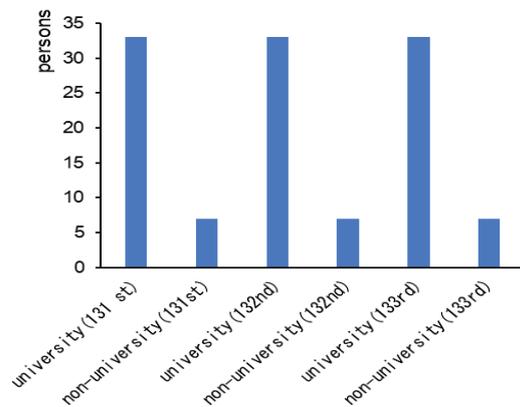


Fig.11 Workplaces of participants (each year)

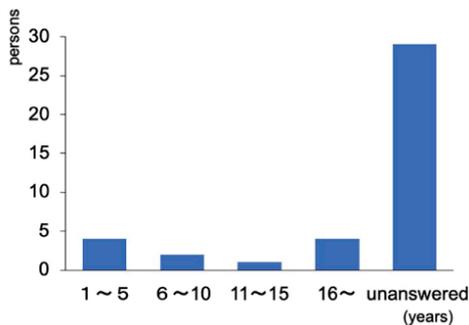


Fig.12 Participants' years of experience

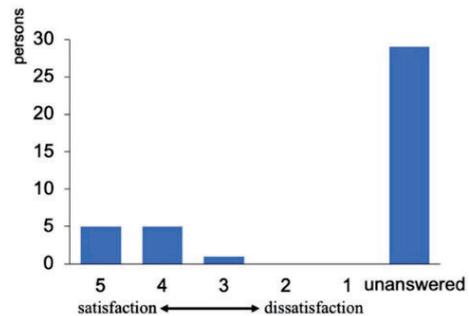


Fig.13 Evaluations of the seminar

Discussion

The past three seminars have been held with a fee, but each seminar has been well attended.

The detachment of magnetic structures from dentures was considered to be caused by the non-use of a metallic adhesive primer or the removal of dentures before room temperature curing of the resin.

Therefore, metal adhesive primer was actively used in the 132nd seminar.

Insufficient pull force of the magnetic attachment was considered to be due to misalignment of the magnetic structure, such as an air gap caused by resin intrusion into the suction surface or polymerization shrinkage. As for the lack of retentive force, we changed the size of the keeper and magnetic assembly from 3.5 mm to 5.0 mm in diameter at the 133rd Annual Meeting; however, the

same lack of retentive force was observed as in the previous two meetings, so it is considered necessary to review the attachment clinical procedures in the future.

Conclusions

In order to promote appropriate clinical techniques for magnetic attachment treatment, which is now covered by insurance, we held a hands-on seminar, titled “How to use the magnetic attachments: laboratory and clinical procedures,” at the 131st through 133rd Annual Meetings of the Japanese Prosthetic Society. Although most participants were satisfied, some problems were identified, such as the detachment of magnet assemblies and insufficient retention. In the future, we would like to investigate the causes of these problems and improve the lectures and practical training.

References

- 1) Ai M, Shiao YY. New magnetic applications in clinical dentistry. Quintessence Publishing Company, Tokyo, 2004, 28–50.
- 2) Hanatani S, Shibuya N, Muraishi E, et al. Dimensional accuracy of autopolymerized resin applied using the brush-on technique. *Int Chin J Dent.* 2009; 9 (1): 9–13.

Acknowledgments

We would like to thank the Morita Corporation, the Kedika Corporation, and the Kikutani Corporation for their support of this seminar, as well as the teaching staff in our department for their cooperation in organizing the seminar.

Retentive force of experimental nickel-free cup-yoke-type dental magnetic attachments

M. Takahashi¹, Y. Takada², A. Kikuchi², T. Nezu¹

¹Division of Biomaterials and Bioengineering, Health Sciences University of Hokkaido, JAPAN

²KEDC Co., Ltd., JAPAN

Abstract

Closed magnetic circuit dental magnetic attachments typically use non-magnetic stainless steel containing nickel as shield rings or spacers to form the magnetic circuit. However, nickel can cause metal allergies, prompting the demand for nickel-free products. This study aimed to develop an experimental nickel-free magnetic attachment and evaluate its retentive force. Chromium, an antiferromagnetic material that is not magnetically attracted to magnets, was plated onto the disk yoke to serve as the shield ring. The disk yoke and cup yoke were laser-welded together, including the chromium plating, to fabricate the experimental magnetic attachment. Retentive force was measured according to ISO 13017 test procedures, including tests with the keeper laterally displaced. Hardness across the mating surface, from edge to center, was also measured. Results were compared to those of a same-sized commercial magnetic attachment, the Physio Magnet 4813. The experimental attachment demonstrated equivalent retentive force to the conventional product. Its behavior during lateral displacement was also similar. The hardness values indicated that the chromium concentration in the shield ring was higher than that of conventional products, suggesting superior corrosion resistance. Thick chromium plating was confirmed to function effectively as a shield ring, enabling the successful development of a nickel-free dental magnetic attachment.

Introduction

Japanese dental magnetic attachments adopt a closed magnetic circuit design. As a result, they exhibit high retentive force even in a compact size compared to open magnetic circuit attachments (i.e., general permanent magnets)¹. To form a closed magnetic circuit, the magnetic assembly consists of both magnetic and non-magnetic stainless steels. The magnetic stainless steel serves as a yoke to facilitate the smooth flow of magnetic flux, while the non-magnetic stainless steel is used for shielding rings (cup-yoke type) or spacers (sandwich type) to magnetically insulate the flux¹. Austenitic stainless steel, such as SUS 316L (Fe-18%Cr-12%Ni-2%Mo), which contains a small amount of nickel, is typically used as the non-magnetic stainless steel^{1,2}. SUS 316L, also known as surgical stainless steel, has high biocompatibility and is widely used in medical implants. To date, there have been no reported cases of metal allergies caused by dental magnetic attachments. However, nickel is classified as a harmful element according to ISO standard and JIS^{3,4}, highlighting the demand for developing magnetic assemblies that do not contain nickel. Some overseas dental magnetic attachments employ a simple open magnetic circuit structure, where permanent magnets are merely covered with stainless steel or titanium^{5,6}. These products are nickel-free and may appear to be safer and more advantageous at first glance. However, open magnetic circuits suffer from significant magnetic field leakage and exhibit lower retentive force relative to their size^{1,5,6}. To address concerns about Japanese dental magnetic attachments while maintaining their superior performance, we have been working on the development of a nickel-free, closed magnetic circuit dental attachment.

In cup-yoke-type magnetic attachments, non-magnetic stainless steel is used as a shielding ring to block magnetic flux. In our previous research, we explored the use of nitrogen-stabilized austenite phase (γ -phase), which forms when nitrogen is dissolved into the ferrite phase (α -phase) of magnetic stainless steel, as a magnetic shielding material⁷. As a result, it was found that by performing heat treatment to dissolve nitrogen into the disk yoke as a solid solution, a shielding ring integrated with the disk yoke could be formed. This method had advantages such as the ability to control the thickness of the γ -phase by adjusting the heat treatment time and the elimination of the need for the cladding process in the manufacturing of the shield disk, which consists of the disk yoke and the shield ring. A prototype was subsequently fabricated, and its retentive force was found to be comparable to that of conventional products⁸. However, due to poor yield caused by insufficient corrosion resistance, commercialization of this method was ultimately postponed.

Therefore, we considered using titanium or gold, both of which are metal elements traditionally utilized in dentistry, as magnetic shielding materials and evaluated their laser weldability with the magnetic stainless steel used for the yoke^{9,10}. The results revealed that titanium readily forms intermetallic compounds when

alloyed with iron, leading to brittle weld beads and poor practicality. On the other hand, gold demonstrated strong weldability with stainless steel, making it a promising candidate. However, gold is an expensive material, and its recovery during cutting and polishing is challenging, resulting in high costs that pose a significant barrier to commercialization.

As a new magnetic shielding material, we focused on chromium, which exhibits antiferromagnetic properties. According to the equilibrium phase diagram of Fe-Cr system¹¹⁾, although the brittle σ -phase may form under certain conditions, iron and chromium are largely mutually soluble in all proportions. Since chromium is already a component of magnetic stainless steel, it appears to be a compatible material.

Objective

In this study, we applied chromium plating technology to fabricate a nickel-free magnetic assembly and evaluated its retentive force characteristics.

Materials and Methods

1. Dental magnetic attachment

This study focuses on a circular cup-yoke-type magnetic attachment. A thick layer of chromium was electroplated onto the disk yoke to serve as a shielding ring. The disk yoke was then incorporated into the magnetic assembly and laser-welded to the cup yoke. The mating face was polished and magnetized in the same manner as commercial products, and a nickel-free magnetic assembly ($\phi 4.8 \times 1.3$ mm) was fabricated. The prototype magnetic assembly was paired with a commercially available keeper of the same diameter ($\phi 4.8 \times 0.8$ mm) for experimentation. Additionally, a commercially available magnetic attachment of the same size (Physiomagnet 4813, Morita) was used as a comparison.

2. Retentive force measurement

A digital force gauge (ZPS, Imada) was connected to a retentive force measurement device compliant with ISO 13017:2020³⁾. Following the test method outlined in ISO 13017, the crosshead speed was set to 2 mm/min, and the retentive force of each magnetic attachment combination was recorded at a sampling rate of 1 kHz ($n = 5$). Applying the known time and speed values, distance was calculated then a retentive force curve generated. Retentive force was measured both when the mating faces were in precise contact and when the keeper was laterally displaced from the precisely contacted position. The measurement was repeated at 100 μm intervals until the keeper detached from the magnetic assembly.

3. Hardness test

A micro-Vickers hardness tester (HM-221, Mitutoyo) was used under a load of 1.961 N (200 gf) with a dwell time of 15 s ($n = 3$). Hardness was measured at 100 μm intervals from the edge to the center of the mating surface of the magnetic assembly. The hardness of the keeper's mating surface was also measured.

4. EDS analysis of chromium concentration in the welded region

The welded region on the mating face of the prototype was observed using an SEM equipped with EDS (SU5000 + EDAX Pegasus EDS/EBSP, Hitachi High-Tech Corp.). The chromium concentration in the welded region was semi-quantitatively analyzed by line analysis.

5. Statistical analysis

Statistical analysis was performed using ANOVA and Tukey's HSD test ($\alpha = 0.05$) to determine significant differences.

Results

1. Retentive force

The average retentive force of the prototype magnetic attachment was 9.13 N (± 0.31 N), and no significant difference was observed compared to the conventional product ($p > 0.05$). Additionally, the maximum retentive force for both was the same at 9.67 N. An example of the retentive force curves for these magnetic attachments is shown in Fig. 1. The point where the mating faces separated was defined as 0 mm. The retentive force curves for both the prototype and the conventional product were similar, with a rapid decrease in retentive force observed as the mating faces separated.

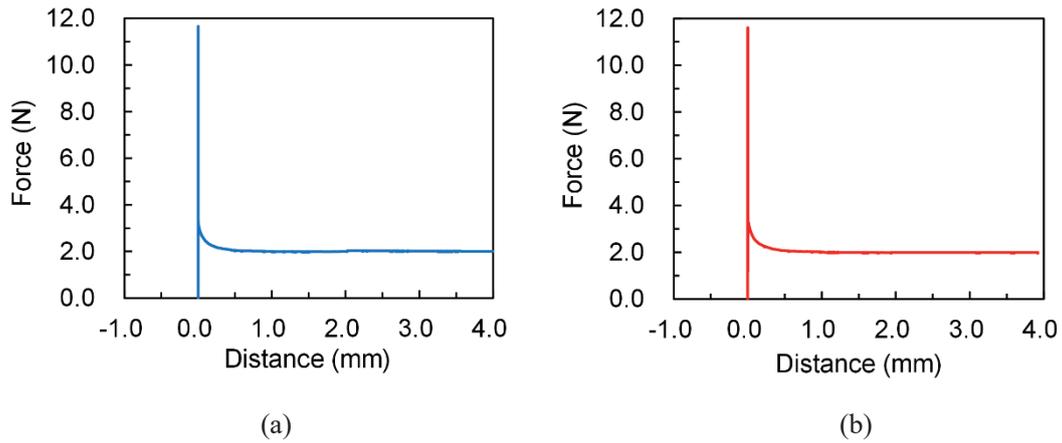


Fig. 1 Retentive force curve. (a) prototype, (b) conventional product

Retentive forces at lateral displacement of the keeper are shown in Fig. 2. As the lateral displacement increased, the retentive force gradually decreased, exhibiting several inflection points. When the displacement was small, the retentive force dropped sharply, and once the displacement exceeded 1 mm, the decrease became more gradual with a convex shape. When the displacement exceeded 4 mm, the decrease continued more gently with a concave shape. This behavior was observed for both types of magnetic attachments.

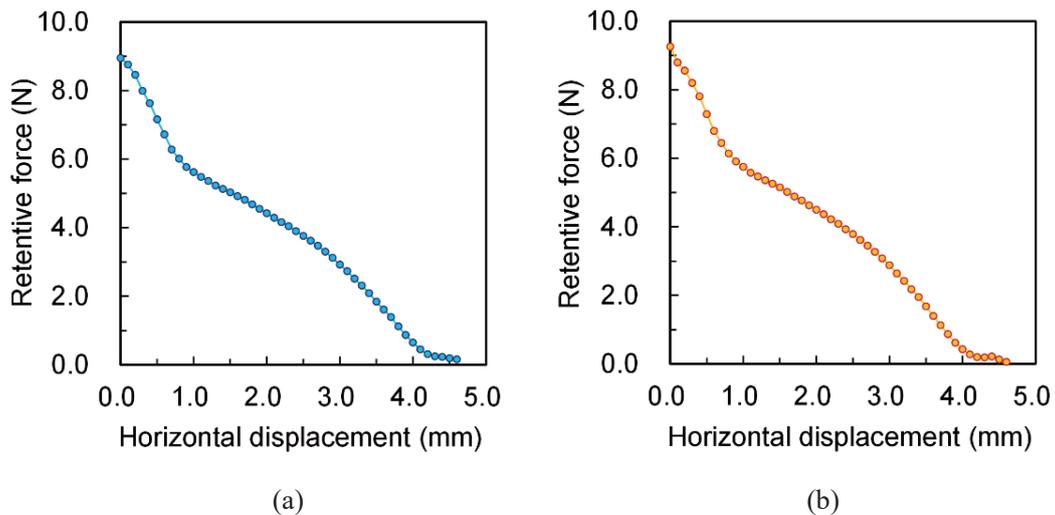


Fig.2 Retentive force against horizontal displacement (a) prototype, (b) conventional product

2. Hardness

Figure 3 presents representative hardness test results for the mating surfaces of magnetic assemblies. The diameter of the mating face is 4.8 mm, so the center of the mating face is at 2.4 mm from the edge. The hardness of the yoke area in the prototype was 220–230 HV, which was similar to that of the conventional product ($p > 0.05$). Additionally, the hardness of the keeper was 247.6 (± 4.8) HV, which was higher than that of the yoke ($p < 0.05$). For both magnetic assemblies, the hardness was significantly higher ($p < 0.05$) in a range of about 400 μm , between 0.3 mm and less than 0.8 mm from the edge, compared to the yoke area. The prototype had a hardness of approximately 400 HV, while the conventional product had approximately 350 HV.

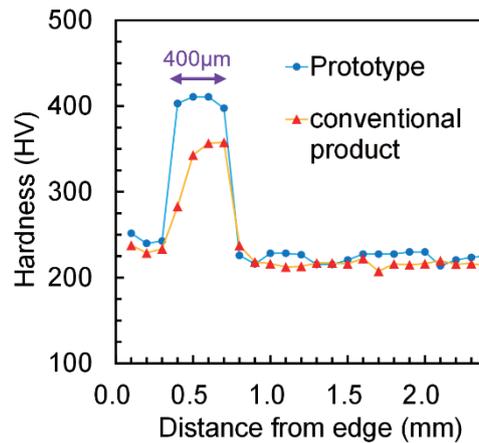


Fig. 3 Hardness profile of the mating face of magnetic assembly

A photograph of the prototype magnetic assembly's mating surface with the hardness profile results is shown in Fig. 4. By adjusting the angle of light when taking the photograph, the welded shielding ring and yoke parts can be clearly identified by the naked eye, as shown in this figure. As indicated in the figure, the areas with increased hardness corresponded to the welded sections.

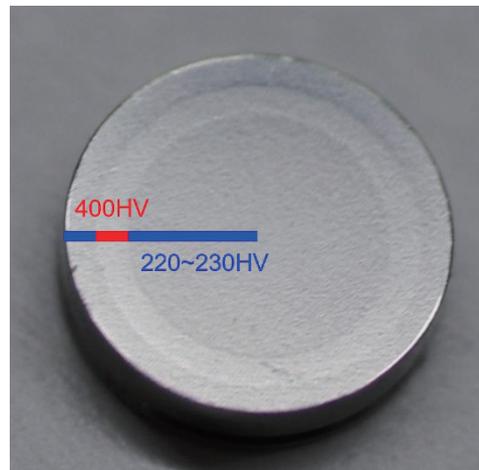


Fig. 4 Mating face view of magnetic assembly and its hardness

3. Chromium concentration in the welded region

The chromium concentration in the welded region of the prototype ranged from 55% to 60%. No precipitates or extreme concentration variations were observed in the welded region.

Discussion

1. Retentive force characteristics of the prototype nickel-free magnetic attachment

The retentive force of the prototype magnetic attachment was comparable to that of the conventional product of the same size in terms of both average and maximum values. According to ISO standard and JIS^{3,4}, to avoid misleading representations, the measured retentive force must be at least 85% of the value stated in the product documentation. The catalog-listed retentive force for the conventional product is 9.6 N. Since 85% of this value is 8.16 N, the measured values of the prototype sufficiently exceed this threshold. Therefore, when marketing this prototype as a dental magnetic attachment, it would be permissible to indicate a retentive force of 9.6 N. The retentive force curves of these magnetic attachments were also identical, and the force rapidly decreased upon detachment of the mating faces. This behavior is characteristic of closed magnetic circuit attachments and indicates minimal magnetic field leakage. In contrast, open magnetic circuit attachments exhibit greater magnetic field leakage, allowing the magnetic force to extend farther, resulting in a more gradual decrease in retentive force after the mating faces separate.

The behavior of retentive force when the keeper was laterally displaced was also the same for both the prototype and the conventional product. Fundamentally, lateral displacement reduces the contact area of the mating face, leading to a decrease in retentive force. In the case of a cup-yoke-type structure, this behavior is accompanied by changes in the contact area related to the closed magnetic circuit, where the cup yoke's contact area with the keeper is primary and the disk yoke's contact area is secondary¹²). In other words, the identical behavior of retentive force during lateral displacement indicates that the magnetic circuit functions equivalently in both magnetic attachments of the cup-yoke type.

These results demonstrate that the prototype nickel-free magnetic attachment possesses the same retentive force characteristics as the conventional product. The cup-yoke, disk-yoke, and permanent magnet components are identical to those used in the conventional product. The key difference is that the conventional product employs SUS 316L for the shielding ring, whereas the prototype utilizes chromium. The thick chromium layer, applied through electroplating, functioned effectively as a shielding ring, and its retentive force characteristics were confirmed to be equivalent to those of the conventional product.

In conventional manufacturing of magnetic assemblies, a cladding process is required to bond non-magnetic stainless steel to magnetic stainless steel. This study has demonstrated that applying thick electroplating can serve as an alternative to this process. The thickness of the plated layer can be controlled through current and time adjustments, allowing for either thinning or thickening of the shielding ring. Adjusting the thickness of the shielding ring could potentially contribute to optimizing the magnetic circuit.

2. Characteristics of the shielding ring using chromium plating

The hardness of the yoke in the prototype was the same as that in the conventional product. As mentioned earlier, this is because the prototype's yoke was made from the same material as the conventional product. The keeper was slightly harder than the yoke. Both the yoke and keeper were made from SUS XM27-equivalent material (Fe-26%Cr-1%Mo), a magnetic alloy. According to JIS²), the hardness of SUS XM27 in the annealed state is specified as 200 HV or lower. The slightly higher measured hardness is presumed to result from work hardening due to polishing and barrel processing. If there were a significant difference in hardness between the yoke and the keeper, the softer material would experience excessive wear during use. The moderate difference observed in this study is considered desirable.

In both magnetic assemblies, the hardness of the welded shield ring area was greater than that of the yoke. The hardened area was approximately 400 μm wide, corresponding to the weld width. While JIS defines the hardness of hard chromium plating as 750 HV or higher¹³), creating the impression that it is extremely hard, the hardness of metallurgically produced metallic chromium typically ranges from 200 to 350 HV¹⁴). On the other hand, the welded region in this study was not pure chromium, but rather an Fe-Cr alloy formed by the alloying of the plated chromium and the iron from the yoke. The chromium concentration in the welded region was 55–60%, and its hardness value (approximately 400 HV) was generally consistent with the hardness of binary Fe-Cr alloys with the same concentration reported in previous studies¹⁵). Chromium is well known for enhancing the corrosion resistance of iron through passivation, as seen in stainless steel. The higher chromium concentration in the shield ring of the prototype compared to the SUS 316L (Fe-18%Cr-12%Ni-2%Mo) used in the conventional product suggests that the prototype may exhibit superior corrosion resistance.

Conclusion

A thick chromium plating functioned effectively as a shield ring. The retentive force characteristics of the prototype were equivalent to those of the conventional product. The development of a nickel-free dental magnetic attachment was successfully achieved.

References

1. Y. Tanaka, *New dental magnetic attachment*, pp 26-57, Ishiyaku Publishers, Inc, Tokyo, 2016.
2. ISO 16143-2:2014. *Stainless steels for general purposes — Part 2: Corrosion-resistant semi-finished products, bars, rods and sections.*
3. ISO 13017:2020. *Dentistry—Magnetic attachments.*
4. JIS T6543:2017. *Dentistry—Magnetic attachments.*
5. Y. Takada, M. Takahashi, Y. Kinouchi, Y. Nakamura, Y. Tanaka, H. Sato, A. Izumida and T. Tenkumo: *Materials and internal structures of foreign-made dental magnetic attachments*, *J J Mag Dent*, 22(1), 96-102, 2013.

6. J. Tanaka, H. Mizutani, Y. Furuichi, K. Sasaya, H. Wakai, T. Mizuguchi, S. Sakuma and K. Hoshino: Comparison of the basic performance of magnetic attachments fabricated within and outside of Japan, *J Jpn Soc Oral Implant*, 31(1), 56-63, 2018.
7. Y. Takada, H. Yamaguchi, H. Sakatsume, K. Sato, K. Sasazaki, A. Kikuchi and M. Takahashi: Development of a magnetic shielding ring that consists of solid-solution containing nitrogen in stainless steel to take the first step toward nickel-free magnetic attachments, *J J Mag Dent*, 24(1), 62-67, 2015.
8. Y. Takada, M. Takahashi, G. Togawa, H. Sakatsume: Development of closed magnetic circuit attachment using nitrogen solid-solution in stainless steel, *Proceedings of the 31st Annual Conference of the Japanese Society of Magnetic Applications in Dentistry*, P331-N, 2021.
9. Y. Takada, J. Shioto, M. Kikuchi and M. Takahashi: Weldability between the nickel-free shield-ring materials and the magnetic stainless steels by laser beam, *J J Dent Mater* 30(5), 325, 2011.
10. Y. Takada, M. Takahashi, A. Kikuchi, H. Sato, A. Izumida, Y. Nakamura, Y. Tanaka, and T. Tenkumo: Laser welding between titanium as a magnetic shielding material and SUS 447J1 stainless steel, *J J Mag Dent*, 22(1), 90-95, 2013.
11. ASM International Alloy Phase Diagram and Handbook Committee. *ASM Handbook Vol. 3 Alloy Phase Diagrams: Section 2, Binary Alloy Phase Diagrams*. Materials Park: ASM Int; 1992, 152.
12. M. Takahashi, H. Sakatsume, M. Kanyi and Y. Takada: Effect of horizontally shifting the center of the magnetic assembly and that of the keeper on the retentive force of cup-yoke dental magnetic attachments, *J J Mag Dent*, 26(2), 8-14, 2017.
13. JIS H8615:1999. Electroplated coatings of chromium for engineering purposes.
14. OTEC.Co.,LTD. Plating information, Hard chrome plating. <<https://www.otec-kk.co.jp/hard-chrome-plating/plating-information/>> [accessed 25.0130]
15. N. Matsui, K. Matsui, K. Kobayashi, A. Sugiyama and K. Ozaki: Effects of Cr content on mechanical properties of Fe-Cr alloy, *J Jpn Soc Powder Powder Metallurgy*, 46(11), 1179-1184, 1999.

Basic research on the fitting accuracy of titanium root caps manufactured by intraoral scanner

Mineyo SONE, Daikei MATSUMOTO, Yuki TANIUCHI, Kenji AOKI, Mie NUMAZAWA, Fumiko NARUMI, Natsumi KOYAMA, and Kazuhiko OKAMOTO

Division of Removable Prosthodontics, Department of Restorative and Biomaterials Sciences, Meikai University School of Dentistry

Abstract

In this study, we report on the accuracy of matching titanium root copings fabricated using an intraoral scanner.

The abutment tooth was a preformed epoxy artificial tooth (A50-359, NISSIN). The manufacturing procedure involved scanning an epoxy artificial tooth using an intraoral scanner (i700, Medit), modeling it using design software (Dental System, 3Shape), and then cutting it with a milling machine (GeoMill ARUM 5X-200, GeoMedi). Five specimens were tested, and the fitting accuracy of the titanium root coping was evaluated using the cement replica method.

The measurement points are the labial margin at point a, the labial cervix at point b, the labial post at point c, the tip of the post at point d, the lingual post at point e, the lingual cervix at point f, and the lingual margin at point g. The average gaps were $92.6 \pm 17.0 \mu\text{m}$ at point a, $77.8 \pm 25.0 \mu\text{m}$ at point b, $66.7 \pm 21.6 \mu\text{m}$ at point c, $95.6 \pm 42.5 \mu\text{m}$ at point d, $63.7 \pm 9.9 \mu\text{m}$ at point e, $70.4 \pm 33.1 \mu\text{m}$ at point f, and $57.8 \pm 22.2 \mu\text{m}$ at point g.

It was suggested that the titanium root coping manufactured using an intraoral scanner could be applied clinically.

Introduction

Recent advances in dental CAD/CAM systems have been remarkable, and they are expected to simplify the workflow and improve the fitness of prostheses. At the 33rd Annual Meeting, we examined the accuracy of the fitness of titanium root copings made by scanning with a technical scanner. In this study, we examined the accuracy of the conformity of the root coping fabricated using an intraoral scanner for digitalization.

Materials and Methods

The abutment was an epoxy artificial tooth (A50-359, NISSIN) with a post part 5 mm deep, as recommended by JSMD. As for the manufacturing procedure, an epoxy artificial tooth was scanned directly with an intraoral scanner (i700, Medit), and it was then scanned using design software (Dental System, 3Shape). After modeling, we cut out a titanium disk (DentalBank) using a milling machine (GeoMill ARUM 5X, GeoMedi) (Figs. 1 and 2). The cement space was the specified value of the software, and there were five test samples (Fig. 3).

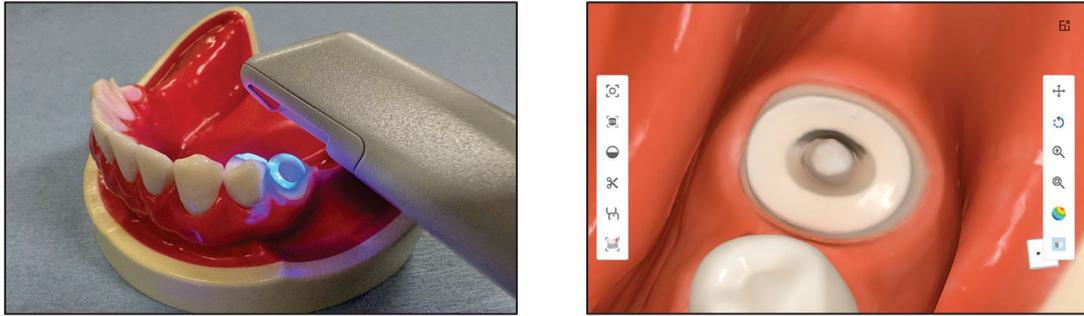


Fig. 1 Scanning the epoxy artificial tooth

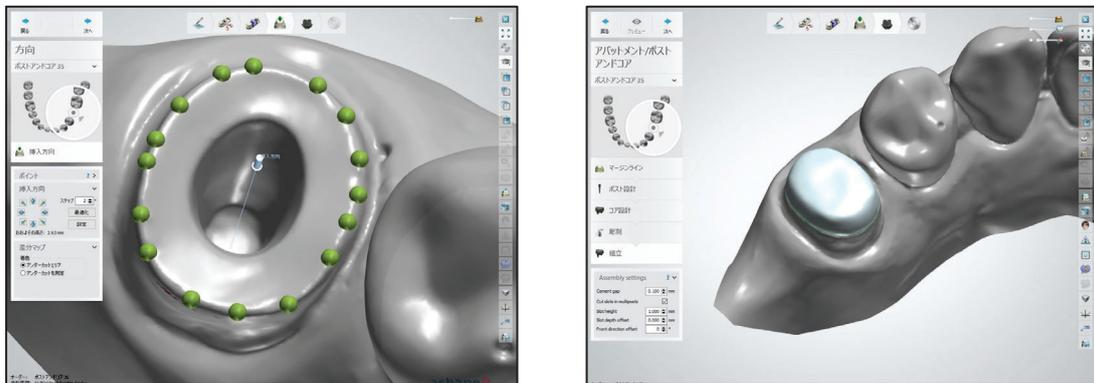


Fig. 2 Scanned model and designed root coping

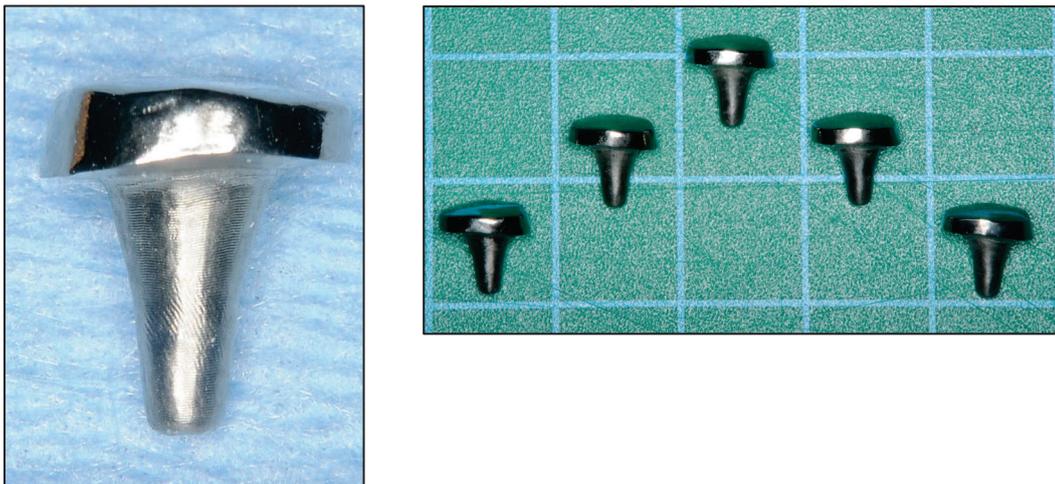


Fig. 3 Fabricated titanium root coping

The fitting accuracy was evaluated using the cement replica method, which quantifies the gap between the model and the root coping based on the thickness of the silicone rubber coating (Fig. 4).

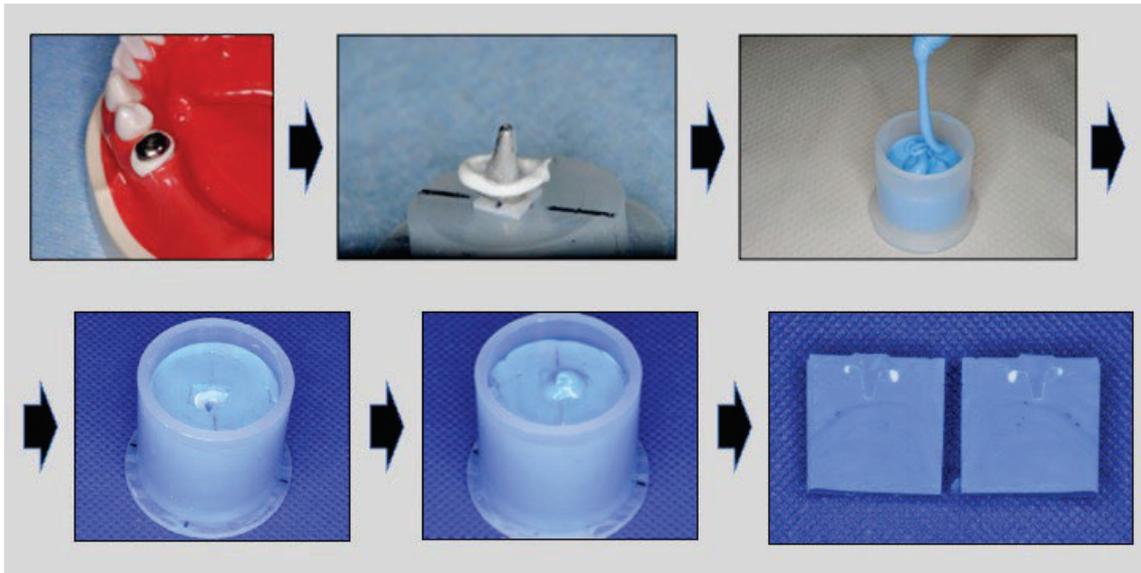


Fig. 4 Fabrication procedure of specimens (cement-replica technique)

In addition, the gap distance was measured by capturing a digital image of the cut surface of the silicone rubber together with a scale used as a reference and measuring it on a PC. In addition, seven measurement points were set as shown in Fig. 5.

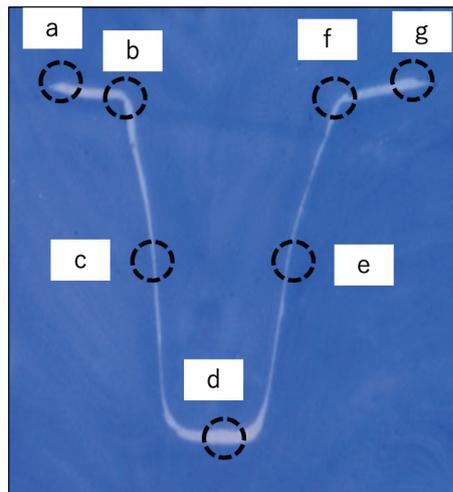


Fig. 5 Measuring points
(a: labial margin; b: labial cervix; c: labial center of post; d: tip of the post; e: lingual center of post; f: lingual cervix; g: lingual margin)

Results

The average gaps were $46.4 \pm 17.8 \mu\text{m}$ at point a, $59.6 \pm 13.6 \mu\text{m}$ at point b, $31.6 \pm 8.9 \mu\text{m}$ at point c, $145.7 \pm 43.8 \mu\text{m}$ at point d, $46.4 \pm 11.2 \mu\text{m}$ at point e, $92.7 \pm 14.3 \mu\text{m}$ at point f, and $72.1 \pm 37.0 \mu\text{m}$ at point g (Fig. 6). All points showed good compatibility as compared with the allowable range of compatibility for CAD/CAM prostheses reported by Suto et al.,¹⁾ which is $100 \mu\text{m}$.

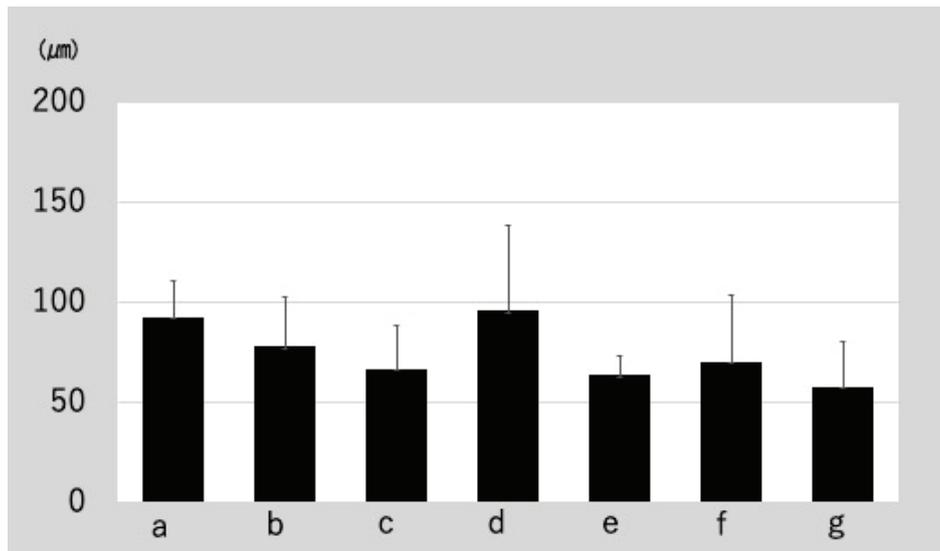


Fig. 6 Average gap volume

Conclusion

This study suggests that the titanium root coping made by an intraoral scanner has a clinically applicable conformance accuracy.

In the future, we will verify the conformance accuracy with a post length of 5 mm or more. We will also consider whether it is possible to set the rotation prevention groove and the keeper housing part and compare their compatibility with the zirconia root coping.

References

1. N. Suto, S. Miura, R. Inagaki, Y. Kaneta, M. Yoda, and K. Kimura: A Basic Study on Fitness of All-ceramic Crown Fabricated by CAD/CAM System, *Ann Jpn Prosthodont Soc*, 1, 21–28, 2009.

A Case of Single Implant Overdenture with Magnetic Attachment

Mitsuki Masumoto, Yasunori Suzuki, Keisuke Kohri, Ryouji Muto, Chikahiro Ohkubo

Department of Oral Rehabilitation and Prosthodontics, Tsurumi University School of Dental Medicine

I. Introduction

Single-implant overdentures (S-IODs) for edentulous mandibular patients can reduce treatment costs and surgical invasiveness, and relatively high success rates have been reported. In this report, we present a case of single implant retained overdenture with magnetic attachment.

II. Objective

Although the height and width of residual ridge was sufficient for two implant overdenture (2-IOD), we chose a S-IOD with one implant placed in the midline of mandible because of economic reasons and less surgical invasion.

III. Case report

1 Patient Information

The patient was a 66-year-old female, presented to our hospital with a chief complaint of broken dentures and difficulty in chewing. Her remaining teeth were suffering from severe periodontal disease, and anterior crown was removed from maxillary right canine. Her existing denture had been used approximately 5 years ago with lots of repairs to denture failure. There were no special notes on her general history.



Figure 1. Panoramic radiograph at the first examination and computerized tomography



Figure 2. Intraoral views at the first examination



Figure 3. Existing maxillary and mandibular removable partial dentures

2 Treatment Procedures

Since alveolar bone resorption and movement of the maxillary right canine tooth were observed, a maxillary overdenture was selected to improve the crown-root ratio. For mandible, S-IOD was selected to retain and stabilize the denture after the extraction of the remaining teeth with severe periodontal disease.

- 1) After extraction of the mandibular left lateral incisor and canine, one implant (Standard Plus, 3.3 mm × 12 mm, Straumann, Basel, Switzerland) was simultaneously placed using surgical guide (Fig.4 and 5).

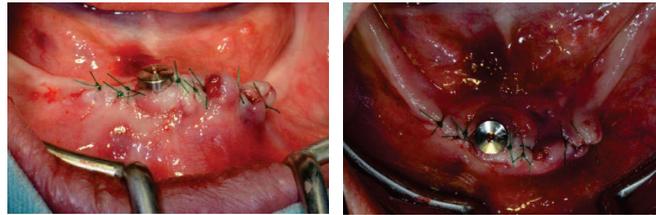


Figure 4. Placement of one implant

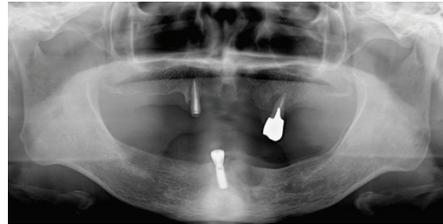


Figure 5. Panoramic radiograph after implant placement

- 2) Three weeks after implant placement, the healing abutment was fitted to denture base with autopolymerized resin for early loading (Fig.6). One month after implant placement, a magnetic attachment (MagFit, Aichi Steel, Aichi, Japan ; a flat-top type with 750 gf magnetic attractive force) was replaced from the healing abutment for denture retention (Fig.7).



Figure 6. Early loading was added 3 weeks after implant placement



Figure 7. Placement of magnetic attachment

- 3) After magnetic attachment was placed, the definitive impression was made and occlusal

relationship was recorded for the mandibular S-IOD using a duplicate denture (Fig.8), a working cast was fabricated. To record the denture space, Piezography technique was performed to record the muscle pressure surface using silicone impression material (Exafine , GC, Tokyo, Japan) by the patient pronounces "SIS, SE, SO, TE, DE, MOO, SEES" etc, (Fig.9).

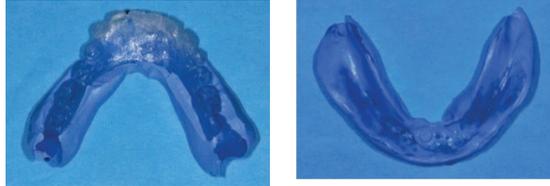


Figure 8. Definitive impressions using duplicate dentures



Figure 9. Piezography

- 4) Denture teeth were arranged and the wax denture was made within the muscle pressure surface morphology obtained by piezography technique.
- 5) RPD with a wire clasp on the left second premolar and resin copings on the right canine was deliver for maxillary jaw. For mandiblar jaw, S-IOD with magnetic attachment was also delivered (Fig.10 and 11). The S-IOD was reinforced by a metal structural framework to improve the strength and rigidity of the denture (Fig.12).



Figure 10. Intraoral view without denture



Figure 11. Placement of final removable denture



Figure 12. Completed mandibular S-IOD

- 6) The definitive denture was fitted without pain. Bilateral balanced occlusion was added to prevent the denture mobility and lateral force to the implant (Fig.13).



Figure 13. Occlusal contacts relationship during lateral movements

IV. Results

The coefficient of variance of masticatory movements was measured using a Biopack (Biopack, Yoshida, Tokyo, Japan). The definitive denture with magnetit attachment showed the stable masticatory movements in all masticatory phases and cycles compared to the existing denture without magnetic attachments (Fig.14).

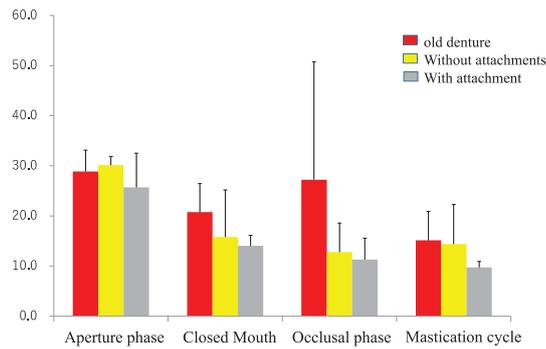


Figure 14. Coefficient of variance of masticatory movements

Pre- and postoperative occlusal examination were performed using Dental Prescale I (Dental Prescale I, GC, Tokyo, Japan). The postoperative occlusal contact area was approximately twice values compared to the preoperative area, and the occlusal force was approximately four times larger than the preoperative one (Fig.15).

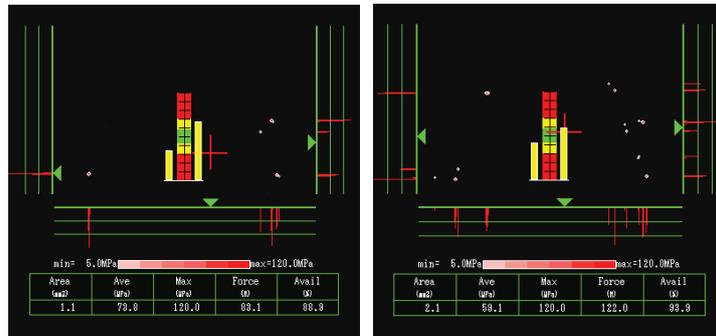


Figure 15. Occlusal examination (Left: Preoperative, Right: Postoperative)

V. Discussions

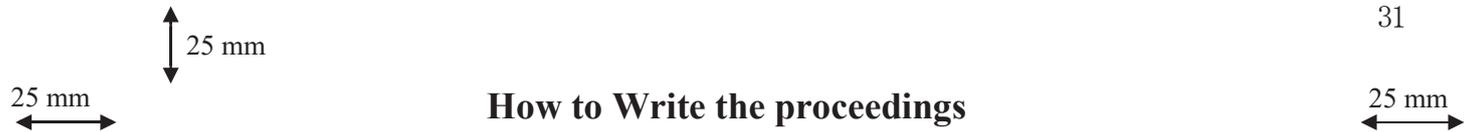
The S-IOD has a single fulcrum point compared to the 2-IOD, which allows more freedom of the denture movements. The careful maintenance must be necessary compared to the conventional 2-IODs to prevent the implant lost.

VI. Conclusions

It has been 9 years since the S-IOD was placed, and there has been no significant bone resorption around the implant, no change of retentive force, and no denture failures, resulting in improved masticatory efficiency and highly patient satisfaction. The application of magnetic attachments to the S-IODs reduced the lateral pressure to the implants and resulted in a good outcome.

References

- 1) Walton JN, Glick N, Macentee MI. A randomized clinical trial comparing patient satisfaction and prosthetic outcomes with mandibular overdentures retained by one or two implants. *Int J Prosthodont.* 2009;22(4):331-9.



How to Write the proceedings

0.5 line

TitlE including No. : Times New Roman 14pt Bold

Name (Initial. Family name) : Times New Roman 11 pt, (indent of a 0.5 line above and under this line)
ex. Y. Takada, N. Takahashi¹ and O. Okuno²

0.5 line

Affiliation: Times New Roman 11 pt, ex. Division of Dental Biomaterials, Graduate School of dentistry, Tohoku University

¹Depatrtnent of Magnet Science, School of Dentistry, Inaka College

²Laboratry of Magnet, Institute of Sendai

One line

0.5pt line (Black)

0.5 line

Abstract: Times New Roman bold 11 pt. Type

Abstract should be 10.5 point type (fonts such as Times New Roman (for body text) and Arial(for Headlines) are easy to read)

0.5pt line (Black)

One line

Manuscript Basics

0.5 line

The proceedings book will be printed directly from the manuscript provided by the author. The conference secretariat staff does not edit or proofread manuscripts, so all material should be concise and error free. The entire paper must be legible.

The components of a paper are (in order of appearance)

Introduction

Objective

Materials and Methods

Results or (Results and discussion)

Discussion

Conclusion

Acknowledgements

References

One line

Manuscripts Should

0.5 line

- be in a one-column format
- be 10.5 point type (fonts such as Times New Roman (for body text) and Arial(for Headlines) are easy to read)
- be single-spaced
- be justified within the column
- be written by the standard format of MS Word 2003 (number of characters and lines in a page)

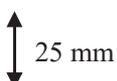
Authors should use the page size of A4 format (210 mm × 297 mm). Four spaces (half size English character) should be inserted in the head of first line between paragraphs.

Main Headings

- bold 12 pt. Type
- 12 pts. (1 line space) before and 6 pts. (0.5 line space) after
- upper- and lower-case
- NO underline (underscore)
- NO italic
- one line of space above and below, except when the heading is at the top of a column
- left justified

Subheadings

- be bold 10.5 pt. type (font: Arial)



- upper and lowercase
- NO underline (underscore)
- NO italic
- indented and on-line with the rest of the paragraph (no extra space above and below)
- **Secondary Subheadings**
- italic 10.5 pt. type (font: Arial)
- upper and lowercase
- NO underline (underscore)
- NO bold
- indented and on-line with the rest of the paragraph (no extra space above and below)

Margins

- Top 25 mm
- Bottom 25 mm
- Left and right 25 mm

Figures and Tables

All figures and tables should be imported directly into the document and will be printed along with the text. Figures and tables will NOT be reduced or enlarged by the conference secretariat staff. All figures and tables will be printed in black and white, so do not refer to colors within text to describe graph lines or particular areas of photos.

However, if you will demand the PDF file of your manuscript, you may use colors because the PDF file refer to colors. Note, however, that you should use colors which can be distinguished even when they are printed in black and white.

All figures and tables should be numbered consecutively and placed in numerical order within the manuscript. For each figure, a caption should be placed directly below the figure, and should include the figure number and caption text.

References

Literature references should be listed at the end of the paper in the same order that they appear in the text, and in accordance with the following examples.

1. Journal article (example): Y. Takada, N. Takahashi and O. Okuno: Electrochemical behavior and released ions of the stainless steels used for dental magnetic attachments, *J J Mag Dent*, 16(2), 49-52, 2007.
2. Book (example): R. Kunin, *On Exchanging Resins*, pp 88, Robert E. Kreiger Publishing Company, New York, 1972.

ニッケルフリー歯科用磁性アタッチメント

ハイパースリムNF

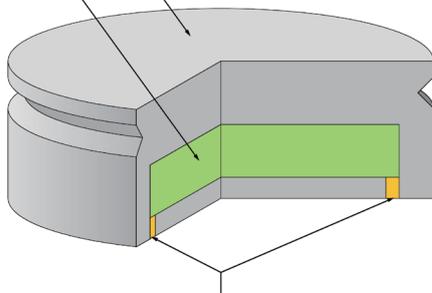
管理医療機器 認証番号: 306ACBZX00017000

従来、0.2~0.4重量%含まれていたニッケルを含まない歯科用磁性アタッチメントが誕生しました。

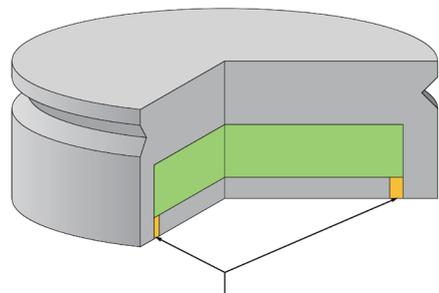
ニッケルアレルギーで磁性アタッチメントの使用を諦めていた患者様にもご使用いただくことが可能です。



磁性ステンレス鋼
(ニッケルフリー)
ネオジム磁石



ニッケルを含むステンレス鋼
従来品



ニッケルを含まない金属
ハイパースリムNF

磁石構造体の一部に使用していたニッケルを含むステンレス鋼をニッケルを含まない金属に置換えることに成功

特許出願中(2024年6月現在)

製品構成

- DB用キーパーセット
- DB用磁石構造体(単品)
- DB用キーパー(単品)



製造販売 株式会社ケディカ 宮城県仙台市泉区明通3-20 〒981-3206 T 022.777.1351
発売 株式会社 モリタ
大阪本社 大阪府吹田市垂水町3-33-18 〒564-8650 T 06.6380.2525
東京本社 東京都台東区上野2-11-15 〒110-8513 T 03.3834.6161

— New Plating Wave —
KECDC

Thinking ahead. Focused on life.



歯科用精密磁性アタッチメント

フィジオ マグネット

磁気吸引力により、義歯の維持力を得る磁性アタッチメント

磁性アタッチメントは、義歯が
鉤歯に与える有害な側方力や
回転力を逃します。

- ・キーパーの酸化・変形を防ぐダイレクトボンド法対応
- ・全8種類、幅広いサイズに対応

2021年9月1日より保険適用(2025年9月現在)



Physio Magnet

DB Keeper Set

フィジオマグネット
DB用 キーパーセット

1組入

歯科用精密磁性アタッチメント

フィジオマグネット DB用 キーパーセット

サイズ 25、30、35、40、45、48、52、55

内容 マグネット 1個、キーパー 1個、キーパーハウジングパターン 1個、MRIカード 1枚

標準価格 各10,100円



製品紹介ページ

<https://www.dental-plaza.com/qr/787>

掲載商品の標準価格は、2025年9月1日現在のものです。標準価格には消費税等は含まれておりません。ご使用に際しましては、製品の添付文書及び取扱説明書を必ずお読みください。

仕様及び外観は製品改良のため予告なく変更することがありますのでご了承ください。製品の色は印刷のため、実際とは異なる場合がございます。

販売名 フィジオマグネット DB用 キーパーセット 一般的名称 歯科用精密磁性アタッチメント 医療機器の分類 管理医療機器(クラスII) 医療機器認証番号 221ACBZX00092A01

製造発売 株式会社クデカ 宮城県仙台市泉区明通3-20 〒981-3206 T 022.777 1351

販売 株式会社 MORITA 大阪本社:大阪府吹田市垂水町3-33-18 〒564-8650 T 06.6380 2525 東京本社:東京都台東区上野2-11-15 〒110-8513 T 03.3834 6161

お問合せ お客様相談センター <歯科医療従事者様専用> T 0800.222 8020(フリーコール)

www.dental-plaza.com