日　磁　歯　誌
J J Mag Dent
ISSN 0918-9629

日本磁気歯科学会雑誌　第三十巻　第二号　J J Mag Dent　日本磁気歯科学会　21

2021 Volume 30. Number 2

JSMAD

日本磁気歯科学会雑誌

The Journal of the Japanese Society of Magnetic Applications in Dentistry

Volume 30, Number 2

The Japanese Society of Magnetic Applications in Dentistry

日本磁気歯科学会

東北大学病院・東北大学大学院歯学研究科 株式会社ケディカ共同研究開発

医療用　高性能洗浄液（医科・歯科）
ケディクリーンシリーズ

ケディクリーンEX/TZK

・歯科器具のタンパク質汚れと歯科セメントを同時に除去可能
・優れた洗浄力により予備洗浄、ブラッシングが不要

ケディクリーンMR

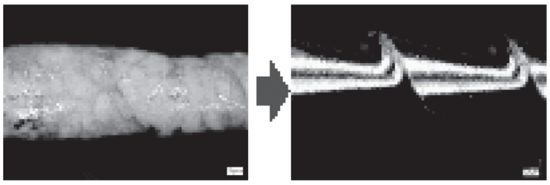
–アルジネート系印象材剥離剤–

・今までにない強力な剥離除去、除菌効果で溶液をクリーンに
・気泡が剥離効果を促進し、溶液に漬けて置くだけで簡単に綺麗に剥離

洗浄工数低減

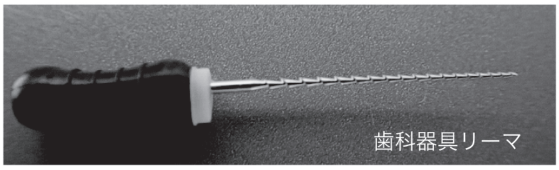
ケディクリーンTZK

歯科器具の**タンパク質**
汚れと**歯科セメント**を
同時に除去可能



セメント・タンパク質が
付着した歯科器具リーマ

洗浄除去後



歯科器具リーマ

ケディクリーンTZK　ケディクリーンEX

優れた洗浄力により
予備洗浄、ﾌﾞﾗｯｼﾝｸﾞ不要

※石膏の洗浄除去、こびりついた肉片は不可

薬液コスト低減

約２０％低減
（同濃度使用時）

環境負荷低減

pHを抑えつつ強アルカリ
洗剤と同等以上の洗浄力

安全性向上
素材ダメージ低減

従来洗浄液と同等か
それ以上の安全性

※電気化学的安定性評価、静的浸漬試験、
長時間浸漬後の強度試験による

改良表面処理医療器具

TKスパーテル

・従来品よりめっき膜の延性により、耐食性に優れ長持ち（当社比）
・焼鈍軟化により初期曲げ加工が容易
・従来では不可とされていた、平滑化再生修理可能

歯科用精密磁性アタッチメント

ハイパースリム　フィジオマグネット製造・販売

—— New Plating Wave ——
KEDC
製造元 **株式会社ケディカ**
〒981-3206
宮城県仙台市泉区明通３丁目２０番
TEL：022-777-1351 FAX：022-777-1357

J J Mag Dent vol. 30 No. 2 2021

The Journal of the Japanese Society of Magnetic Applications in Dentistry

Volume 30, Number 2

Proceedings of the 20th International Conference on Magnetic Applications in Dentistry

The Japanese Society of Magnetic Applications in Dentistry

The ~~19~~20th International Conference on Magnetic Applications in Dentistry

The ~~19~~20th International Conference on The Japanese Society of Magnetic Applications in Dentistry organized by JSMAD was held on the Internet as follows;

Meeting Dates:

Friday, February 26 to Tuesday, March 16, 2021

Location:

JSMAD web site

http://jsmad.jp/international/20/

General Chair:

Prof. Jun Takebe, Aichi-Gakuin 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. Yukyo Takada, Tohoku University

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

Dr. Masayuki Hideshima, Tokyo Medical and Dental University

Conference Secretary

Dr. Masatoshi Takahashi, Tohoku University

Conference Organizing Committee

Dr. Hideki Aita, Health Science University of Hokkaido
Dr. Masatake Akutagawa, The University of Tokushima
Dr. Tetsuo Ichikawa, The University of Tokushima
Dr. Shuji Ohkawa, Meikai University
Dr. Tetsuo Ohyama, Nihon University
Dr. Chikahiro Ohkubo, Tsurumi University
Dr. Tohru Kurabayashi, Tokyo Medical and Dental University
Dr. Hisashi Koshino, Health Science University of Hokkaido
Dr. Mineyo Sone, Meikai University
Dr. Jun Takebe, Aichi-Gakuin University
Dr. Joji Tanaka, Tanaka Dental Clinic
Dr. Fujio Tsuchida, Mami's Dental Office
Dr. Kazuo Nakamura, Sanno Hospital
Dr. Kazuhiro Nagata, The Nippon Dental University
Dr. Yuji Honda, Honda Shika Daiichi Shinryoujo
Dr. Eri Makihara, Kyusyu Dental University
Dr. Shinichi Masumi, Kyusyu Dental University
Dr. Shunsuke Minakuchi, Tokyo Medical and Dental Universit
Dr. Motonobu Miyao, Asahi University

Conference Arrangements Committee

Dr. Shunsuke Minakuchi, Tokyo Medical and Dental Universit
Dr. Masatake Akutagawa, The University of Tokushima
Dr. Shogo Ozawa, Aichi-Gakuin University
Dr. Hisashi Koshino, Health Science University of Hokkaido
Dr. Shuji Ohkawa, Meikai University

Proceeding Committee

Dr. Mineyo Sone, Meikai University
Dr. Hideki Aita, Health Sciences University of Hokkaido

Published by the Japanese Society of Magnetic applications in Dentistry

c/o Dental Clinic for Sleep Disorders (Apnea and Snoring)
Tokyo Medical And Dental University, Dental Hospital
1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8549 JAPAN

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

Visit JSDMD Home Page for updates!
http://www.jsmad.jp/

The 21th International Conference on Magnetic Applications in Dentistry General Information

General Information

The Japanese Society of Magnetic Applications in Dentistry (President: Yukyo Takada, Tohoku University) is a scientific association founded in 1991 and is devoted to furthering the application of magnetism in dentistry. The 21st International Conference on Magnetic Applications in Dentistry organized by JSMAD will take place on the Internet as follows.

Meeting Dates:
Monday, February 21 to Monday, March 7, 2022

Location:
JSMAD web site:
http:/ /jsmad.jp/international/21/

General Chair:
Clin. Associate Prof. Tetsuo Ohyama, Nihon University
Executive Committee Chair:
Assist Prof. Hiroyasu Yasuda, Nihon 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

Registration Infomation

Registration:
Send e-mail titled "registration for 21st 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 24, 2022
Poster submission: February 7, 2022

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

Hiroyasu Yasuda, Nihon University

E-mail: jsmad31@gmail.com

Tel: +81-3-3219-8144

Visit JSMAD Home Page for updates!
http://jsmad.jp/

Contents

A case report of a removable denture using magnetic attachments for a missing mandibular molar with a decreased occlusal vertical dimension followed up for 9 years

M. Sone, D. Matsumoto, N. Koyama, F. Narumi, T. Matsukawa, S. Uchida, S. Somekawa, K. Takahashi, M. Suzuki, Y. Miyoshi, D. Sakamoto, K. Okamoto, and S. Ohkawa

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

Abstract

This case report describes our establishment of an appropriate OVD for a patient with a decreased OVD to restore the aesthetics and function by the use of magnetic attachments.

As a definitive prosthesis, a maxillary removable overlay denture with coping-type magnetic attachments and a horseshoe plate as the major connector was fabricated, and a mandibular removable partial denture with an extracoronal-type magnetic attachment was also fabricated.

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 maintain a harmonious craniofacial system, it is essential to establish an appropriate occlusal vertical dimension (OVD).[1] This case report describes our establishment of an appropriate OVD for a patient (missing mandibular molar) with a decreased OVD to restore the aesthetics and function by the use of magnetic attachments.

Clinical History

The patient, a 59-year-old female, complained of aesthetic dissatisfaction and masticatory dysfunction. The patient had a partially edentulous maxilla (Eichner classification :B3, Disease type classification at Japan Prosthodontic Society :1- I Level I and Occlusal-triangle :area A) (Figs.1, 2, and 3). All fixed prostheses were failed restorations with marginal discrepancies and damaged by caries and periodontal disease. The patient refused to wear a mandibular removable partial denture because of dissatisfaction with a visible metal clasp on the anterior teeth. She was diagnosed with infraocclusion by analysis of OVD.

Fig.1 Intraoral view at the first visit

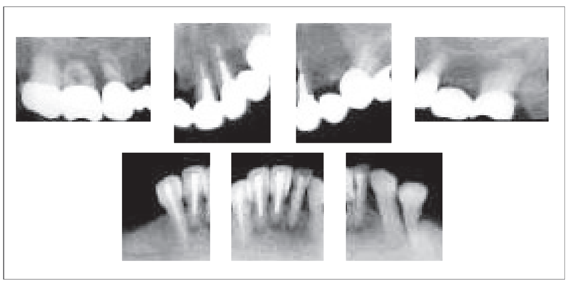


Fig.2 X-ray photographs at the first visit

BOP		○	○	○					○	○					○	
Mobility		1	2	1					1	1					1	
PCR																
EPP		322	234	212					322	223			333		343	
(mm)		422	364	323					322	323			333		444	
Location	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
Location	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
EPP						223	222	212	222		212	343				
(mm)						333	212	111	222		322	323				
PCR																
Mobility						0	1	1	1		0	0				

Fig.3 Periodontal disease examination at the first visit

Treatment Procedure

First, the prosthesis with the marginal discrepancy was removed (Fig.4), and temporary restorations were placed. The 3 and 12 teeth were extracted because of severe caries. After preprosthetic treatment, the OVD was increased by the use of the treatment denture, and the patient obtained an adequate occlusal relationship (Figs.5 and 6).

Fig.4 Intraoral views of removing the prosthesis

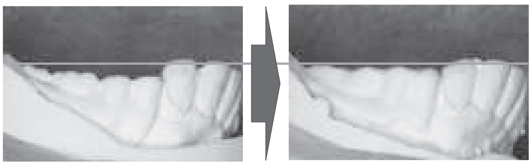


Fig.5 Occlusal reconstruction of denture

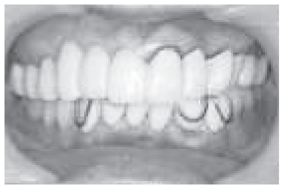


Fig.6 Intraoral views of inserting temporary restorations

As a definitive prosthesis, a maxillary removable overlay denture with coping-type magnetic attachments and a horseshoe plate as the major connector was fabricated , and a mandibular removable partial denture with an extracoronal-type magnetic attachment was also fabricated. The magnetic attachments used in this case report were GIGAUSS C400® (GC, Japan). The keepers of the magnetic attachment and magnetic assemblies were fixed with adhesive resin cement (Multilink® Automix, Ivoclar Vivadent, Liechtenstein) (Figs.7 and 8). Figure. 9 shows an intraoral view of the definitive prosthesis.

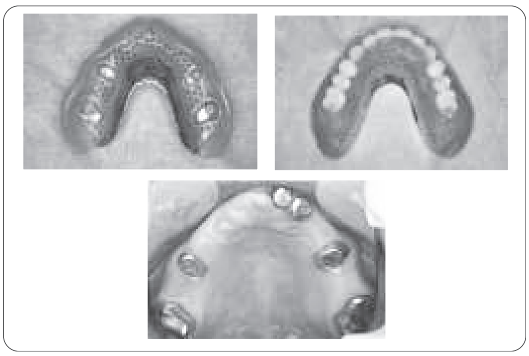


Fig.7 Maxillary removable overlay denture and the magnetic attachment

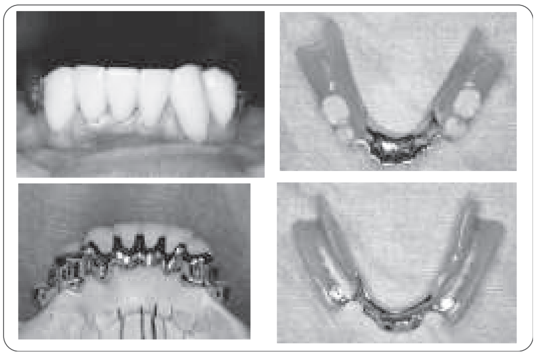


Fig.8 Mandibular removable denture and the magnetic attachment

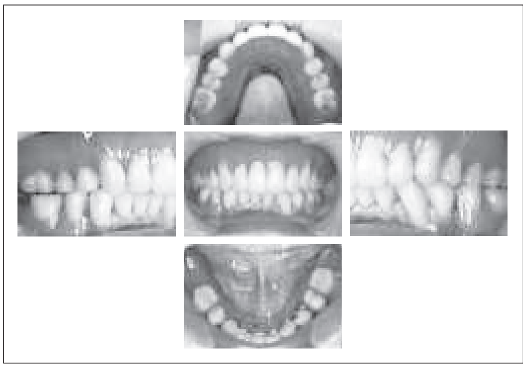


Fig.9 Intraoral view with definitive prostheses

Outcome of Treatment

Presently, 9 years and 6 months have passed since the definitive prosthesis was set(Fig.9). During that time, maintenance was initially carried out every month; however, after 3 years, at the request of the person, it was reduced to every 3 months. The results of the most recent treatment of periodontal disease examination showed no significant change in both periodontal pockets and tooth mobility compared to the end of the definitive prostheses. The results of examination during the most recent treatment of periodontal disease showed no significant change in periodontal pockets or tooth mobility as compared to the end of the definitive prosthesis setting. The results of dental X-ray photographs showed enlargement of the periodontal ligament cavity of the left support tooth from the middle of the mandible (Fig.10). In addition, gingival recession of #34 was recognized in the oral cavity, and significant bite wear of the artificial tooth of #35 was recognized (Fig.11). From the inquiry result that the remaining part of the maxillary abutment tooth was biased to the left side and the habitual chewing side was on the left, it was inferred that this was caused over time because the burden of the bite force was larger than that of the right side.

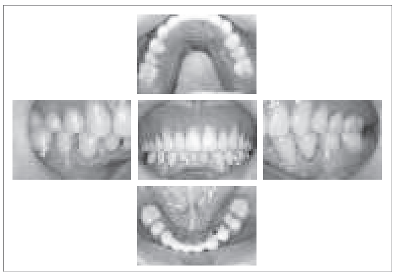


Fig. 9 Intraoral view with definitive prosthesis at 9 years after treatment

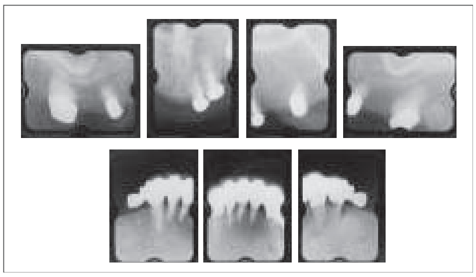


Fig.10 X-ray photographs at 9 years after treatment

Fig.12 Degradation over time

The elution amount of glucose in the masticatory function test 3 years after the operation was 121 mg/dl, but increased to 150 mg/dl after 9 years and 6 months (Fig.12).

Additionally, the score of OHRQoL using OHIP-14[2)] decreased over time, and treatment results were obtained with high patient satisfaction (Fig.13).

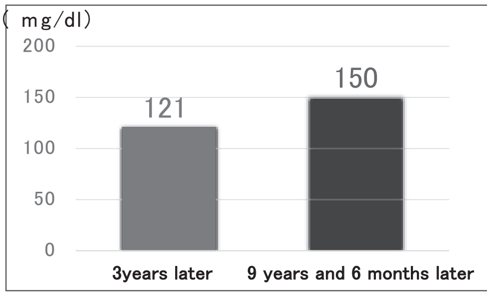


Fig.12 The masticatory function test

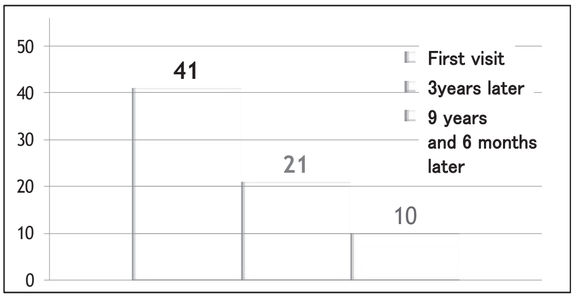


Fig.13 Oral Health Impact Profile-14 for Japanese

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.

References

1. M. Sone, Y. Kawakami, F. Okutsu, T. Matsukawa, Y. Toyota, R. Negoro, S. Shimokawara, K. Okamoto, and S. Ohkawa: A case report of Occlusal Reconstruction with Overdentures Using Magnetic Attachments, JJ Mag Dent, 23(2), 1-3, 2014
2. Allen F, Locker D: A modified short version of the oral health impact profile for assessing healthrelated quality of life in edentulous adults, Int J Prosthodont 15, 446-450, 2002.

A case report of removable partial denture applied magnetic attachment and zirconia framework for a patient with decreased occlusal vertical dimension

TAKEYAMA J[1], SUZUKI Y[1], HARADA N[2], SHIMPO H[1], KURIHARA D[1], MUTOH R[1], OHKUBO C[1]

1) Dept. of Removable Prosthodontics, Tsurumi University School of Dental Medicine

2) Dental Technician Training Institute, Tsurumi University School of Dental Medicine

Introduction

Infraocclusion is one of the most difficult prosthetic problems because it often leads to denture fracture and the pain of alveolar ridge due to excessive occlusal force and insufficient denture space. In this case report, a case of partial denture with magnetic attachments and zirconia framework for a patient with Eichner's classification B4 who had a infraocclusion due to high occlusal wear, was introduced.

First consultation

Patient: 84 years old, male

Chief complaint: Masticatory disturbance and repeated denture fractures

Past history: Right trigeminal neuralgia

Remaining teeth:

74 2	2
3	57

Eichner classification: B4

Fig.1 Intraoral at first consultation

Fig.2 Panoramic x-ray

Table 1. Pocket depth

Pocket (mm)	4	/	/	4	/	3	3	3	3	/	/	/	/	/
dental formula	7	6	5	4	3	2	1	1	2	3	4	5	6	7
dental formula	7	6	5	4	3	2	1	1	2	3	4	5	6	7
Pocket (mm)	/	/	/	/	3	3	3	3	3	3	3	3	/	4

Materials and Methods

Since infraocclusion was considered as the cause of the disturbance, occlusal vertical dimension was increased by insertion of mandibular treatment denture that covered on the occlusal surfaces of the remaining teeth (Fig. 3). After obtaining an adequate occlusal relationship, the definitive denture was fabricated, which was supported by occlusal rests on the worn occlusal surfaces similar to the treatment denture. The magnetic attachment (GIGAUSS C, GC) (Fig. 4) and clasps were applied as retainers, the framework including major connector was milled from zirconia disk based on the scanned STL data of the wax denture (Aadva E Ⅰ, GC) (Fig. 5). The zirconia framework was tried to fit in patient’s mouth, then the mandibular removable partial denture was conventionally completed (Fig. 6-8). After about three weeks from the definitive denture were deliverd, the magnetic assembly was fixed to the zirconia framework.

Fig. 3 Treatment denture

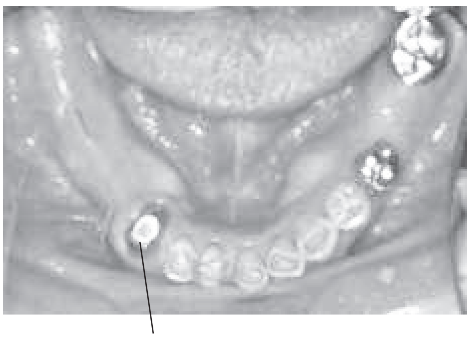


Fig. 4 Magnetic attachment (GIGAUSS C, GC)

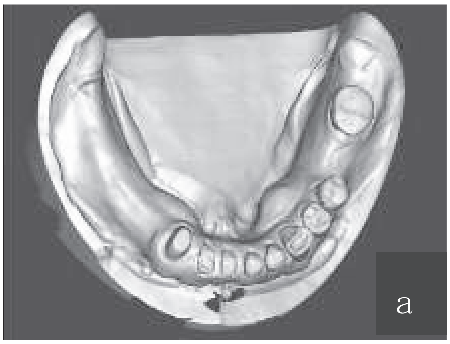


Fig. 5a Scanned image of mandibular working model

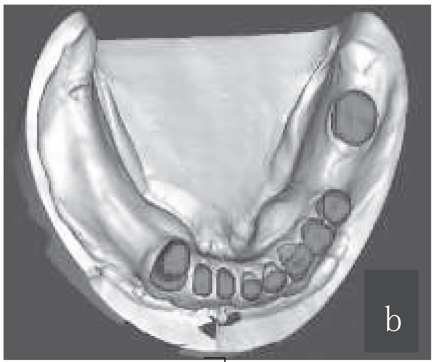


Fig. 5b Repair the undercut of remaining teeth and space making for magnetic assembly

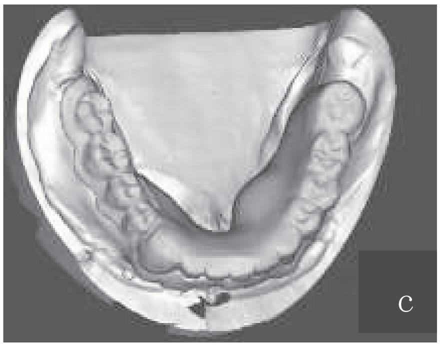


Fig. 5c Framework design

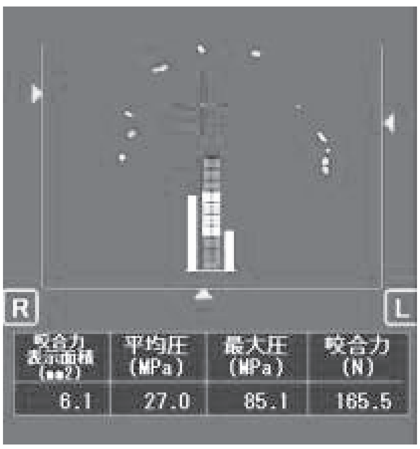
Fig. 6 Trial fitting of zirconia framework (High permeability zirconia, Aadva E I)

Fig. 7 Definitive mandibular denture

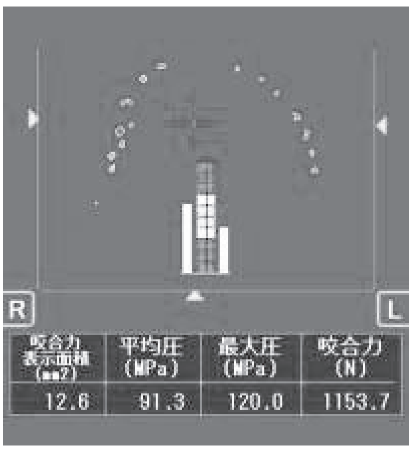
Fig. 8 Placement of the definitive denture

Results and Discussion

Compared with the previous denture, the definitive denture improved denture rigidity and stability. Futhermore, the occlusal contact area and the maximum occlusal force were increased.(Fig.9) The paitient’s satisfaction and masticatory function were improved by the placement of removable partial denture with the magnetic attachments and zirconia framework using CAD/CAM technology.



Previous denture



Definitive denture

Fig. 9 Occlusal examination by dental prescale

Clinical evaluation of implant overdentures using magnetic attachment: retrospective study

Takayama H[1,2], Suzuki Y[1,2], Kurihara D[1,2], Maruo R[1,2], Shimpo H[1,2],Ohkubo C[1,2]

[1)]Dept. of Removable Prosthodontics, Tsurumi University School of Dental Medicine
[2)]Center of Oral and Maxillofacial Implantology, Tsurumi University School of Dental Medicine

Introduction

Implant overdenture (IOD) is one of the most effectiveness treatment for removable denture treatment to provide improvement for removable denture. The objective of this retrospective clinical study was to evaluate performance of IOD using magnetic attachment and to identify risk factors for prosthetic complications.

Materials and Methods

This retrospective study evaluated data collected from edentulous and partial edentulous patients treated April 2003 and November 2018 in Tsurumi University with IOD using magnetic attachment. Outcome measures were implant and prosthetic survival rates, patient age when IOD delivering, ratio of male and female, location and number of implant.

Results

A total of 14 patients (3 males and 11 females) with 42 implants (30 maxilla and 12 mandibular) and 36 magnetic attachments were included in this study.The mean age of these patients was 65.5 years (in a range from 64 to 80 years) (Fig. 1,2). The patients were treated using a conventional 2-loading protocol.

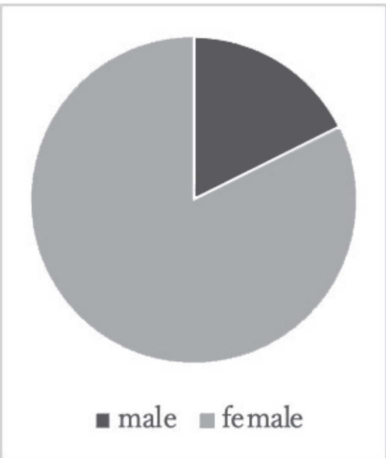


Fig.1 Gender ratio

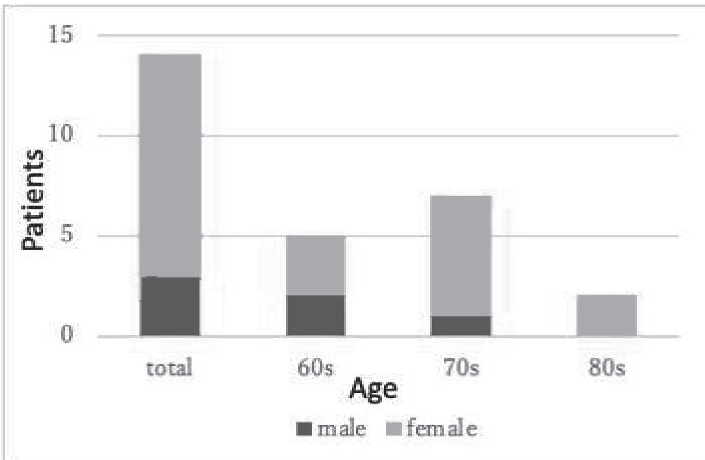
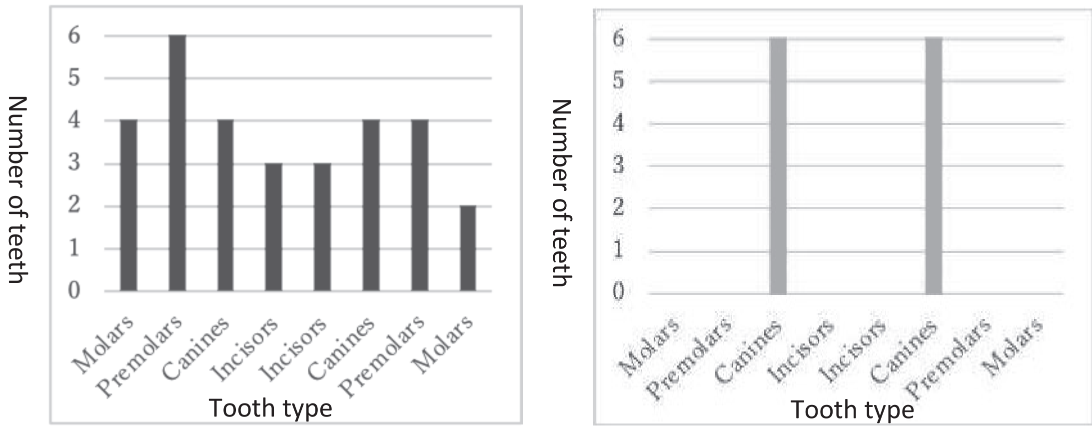


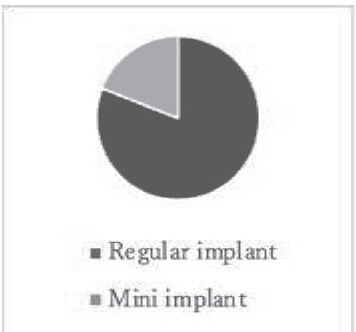
Fig.2 Age Gender

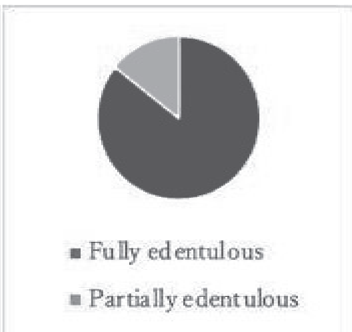
A total of 42 implants were placed, 30 (71,4%) in the maxilla and 12 (28,6%)in the mandible. The positions of implant placement were: incisor (14,3%) ; canine (47,6%) ; premolar (23,8%) and molar(14,3%). In mandibular, a greater number of implants were anterior compared to posterior. (Fig. 3). Two different implant systems were used : 30 implants were regular implants and 12 implants were mini implants(Fig.4). Approximately 2patients (14,3%) were partially edentulous, and 12patients (85,7%) were fully edentulous (Figures 5). The most common denture material was resin base (8 dentures), followed by Co-Cr base (4 dentures) and titanium base (2 dentures) (Fig. 6).



Maxilla Mandibular

Fig.3 The position of Implant placement





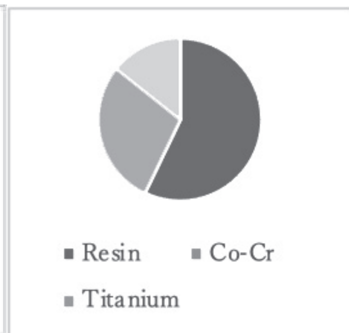


Fig.4 Type of implant Fig.5 Missing teeth situation Fig.6 Denture modalities

One (maxilla incisor) of 42 implants failed because of lack osseointegration, during the 7 years after placement. The implant have functioned at a rate of 97 % (maxilla91,7% mandible 100%). The failed implamt case was no occlusal contact in spite of remaining maxillary and mandibular teeth (Eichner classification C1), which is caused by excessive occlusal force to the implant. In prosthetic complication, attachment loosing (maxillary anterior region and mandibular canine region) were observed 3 patients, during the 1 to7 years after denture delivered. (Figs.8and 9). However some of attachment looseing and detachment may also be attributed to nomal functions, including patient insertion and removal of the prostheses. Therefore, it seems to be impotant that controls for these complication risks be made at regular intervals in clinic.

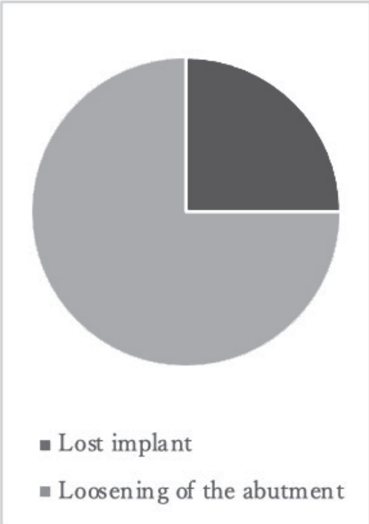


Fig.8 Complication

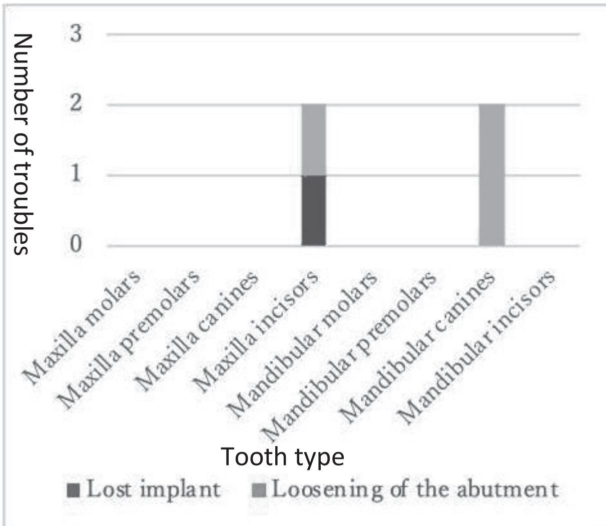


Fig.9 Complication area

Conclusions

In this study, 14 patients (mean age 65.5 years, 3 males and 11 females) with 42 implants and 34 magnetic attachments with a maximum follow-up of 16 years were included. One of 42 implants were failed and attachment loosing were observed 3 patients, but most of the patients were used without any major complaints.The implant over denture with magnetic attachment were exceedingly for rehabilitation with a high survival rate.

Effect of crosshead speed on retentive force measured using a device specified in ISO 13017:2020

M. Takahashi[1], G. Togawa[1], M. Kanyi[2], H. Yamaguchi[1,3] and Y. Takada[1]

[1]Division of Dental Biomaterials, Tohoku University Graduate School of Dentistry
[2]Moi Teaching and Referral Hospital, KENYA
[3]Division of Advanced Prosthetic Dentistry, Tohoku University Graduate School of Dentistry

Abstract

ISO 13017:2020 has specified a device for measuring the retentive force of dental magnetic attachments accurately. The recommended crosshead speed of measuring the retentive forces using this device has not been investigated yet. In this study, the retentive force measurements of two different types of magnets (Nd-Fe-B, Sm-Co) and one magnetic attachment (GIGAUSS D600) were done at crosshead speeds of 0.5 – 500 mm/min. From the obtained data the impact of crosshead speed on the measured values of retentive force was investigated.

There was no significant difference in the measured values at crosshead speed of 0.5 – 50 mm/min for all magnets and attachment. However, the measured values at 100 mm/min or more were significantly higher than the reference value at 0.5 mm/min. By using the retentive force measuring device specified in ISO 13017:2020, it is possible to measure retentive forces accurately at crosshead speed of up to 35 mm/min. Crosshead speeds above 50 mm/min yield measured values higher than the true retentive force as a result of extra force necessary to accelerate the movable part of device to the highly set crosshead speed.

Introduction

Retentive force is one of the most important properties of dental magnetic attachments[1)]. Retentive force testing applies similar principle to tensile test. Tensile (pulling) forces applied to a dental magnetic attachment until separation of the attachments occurs are measured[2)]. In a tensile test, the appropriate crosshead speed is specified based on the type of material used[3-5)]. In 2009, Ogawa *et al*. evaluated the effect of crosshead speed on the retentive force of a magnetic attachment, and concluded that there was no statistically significant difference in retentive forces measured at crosshead speeds of 0.5 – 5.0 mm/min[6)]. Based on the result of this research; International-Organization-for-Standardization (ISO) 13017 published in 2012 specified that the retentive force should be measured at a crosshead speed of 5.0 mm/min or less[7)]. However, it was still difficult to measure retentive force with acceptable accuracy and repeatability. This necessitated the development of a device for measuring retentive force with sufficient accuracy and repeatability. Thereafter, ISO 13017 amendment 1 was published in 2015 with detailed specifications of a device suitable for measuring the retentive force of dental magnetic attachments[8)].

An SC2/WG22 meeting under ISO/TC106 technical committee responsible for formulating a standard that combines ISO 13017 and its amendment 1 started in 2017[9)]. In 2018 at the Milan meeting; a concern that the retentive force measured at a crosshead speed of 5.0 mm/min was too fast emerged. The recommendation was to maintain a crosshead speed of 2.0 mm/min or less. As a result, ISO 13017 published in 2020 specified that the crosshead speed should be 2.0 mm/min or less[2)]. However, there is no scientific evidence found that confirms the recommended cross head speed value of 2.0 mm/min. The study done by Ogawa *et al*. in 2009 was done before specifications on the measuring device, in accordance with ISO, were developed. Furthermore, the study only focused on closed magnetic circuit utilized by most of the dental attachments. Open magnetic circuit is also utilized in some dental magnetic attachments albeit rare. There are no other studies found which investigate the effect of crosshead speed on retentive force values. It is important to investigate the effect of crosshead speed on retentive force of both closed and open magnetic circuit attachment done on a device that matches the ISO 13017:2020 specifications.

Objective

The aim of this study was to investigate the effect of crosshead speed on retentive force value measured using a device specified in ISO 13017:2020.

Materials and Methods

Magnets and dental magnetic attachment

Magnets portray an open magnetic circuit. They form part of the components used to make dental magnetic attachments. Two types of magnets and one type of magnetic attachment were used in this study. One pair of cylindrical neodymium magnets (Nd-Fe-B: 4 mm in diameter and 2 mm in height, Trusco) and one pair of samarium-cobalt magnets (Sm-Co: 4 mm in diameter and 2 mm in height, Magna) were prepared. GIGAUSS D600 (GC), a dental magnetic attachment that utilizes closed magnetic circuit, was used in this study. Each set of magnets of the same type and the magnetic attachment was subjected to retentive force measurement five times.

Test procedure for measuring retentive force

The retentive force measuring device used in this study matches the basic description in ISO 13017:2020. It was connected to a digital force gauge (ZPS, Imada). Retentive forces were measured and recorded in accordance with the test procedure stipulated in ISO 13017:2020 and retentive force curves generated. Crosshead speed was controlled by a universal testing machine (AGS-5kNG, Shimadzu).

Crosshead speed

Measurements were done at 19 different crosshead speeds (mm/min): 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 50, 100, 200, 300, 400 and 500. The retentive force value attained at the lowest speed of 0.5 mm/min was used as a reference value. This concept was applied in both scenarios of magnet combinations and magnetic attachment. The obtained data in comparison to reference value was statistically analyzed using ANOVA and Tukey's HSD test ($\alpha = 0.05$).

Results and Discussion

1. Measured values of retentive force and crosshead speeds

Measured values of retentive force to crosshead speeds are shown in Figs. 1-3. There was no significant difference ($p>0.05$) in the measured values obtained at crosshead speed of 0.5 – 50 mm/min in each combination. On the other hand, the measured values at 100 mm/min and more were significantly higher ($p<0.01$) than those obtained at 0.5 mm/min.

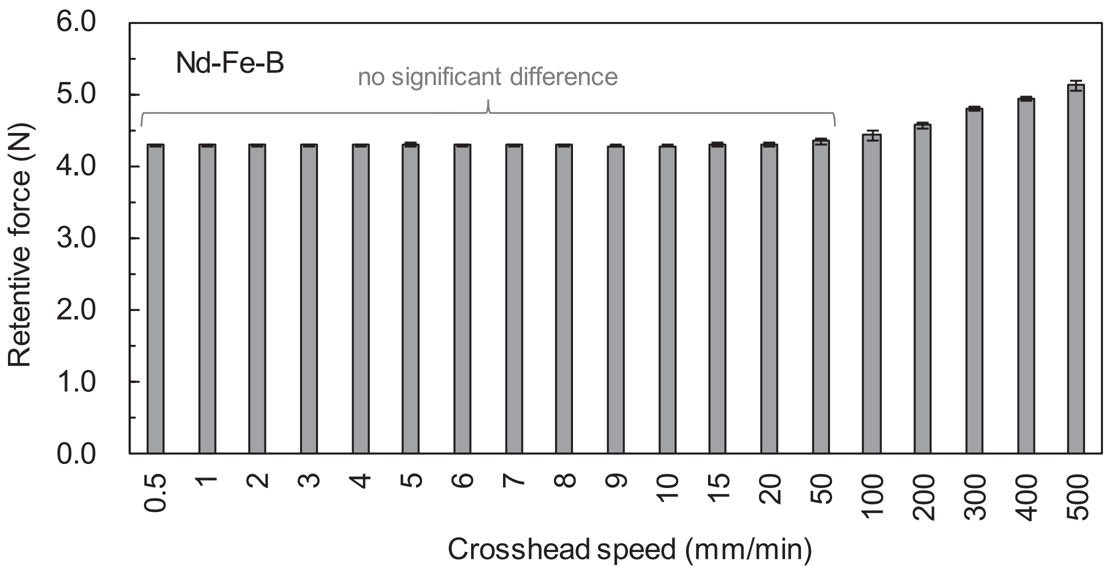


Fig. 1 Measured values of retentive force to crosshead speeds in Nd-Fe-B magnets

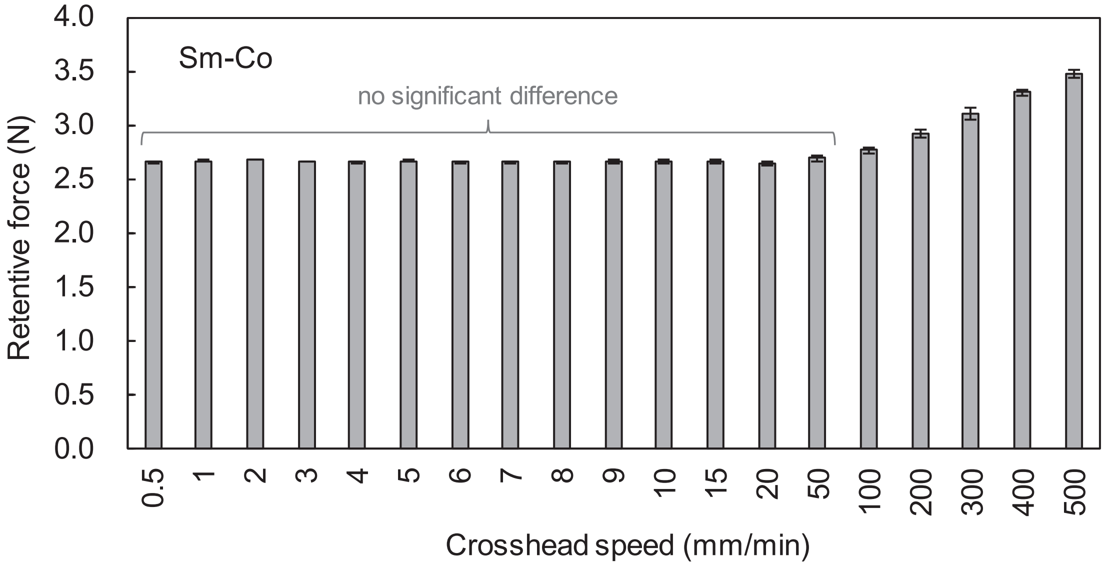


Fig. 2 Measured values of retentive force to crosshead speeds in Sm-Co magnets

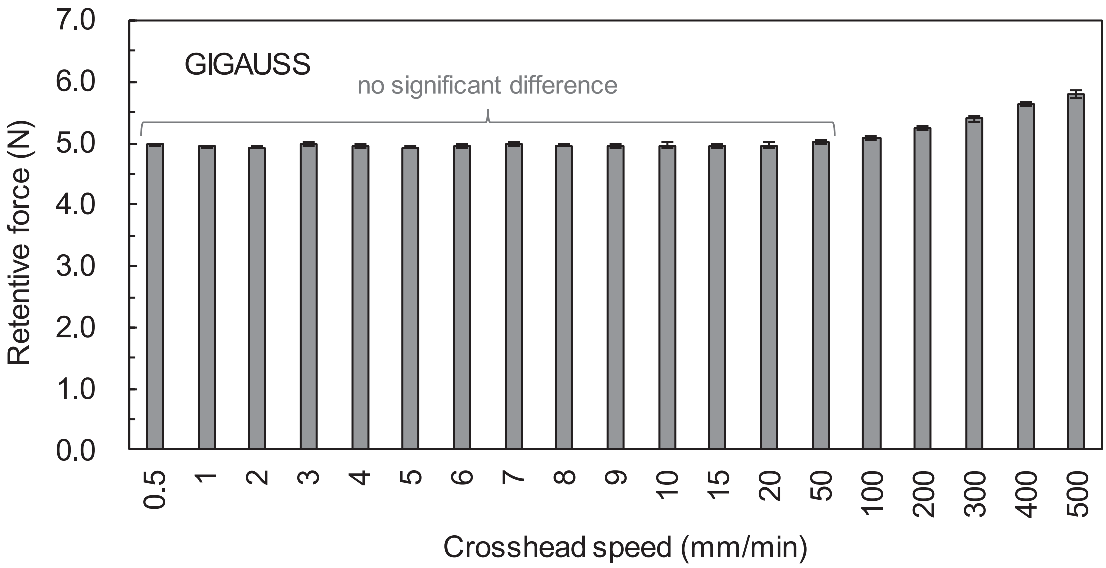
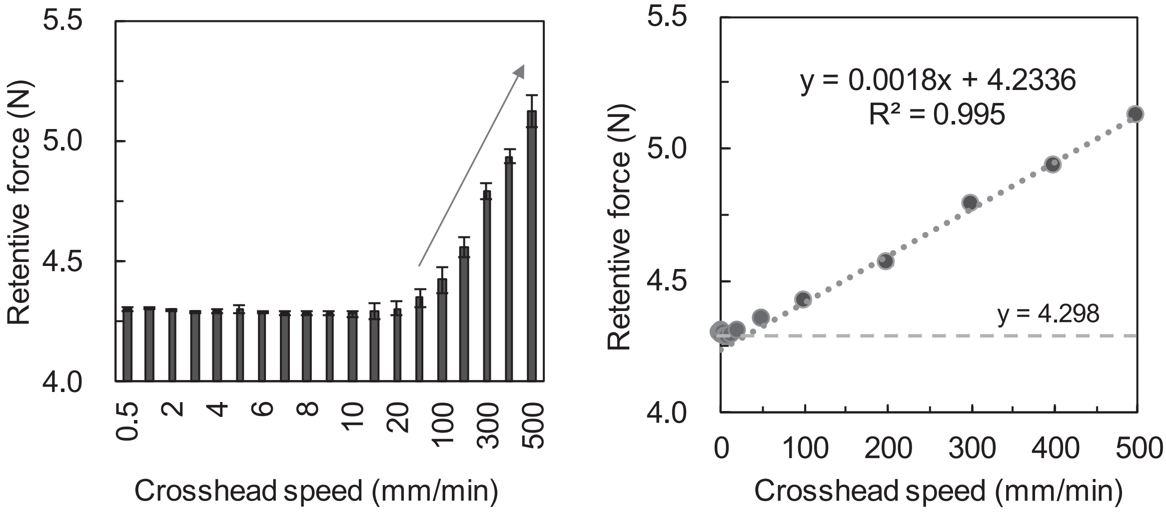


Fig. 3 Measured values of retentive force to crosshead speeds in GIGAUSS magnetic attachment

Retentive force values of neodymium (Nd-Fe-B) magnet at different crosshead speeds are represented in the form of a bar chart in Fig 4a whereas Fig 4b is a scatter diagram. Beyond 50 mm/min, the measured values of retentive force increase with increase in crosshead speed. As shown in Fig. 4b; at crosshead speed of 100 mm/min and more, retentive force and crosshead speed show a strong positive correlation (R^2 = 0.995). Both Sm-Co and GIGAUSS show a strong positive correlation.

In all combinations, the measured retentive force value at crosshead speed of 50 mm/min was higher than the reference value. The difference was not statistically significant. The crosshead speed above which the parameter speed has no influence on retentive force values measured, was determined as the intersection between lines $y = ax + b$ (linear approximate equation) and $y = c$ (c: reference value), as shown in Fig. 4b. The results are shown in Table 1.



a: Bar graph b: Scatter diagram

Fig. 4 Retentive force and crosshead speed in Nd-Fe-B magnets

Table 1 The minimum crosshead speed that influences the retentive force values, derived from the regression analysis.

	Nd-Fe-B	Sm-Co	GIGAUSS
Minimum speed (mm/min)	35.8	42.6	46.8

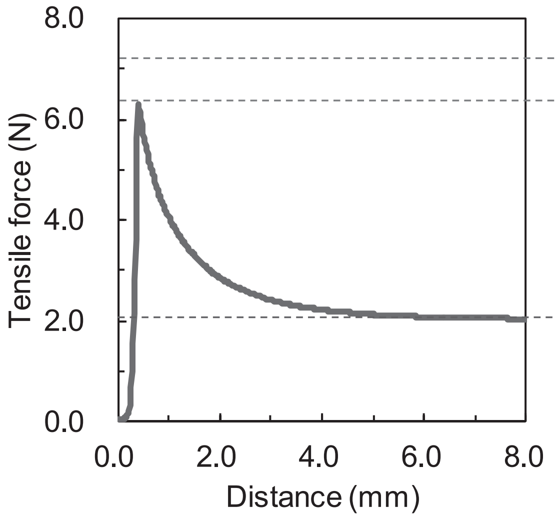
Although retentive forces can be accurately measured at crosshead speed of up to 50 mm/min using a device as specified in the ISO 13017:2020; it is advisable to limit speed to approximately 35 mm/min based on the above results. Ogawa *et al*. reported[6] that retentive forces could be accurately measured at crosshead speed of up to 5.0 mm/min. With the development of a high-performance device such as the one specified in ISO 13017; retentive forces can be accurately measured at faster speeds of up to 35 mm/min. Crosshead speed of 2.0 mm/min or less which is specified in ISO 13017:2020 is very slow albeit accurate.

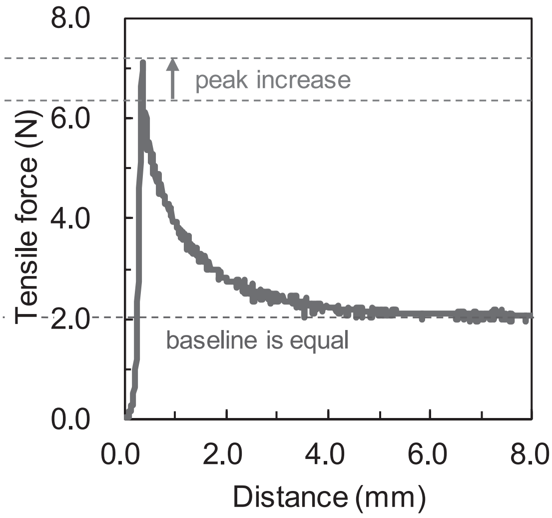
2. Increase in measured values of retentive forces

There was a general increase in retentive forces with increase in crosshead speed. This may be attributed to the influence of friction by the ball bearing slider and acceleration force required to induce movement of the movable part of measuring device up to the set crosshead speed.

2.1 Effect of dynamic friction on measured values of retentive force

Two different types of dynamic friction forces exist: sliding friction and rolling friction. The low friction ball bearing slider used in the measuring device undergoes a rolling type of friction force. The coefficient of rolling friction increases with increase in the rolling speed. In spite of the sharp increase in crosshead speed from 10 to 500 mm/min as shown in the retentive force curves Fig. 5 only the peak force values showed a spike. The baseline force values measured remained steady. These results reveal that the impact of dynamic friction on measured values of retentive force is negligible.



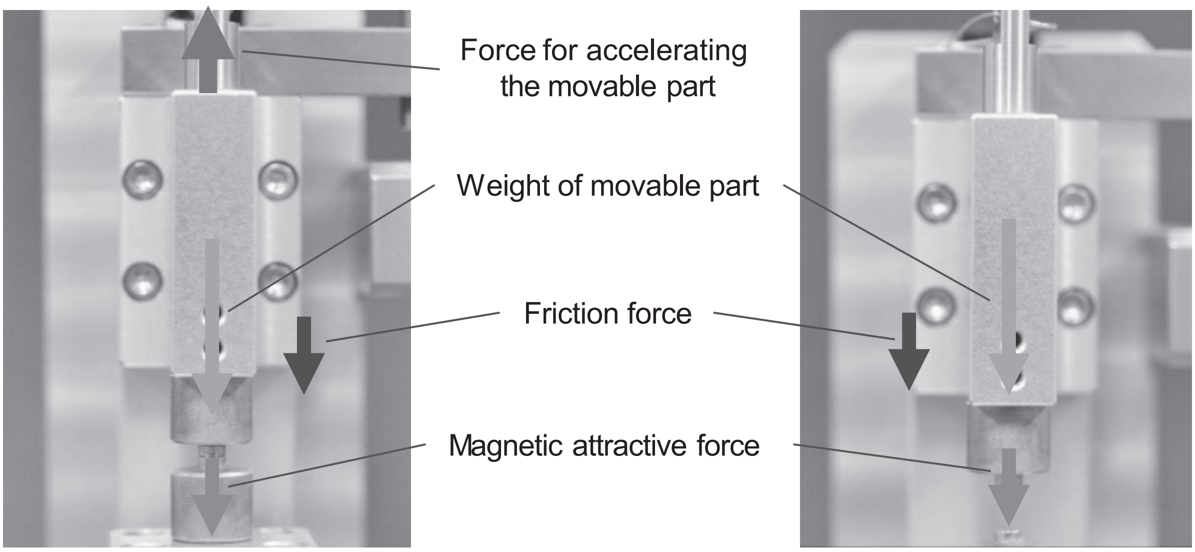


a: 10 mm/min b: 500 mm/min

Fig. 5 Retentive force curves of Nd-Fe-B

2.2 Effect of acceleration motion force on measured values of retentive force

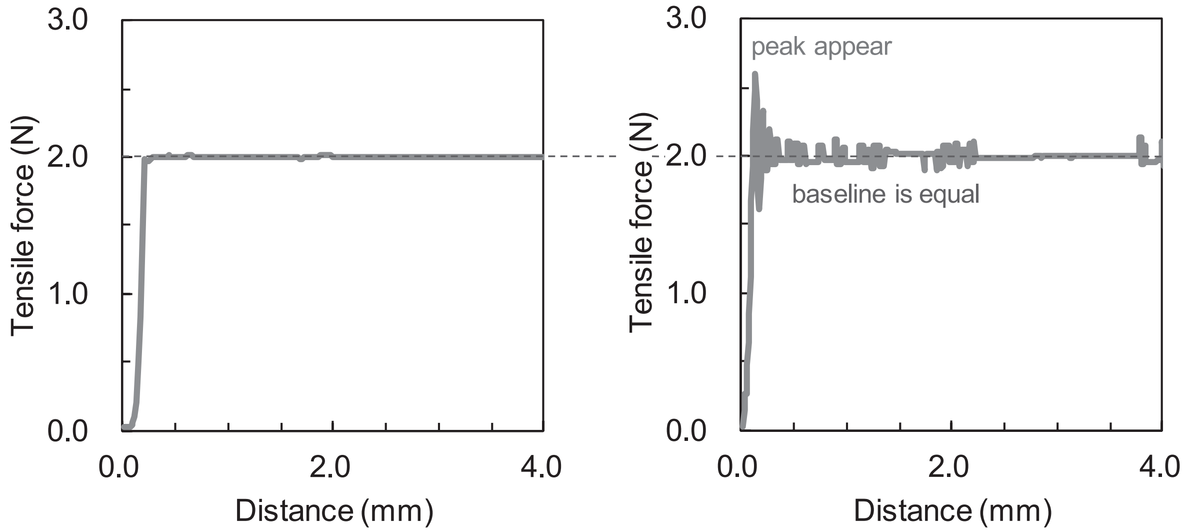
Fig. 6 shows the different forces acting on the movable part of the measuring device during retentive force testing. At the start of the testing shown in Fig. 6a, the movable part of the measuring device requires energy to change from the static state into motion at the set crosshead speed. The force that sets the movable part of device into motion can be derived on the basis of Newton's law of motion equation $F = ma$. The “m” in the equation is equal to the mass of the movable part of device and apparent mass caused by the magnets under attractive force. When the set crosshead speed is attained, the set-up changes from accelerated motion to uniform motion as shown in Fig. 6b. In the absence of force for acceleration, the baseline force values do not change as they are not dependent on crosshead speeds Fig 5. Therefore, the force required to accelerate the movable part is the main contributor towards the pattern of increased measured values of retentive force with increase in crosshead speed.



a: Accelerated motion b: Uniform motion

Fig. 6 Forces acting on movable part of measuring device

To measure the forces acting to the movable part of measuring device; retentive force measurements were done with no magnet or keeper on the lower table. The resultant curves are shown in Fig. 7. At low crosshead speed of 10 mm/min (Fig. 7a), the measured force values showed an initial steep rise then smoothly stagnated after generation of a force sufficient to counter weight of the movable part and friction force. Contrastingly, at high crosshead speeds of 500 mm/min (Fig. 7b), a peak representative of increased force of acceleration exists before stagnation of values measured. Baseline force values for both high and low crosshead speeds were equal. These results further demonstrated that the force of acceleration affected the retentive force values measured. Therefore; crosshead speed has an effect on the retentive force values measured.



a: 10 mm/min b: 500 mm/min

Fig. 7 Curves of net force on movable part of measuring device at low and high cross head speeds

Conclusion

Using the retentive force measuring device specified in ISO 13017:2020; it is possible to measure retentive forces of magnets and magnetic attachments accurately at crosshead speed of up to 35 mm/min. Crosshead speeds higher than 50 mm/min, lead to higher measured values than the actual retentive force due to an increase in force necessary to accelerate movable part of device to the set speed.

Acknowledgments

The authors gratefully acknowledge contributions from the following individuals of Tohoku University School of Dentistry: Ms. Yuna OSAKA, Mr. Takumi ANDO and Mr. Kei ITO.

References

1. Y. Tanaka, New dental magnetic attachment, pp 2-90, Ishiyaku Publishers, Inc, Tokyo, 2016.
2. ISO 13017:2020. Dentistry — Magnetic attachments.
3. ISO 22674:2016. Dentistry — Metallic materials for fixed and removable restorations and appliances.
4. ISO 527-1:2012. Plastics — Determination of tensile properties — Part 1: General principles.
5. ISO 37:2017. Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties.
6. Y. Ogawa, Y. Umekawa, T. Ishigami, Y. Takeuchi, N. Tsukimura, K. Ohtani and S. Ohno: Effect of crosshead speed on magnetic retentive force, J J Mag Dent, 18(2), 39–41, 2009.
7. ISO 13017:2012. Dentistry — Magnetic attachments.
8. ISO 13017:2012/Amd.1:2015 Dentistry — Magnetic attachments.
9. Y. Takada: The commission report of the ISO corresponding committee working toward the international standardization of dental magnetic attachments -ISO/TC106 meeting in Osaka-, J J Mag Dent, 29(1), 20–26, 2020.

Mechanical consideration of implant support in removable partial denture design applied by a magnetic attachment using three-dimensional finite element analysis

Kumano H, Kanbara R, Fujinami W, Matukawa R, Ando A, Hata M, Kojima N, Yoshioka F,

Ozawa S, Nakamura Y, Nakamura H, Shoji K and Takebe J.

Department of Removable Prosthodontics, School of Dentistry, Aichi Gakuin University

Abstract
The purpose of this study was to examine the mechanical effects of implant support in removable partial denture design using three-dimensional finite element analysis. The analysis model was a partial edentulous mandibular where #35, 36, 45, 46 and 47 were missing. For design of the basic model, the RPI clasps were designed on #34 and #44 as retainer, and a magnetic attachment was applied on #37 as overdenture abutment. The implant support models were created in which two types of implants with different lengths (6.5 mm and 10.0 mm) were placed in cantilever missing on the right side of the mandible of the basic model. Stress analysis of these analysis models was conducted. In the implant support models, there was no significant difference in the analysis results depending on the length of the implant. Additional support by the implant demonstrated the stress reducing of the abutment teeth even by the short implant. These results suggest implant supported removable partial denture would expand its indication on designing removable partial denture.

Introduction

In the design of removable partial dentures in which tooth support and tissue support with different amount of tissue displacements are complicated, it is very difficult to set appropriate mechanical distribution especially for cantilever missing.

In such a situation, the application of the magnetic attachment to the posterior molar can change the missing form from the cantilever missing to an intermediary missing by providing the tissue support at the posterior position. In addition, it is clinically very useful to acquire the retentive force of the denture by the attractive force of the magnetic attachment.

In recent years, as a method of prosthetic treatment from the crown bridge to the removable denture, although implant treatment has been established, as another method, as well as the magnetic attachment applied to the posterior molar, There is also report on the use of implant support in the at the posterior position to stabilize removable partial denture.

However, there are still many questions about the mechanical effects of implant support in the design of removable partial denture.

Objective

The purpose of this study was to examine the mechanical effect of implant support in the design of removable partial denture applied by a magnetic attachment using three-dimensional finite element analysis.

Material and Methods

1. Analysis model

The mandibular model used in this study is shown in Fig.1. For model construction, a mandibular plaster model and a skull model (P10 - SB.1) manufactured by Nissin Co., Ltd. were used (Fig. 2).

Initially, this mandibular plaster model was scanned using a model and impression scanner (7 series, Dental Wings, Montreal, Canada) to make model shape data in STL format. Next, a skull model was CT photographed and the obtained CT data was prepared in STL format with mandibular bone data and tooth root shape data using three-dimensional construction soft (Mimics version l1.0, Materialise, Leuven, Belgium). We imported these data into computer aided engineering（CAE）pre／post processing software (Patran 2013 windows 64bit, MSC software, Los Angeles, USA) and constructed a model. The thickness of the residual ridge mucosa and periodontal ligament were set with reference to the literature values and the morphology of the mandible was simple form.[1]

Fig.1 : The mandibular model used in this study

Fig.2 : Mandibular plaster model and a skull model

The design of the removable partial denture is shown in Fig.3. The magnetic attachment was applied on #37 as overdenture abutment and the RPI clasp was applied on #34 and #44 as the direct retainer. The magnetic attachment applied in this research was GIGAUSS D1000 and accurately reproduced its high diameter and width for model construction.
The analysis model created by the above method was used as the basic model in this study.

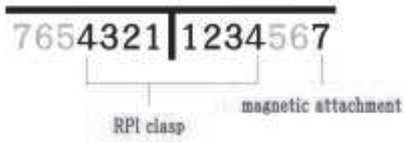


Fig.3 : The design of the removable partial denture

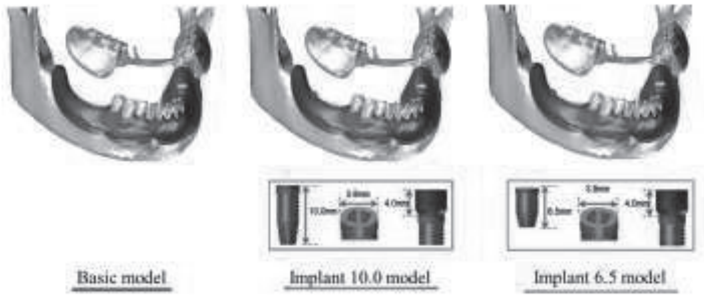


Fig.4 : Analysis items

2. Analysis Items

Analysis items are shown in Fig.4. The implant support models were created in which two types of implants with different lengths (6.5 mm and 10.0 mm) were placed in cantilever missing on the right side of the mandible of the basic model. The implant of the implant support model was equipped with a healing abutment (height 4.0 mm) and set as a support area under the denture base.

The mechanical property values of the analysis model are shown in Table 1. About the periodontal ligament and the residual ridge mucosa, these nonlinear viscoelastic properties were introduced by material constant conversion program（Table 2）.

Table1 : Mechanical property values

	Young Modulus (MPa)	Poisson Ratio
mandibular bone	11,760	0.250
enamel	41,400	0.350
dentin	18,600	0.350
metal(Co-Cr)	70,000	0.300
resin	2,450	0.300

Table2 : Material constant conversion program

	Young Modulus (MPa)	Poisson Ratio
Periodontal Ligament	0.020	0.200
	0.085	0.300
	1.500	0.350
	2.500	0.400
	4.000	0.490
Residual Ridge Mucosa	0.150	0.300
	0.700	0.350
	3.000	0.350
	3.900	0.350
	4.600	0.450
	11.000	0.470
	16.500	0.490

3. Analysis Conditions

The load conditions are shown in Fig.5. The loading site was a total of 4 places on the denture occlusal surface and the loading direction was perpendicular to the occlusal plane. Based on the literature value, the load amount was set to 200 N in total[2]. The inferior border of the mandible was defined as a constraint condition in the x, y, and z directions. In the contact

Fig.5 : Load conditions

condition, the contacting relationship with the tooth and the mucosa in contact with the denture was added by Coulomb friction and the coefficient of defined Coulomb friction was set at μ = 0.090 for this study. [3]

The evaluation of the analysis results was based on the Von Mises stress and the displacement of the denture.

Analysis Results

1. Stress distribution in the alveolar bone

Fig. 6 shows a stress distribution in the alveolar bone in each abutment tooth. In the #37 of the alveolar cavity which applied a magnetic attachment, stress relaxation was confirmed in the implant 10.0 model, the implant 6.5 model as compared with a basic model. Next, in the #34 of the alveolar cavity, no significant difference was confirmed in the alveolar cavity in any of the models. However, in the distal alveolar cavity, stress relaxation was confirmed in the implant 10.0 model and the implant 6.5 model compared with the basic model.

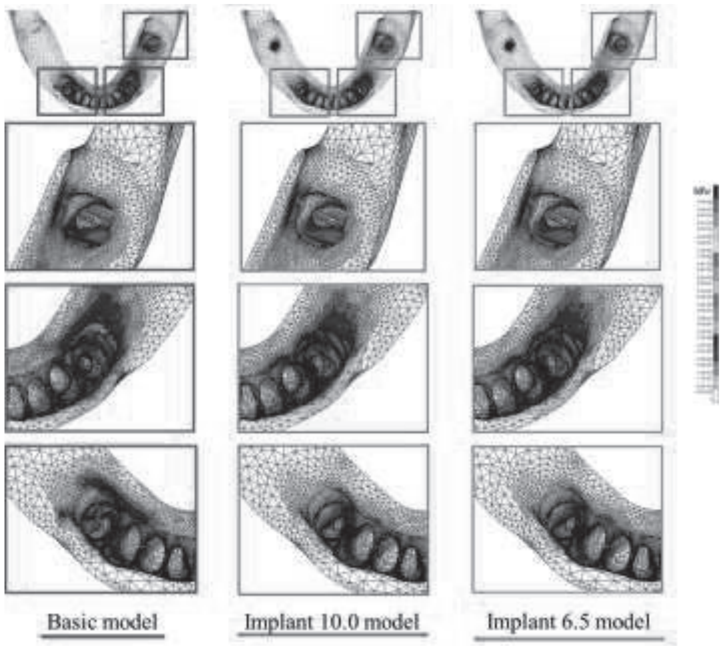


Fig.6 : Stress distribution in the alveolar bone

2. Stress distribution in the residual mucous membrane

Fig. 7 shows the stress distribution in the residual mucous membrane. In the residual mucous membrane of the right side, significant stress relaxation was observed in the implant 10.0 model and the implant 6.5 model compared with the basic model, confirming that the mucosa supporting area of denture was decreased. Next, comparing the implant 10.0 model with the implant 6.5 model, no significant difference was observed in stress distribution in the residual mucous membrane.

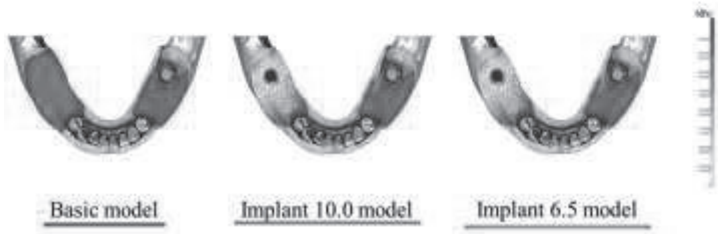


Fig.7 : Stress distribution in the residual mucous membrane

3. Displacement of denture base

Fig. 8 shows the amount of displacement of the denture base. In the part corresponding to the # 45, 46 and 47, a decrease in the amount of displacement was observed in the implant 10.0 model and implant 6.5 model compared with the basic

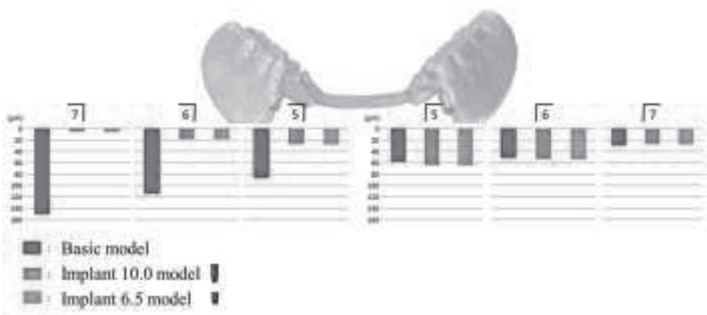


Fig.8 : A mount of displacement of the denture base

model. The basic model showed a tendency for the displacement amount to increase toward the distal side, and the implant 10.0 model and the implant 6.5 model showed a tendency for the displacement amount to increase toward the mesial side. In the part corresponding to the # 35, 36 and 37, the difference in the amount of displacement was not observed in all models, and the amount of displacement tended to increase toward the mesial side.

Discussion and Conclusion

From the results of this study, as a mechanical effect of implant support in the design of removable partial denture,

1: Stress relaxation was observed in the tissue around the abutment tooth, including the magnetic attachment.

2: In the burden style of denture, it was confirmed that the tissue borne area was reduced and the displacement of the denture base was suppressed.

3: In the implant 10.0 model and the implant 6.5 models, significant differences were not observed in both stress distribution and denture displacement in the alveolar bone.

Therefore, these results suggest implant supported removable partial denture would expand its indication on designing removable partial denture.

References

1. M. Kishi : Experimental studies on the relation between area and displacement of loading surfaces in connection with displaceability in the mucosa of edentulous alveolar ridge under pressure, Shikwa Gakuho, 72, 17-45,1972.
2. M. Manda, C. Galanis, V. Georgiopoulos, C. Provatidis, P. Koidis : Effect of severely reduced bone support on the stress field developed within the connectors of three types of cross-arch fixed partial dentures, J Prosthet Dent, 101, 54-65,2009.
3. Y. Sato, Y. Abe, Y. Yuasa, Y. Akagawa : Effect of friction coefficient on Akers clasp retention, J Prosthet Dent,78, 22-7,1997.

25 mm

25 mm

How to Write the proceedings

25 mm

TiTle including No. : Times New Roman 14pt Bold

0.5 line

Name (Initial. Family name) : Times New Roman 11 pt, (indent of a 0.5 line above and under this line)
ex. Y. Takada, N. Takahashi[1] and O. Okuno[2]

0.5 line

Affiliation: Times New Roman 11 pt, ex. Division of Dental Biomaterials, Graduate School of dentistry, Tohoku University
[1]Depatrtment of Magnet Science, School of Dentistry, Inaka College
[2]Laboratry of Magnet, Institute of Sendai

0.5pt line (Black)

One line

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)

25 mm

- 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.

医歯薬出版 ● 新刊・好評書のご案内

新・磁性アタッチメント
磁石を利用した最新の補綴治療

田中 貴信 編

磁性アタッチメントの第一人者が
わかりやすく解説した必携ガイドブック!!

- ● 口腔内での維持･安定性が高度である磁性アタッチメントの臨床術式・手順について，豊富なカラー写真･図を用いてわかりやすく解説.
- ● 旧来の機械的支台装置とは異なる特性をもった磁石・磁性アタッチメントの基本的事項の記述はもちろん，最新臨床術式や各種専用付属品の活用法を具体的にまとめバージョンアップをはかった最新版.

■ B5判 ／ 240頁 ／ カラー
■ 定価 17,600円（本体 16,000円+税10%）

新 インプラント オーバーデンチャーの 基本と臨床
磁性アタッチメントを中心に

田中 譲治 著

30年以上の臨床経験からノウハウを余すことなく紹介した待望の最新刊

- ■ 成功のための７つの勘所，各章または各項に設けられた重要ポイント，設計チャート，確認チェック表などを掲載し，インプラントオーバーデンチャーの理解と臨床での活用がすみやかに進むよう工夫を凝らしました.
- ■ 20年を超える長期経過症例を含む120以上の代表症例を供覧し，義歯の設計，術式，注意点，実際の臨床に即したテクニックなどをわかりやすく詳細に解説しています.
- ■ 要介護を見据えた補綴のあり方や，CAD/CAM，CT，3Dプリンター，口腔内スキャナーなどを応用した次世代の義歯製作法まで，新しい時代を拓く臨床例も網羅.

■ A4判 ／ 200頁 ／ カラー　■ 定価 19,800円（本体 18,000円+税10%）

SINCE 1921 100th 医歯薬出版株式会社
〒113-8612 東京都文京区本駒込1-7-10 TEL.03-5395-7630　FAX.03-5395-7633 https://www.ishiyaku.co.jp/

Thinking ahead. Focused on life.

MORITA

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(2021年9月現在)

歯科用精密磁性アタッチメント

フィジオマグネット キーパーハウジングパターン 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

掲載商品の標準価格は、2021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 キーパーハウジングパターン 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　株式会社ケディカ　宮城県仙台市泉区明通3-20　〒981-3206　T 022.777 1351
販　　売　株式会社 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
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