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MONTHLY FOCUS

Considering prosthodontics in the aging society

Round-table discussion

Implant Overdentures for mandibular edentulous patients

- First part: Searching its application and boundary



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Writing contributions to academic journals and commercial publications.

Major books: “Overdentures applied to clinical cases”, “Implant clinical cases using magnetic appliances (co-authorship)” (both published from our publishers)



Jiro Abe,

Born in 1955 with 27 years clinical experience. Private practice director of Abe Dental Clinic, Chofu, Tokyo. Many lectures, books and articles on “Suction theory of the mandibular complete denture retention”.

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Yukio Kameda,

Born in 1963 with 20 years clinical experience. Private practice director of Kameda Dental Clinic, Kawaguchi, Saitama. Variety of writing contributions including prosthodontics, periodontics and occlusion science.

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Introduction

Kameda (Moderator): In these recent years of high blooming of dental implant therapy, world attention has been on overdentures supported with implant structures as they call an implant overdenture (hereafter called IOD) as a new alternative option of restoring the mandible edentulous jaws.

Now here we are at the discussion table with three of us, Prof.Yoshinobu Maeda from Osaka University, who is one of leading researchers in Japan for overdentures supported by natural teeth or implant structures, and Dr.Jiro Abe, who has been well known as a private practitioner of complete denture therapy as well as other prosthetic therapies keeping in mind of periodontic concern. And Yukio Kameda, I myself have been practically involved with IOD therapies in edentulous mandibular jaws.

We are going to discuss on current reality and future possibility of IOD specially focusing on “edentulous mandibular jaws”.



Objects designed for this discussion (First part)

- ☞ To know that implant supported prosthetics should rest on a denture base.
- ☞ To know how to determine the grade of difficulty in an edentulous ridge case.
- ☞ Current ideas of applying implant supported overdentures from mutual views of literature and practice.

1. Why is IOD applied to an edentulous ridge?

Grade of difficulty in an edentulous patient is becoming higher and demanding.

Kameda: First of all, Dr.Abe, please state your reasons why IOD is paid attention to in an edentulous patient. Dr.Abe has been well known in practice for the complete denture construction. Many readers will be in wonder and interested to know if you would state reasons why you are involved.

Abe: Conclusively, our practical feeling has confirmed that it is difficult to enhance patient's degree of satisfaction only with conventional type of complete denture in order to deal with difficult cases, as you may call, among many edentulous cases. **(Fig.1)** I have been long involved with practices as a professional expert of complete dentures, and this is my practical feeling.

And also I think that possible treatment boundary of complete dentures would be crossed over with the modality of IOD. Today I would like to refer to the boundary of complete denture therapy based on my personal experiences, and I firmly believe that there should be any possibility of IOD with what this boundary would be overcome. And we would like to discuss with you here over the issue where the priority of IOD could be found, if any.

Kameda: We all agree to discuss exclusively on the case of difficulty, do we?

Abe: Yes, we do. Our clinical attention of edentulism should be focused on complete denture prosthetics and should not be deviated. IOD is definitely agreeable under certain conditioned circumstances. Overdenture is poor in cleaning performance because the denture base is designed to cover the abutment body. Some clinicians consider it tabooed from the periodontic viewpoint. In this regard, I would like to refer to my personal views from periodontics.

Kameda: I agree that edentulism should be based on complete prosthetics like Dr.Abe. Reasons why I perform IOD cases are because I also firmly believe that there should be any possibility over the case of difficulty. It is true that relative number of complete denture patients in my whole practice is decreasing year after year, and yet number of difficult cases has increased. Those patients are as in good health as ever

and their demand is higher rather than before, when accepting complete dentures.

To meet those patients' demand, IOD's are effective, and their degree of satisfaction would be as comparatively high as complete denture wearers. In spite of their low invasiveness and low costing among various kinds of implant therapies, I think that their effectiveness is gravely significant.

Now, Prof.Maeda, you already have taken careful attention for quite some time to overdentures to be supported by natural teeth or implant structures. Could you please illustrate how and when you became involved with this?



Fig.1 a~e Before we take an option of IOD, let us brush up properly the construction skills of complete dentures! (Abe)

In order to construct a highly sophisticated denture within the three-dimensional space of edentulous patient oral cavity, exact impression taking, proper occlusal registration, error-controlled resin polymerization are extremely important. When once one of these vital items should fail, score of this denture would be down to point zero.

In order to perform a series of process perfectly without errors, it is advised to learn the technique of BPS (Bio-functional Prosthetic System, Ivoclar Vivadent AG. imported by Hakusui Trading Co.) that has been currently approved as a teaching

system by 23 dental schools out of totaling 49 in the United States.

IOD should be definitely based on the denture base.

Maeda: When I was a graduate student, my senior researcher took a degree with thesis in overdentures. And in this opportunity I took an example of clinical case and was impressed with its usefulness after that. In those years there was yet still substantial number of patients who lost teeth extensively among not only aged people. At that time I was involved with issues how to conserve multiple tooth loss seeking solutions of overdentures supported by natural tooth abutment.

Both of you already demonstrated your interest in IOD from the view of complete dentures, and I did not enter in the realm of overdenture through the implant therapy, either. My entry was not originally for positive introduction of dental implants into overdentures, but my long-time quest was whether or not there was a way to cope with 'a similar jaw condition like a few remaining natural teeth'. It was like a denture but incorporated with implants within. In other words, I meant "a denture is an ultimate prosthetic base".

In fact, conventional prosthetic modality should be deeply rooted and it is important to take an implant into account on this principle.

Abe: Yes, definitely. Generally speaking, as long as an edentulous ridge is sound in shape, most patients may be satisfied with complete prostheses. In a case of stable ridge and occlusion, if an implant is occasionally introduced only for reasons that a dentist cannot construct with a complete denture, it must be a dangerous case. If this dentist cannot perform basic therapeutic procedures of impression, occlusion, teeth arrangement and adjustment to a simple case, he or she could never perform procedures of IOD. (**Fig.1**) Low level of techniques of impression taking and provision of occlusion will raise a serious problem of denture mobility involved with implant abutment, and giving way to collapse.

My belief is that "A complete denture should be constructed three-dimensionally in the oral cavity." And technically speaking, "A denture should be stabilized as much

as possible on the ridge mucosa.” This must be consistent with IOD.

Maeda: You are exactly right. Unless you have proper technique of complete denture construction, there is no chance of IOD. Our conception should not be like making a denture in an accidental place where an implant lies. On the contrary, ideas should be well thought that an implant is in place within range of denture.

Summary

- IOD has possibilities of reaching beyond boundaries of complete denture therapies. (Abe)
- IOD is effective amid growing demand of patients while difficult cases of complete denture are increasing. (Kameda)
- IOD is, however, never possible without mastering technique of complete denture construction. (Maeda, Abe and Kameda)

2. IOD: Historical background

History of IOD is old.

Kameda: Now, next, Prof.Maeda will illustrate historical background of IOD and current status of researches.

Maeda: When we track back of origin of IOD, it is not a new one as a matter of fact and was already available in 1970's at the time when a dental implant was also developing. But IOD was used as a last possible alternative means before the early part of 1980's in clinical case where multiple implant fixtures were not placed.

Serious study of IOD was in fact started from the late 1980's. Majority of studies, however, were limited to the survival rates of implants placed, and what was worse, its survival was rated low. There were many various reasons for its low rate.

① No definitive studies of effectiveness were processed through taking comprehensive account from clinical data like in the present time.

② Survival rates were studied mixed with maxillary cases.

These facts can be included among many reasons. That is, general information was

not yet organized.

In the meantime, at McGill University Canada in 2002, a workshop session on IOD was opened and there was a consensus statement presented (hereafter called McGill consensus statement) as in “Implant overdentures: The standard of care for edentulous patients”, and same name of book was published. (Fig.2)

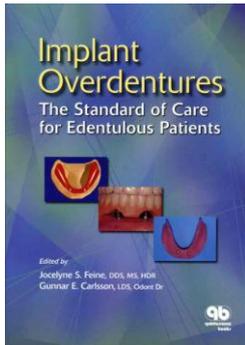


Fig.2 a,b “The McGill Consensus Statement” defines “IOD as first choice standard of care for mandibular edentulous patients”.



- Conventional types of removable dentures are no longer best proper choice in prosthetic therapy.
- First choice of prosthetic care for mandibular edentulous jaw case is a removable type of two-implant supported overdenture.

Fig.2 a,b The book, “Implant Overdentures, The standard of care for edentulous patients” published by Quintessence Publishing Co.,Inc. (U.S.A.) contains part of summary (a) of “McGill Consensus Statement” in “IOD is first choice of mandibular edentulous ridge therapy” and in context referring to IOD workshops and details of McGill Consensus Statement.(b)

“McGill Consensus Statement” that organized IOD.

Abe: Yes, Dr.Kameda and myself read the book, and this McGill Consensus offered for me a good opportunity to take interest in IOD for treating edentulous mandibular jaws. I have a long question how much worldwide appreciation was about this consensus.

Maeda: That is a hard question. I heard directly some attendants speaking to me “There is a question whether every opinion has been dealt with justly.” Or “Somewhat biased. That was a conference where IOD has to be justified.”

However, it has been highly valued that IOD and conventional complete dentures were compared from various angles. Particular attention to the following two items would be significant.

- ① They have concluded that IOD is significantly effective in case of mandible.
- ② This opportunity has been taken first time for evaluating IOD from the viewpoint of ‘the degree of patient satisfaction’.

Moreover, it is true that Randomized Clinical Control Trial (RCT) ^{*1} has become more active than before since the McGill Consensus Statement, including comparative clinical studies of IOD. This consensus did undoubtedly promote active.

Increasing demand of IOD

Abe: I feel that IOD cases are getting more active throughout the world. I have been appointed as certified instructor of a complete denture construction system, “BPS” from Ivoclar Vivadent ^{*2}, and I had a discussion last year-end with leader of headquarter there over the issue. Then and there he said, “Our present goal of BPS does not rest on complete dentures but on IOD’s”. This is what surprised me most. In addition to this, some famous dental technician in the United States referred to the fact, “40% of edentulism in the States are restored with conventional complete dentures, and the rest of 60% receive fixed implant superstructures or IOD’s.”

In this case, however, I have no idea whether this is applied to my stated indication of IOD, or “a case of difficulty in edentulous ridge”. Even though the McGill Consensus Statement has concluded, stating “Mandibular two-implant overdentures as first choice standard of care for edentulous patients”, my feeling has hinted that there might be lacking some word in it.

When we read carefully the book summing up on the McGill Consensus, the mandibular edentulous cases listed here are all equivalent to the level of “difficulty”.

So I thought it better that might be written clearly in “the mandibular edentulous cases of difficulty”.

Maeda: You are exactly right. I think also that does not mean “all cases of edentulous jaws”.

Kameda: In any case, IOD is attracting worldwide attention undoubtedly and we practitioners should think it vital to have clear indication criteria.

Summary

- IOD itself was a method even before 1970's, but since the McGill Consensus Statement in 2002, its clinical application and research has been definitely advanced.

Key Word for better understanding of this discussion

*1 **What is RCT?:** RCT is abbreviated from Randomized Clinical Trial. In this test, trial subjects are randomly discriminated into groups (randomization) and they are tested in one method as Method A and in the other as Method B, and test results are assessed for comparison. For this reason, this method is regarded as highly defined in evidence level.

*2 **What is BPS?:** BPS is a denture construction system developed by Ivoclar Vivadent AG (Liechtenstein) based on studies of Dr.Rainer Strack, Dr.Eugen Schleich and other researchers (Tubingen University) and is abbreviated from Biofunctional Prosthetic System. Currently 23 dental schools out of totaling 49 in the United States have approved as teaching system.

3. Indication criteria of IOD in contrast with a complete denture

Case of difficulty in edentulism is indicated to IOD

Kameda: Now we would like to discuss over the issue of IOD indication criteria. Previous discussion has already confirmed, “It will be indicated to a difficult case of an edentulous mandible”. But in practical cases there may be differences in thinking about one case of difficulty from another among clinicians. And moreover, facts have already indicated that their techniques and skills are different to some degree.

Abe: The question is displeasing to anyone. (laughter) When we try to design high degree of function, shape and restoration of structures, every case of edentulous ridge would belong to case of difficulty. Roughly speaking, whether or not the ridge shape is favorable, all edentulous ridges are potentially indicated to difficulty. It is same again even from the degree of patient satisfaction. If a patient is not satisfied, no other than fixed type implant substructures or IOD will be selected.

And, therefore, when we are asked, “In what specific case is IOD needed?”, then the answer might be “In every case” if theoretically speaking. But if you set condition, like “Only a dentist who can make a denture three-dimensionally in the mouth should place an implant”, then the case of difficulty in edentulism is indicated to the criteria of IOD. Now being based on this discussion, here we have the principles of difficult cases as in the following.

- ① Patient whose ridge resorption is so much advanced with unstable occlusion.
- ② Patient whose function cannot be restored well.
- ③ Patient whose degree of satisfaction is low.

Evaluation of IOD criteria from the residual ridge

Abe: Let me present an example case. First of all, the case of ① in Fig.3 is good for the ridge condition, and it might be simple to construct a complete denture, and so IOD criteria will exclude this kind of case.

Kameda: Yes, right. Even if a patient wishes an implant placement in this case of ① in Fig.3, the placement will not be in the anterior region but in the posterior site,

and a fixed type of bone anchored bridge will be designed.

Abe: The case of ② in Fig.3 is a case with normal residual ridge. This type of ridge would be controversial whether a complete denture be given or IOD, depending on the skills of an operator. But, to my personal opinion, for a dentist who is not sure of the complete denture construction on this type of ridge, top priority should be to learn the skills first for constructing a complete denture. So if we do not mention to patient's wish or degree of patient satisfaction, I would think the case of ② in Fig.3 not indicated to of IOD criteria.

Kameda: Even if the case of ② in Fig.3 is taken up to place an implant according to a patient's wish, IOD is not taken account of as the best choice, like the case of ① in Fig.3.

Abe: Now as for the case of ③ in Fig.3, this would be all agreeable with the case of difficulty for constructing a complete denture. Around here in such a case the priority of IOD would be found.

Kameda: Yes, I agree. The case of ③ in Fig.3 shows the ridge resorption and we presume the ridge is hardly present. This is exactly a case of difficulty of complete denture. Even in case of placing implants, the fixed bone anchored bridge will not be sufficient if an extensive implant surgery is not performed.

Maeda: No, it will not. It will not be impossible with the fixed type of implant placement in this case of ③ in Fig.3, but any type of bone anchored bridge would build up a crown restoration away from the ridge level, and its crown form would be difficult. In other words, in a case like this, IOD will be better indicated for satisfactory reasons of form restoration and speech articulation. Also this option would be easier.

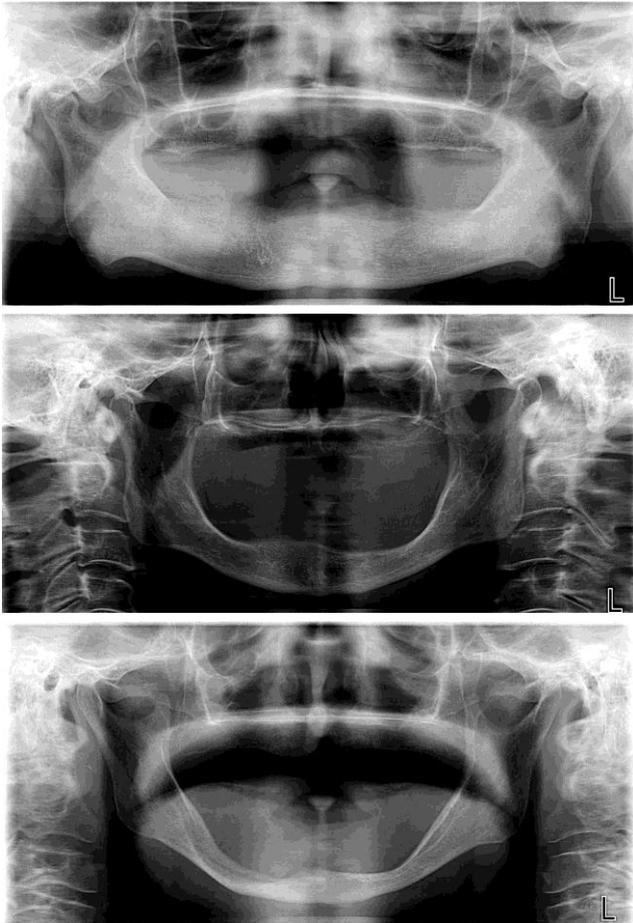


Fig.3 Consideration on IOD indications from different residual ridge conditions (Abe)

- ① Case where bone resorption is rarely seen. ☞ Not considered as IOD indication.
- ② Case where bone resorption is in the medium degree. ☞ IOD is possibly indicated, but if complete denture construction is possible with confidence in this degree of ridge condition, IOD should not be opted.
- ③ Case where bone resorption is highly advanced. ☞ IOD is indicated.

Fig.3 IOD indications considered from different residual ridge conditions.

Recent suggestions to GBR for enhancing esthetics and to a bone augmentation for improving anatomical conditions as well as to “All-on-4 dental implants” and immediate dental implant loading for establishing early functional restoration are all in topics in the news. But as far as oral functions such as mastication, articulation and swallowing are concerned, restoring with a denture plate over the

missing part of the ridge might be more reasonable, natural and effective.

Kameda: Let me summarize here. We believe that any case that retains the residual ridge can be properly opted with a complete denture. In case an implant placement is applied, options are available including the fixed type of bone anchored bridge. Meanwhile, in such a case as the ridge resorption is highly advanced, IOD should be indicated. And it happens to be more often efficient in restoring functions than a complete denture. Also in such a case, IOD would be more advantageous in esthetics and articulation than a bone anchored bridge.

Maeda: On the contrary, patients' ages of reaching edentulous jaws at present will not be same as those who are reaching edentulism in the future. For the future after more people are advanced in ages, they will become edentulous completely in later ages, exhibiting resorbed ridges and impaired adaptability to use new dentures. These cases will belong to the case of difficulty especially for younger dentists and they will be all the more difficult cases of edentulous jaws. For this reason, earlier option of IOD should be better taken up at an early stage of less amount of ridge resorption before entering a difficult case.

However, it is admitted from present situation that patients of difficult case are in great troubles. And there may be still clinicians who can manage these cases, but in the future, there will be less number of experts who can handle them.

Abe: By all means, in the future, there will be increasing cases of implant application to cases of difficulty. Here what we have to pay attention to is that, even if a case is indicated and a dentist is adaptable with skills, this is not enough for opting toward difficult cases. The more difficult is the case, the more difficult the construction of superstructures will be. Dental management of cleaning and maintenance will be furthermore difficult, and any one of factors are essential and, if lacking, implant failure will be increased.

In fact, in addition to mastering the construction skills of complete dentures together with dental technicians, both patients and dental hygienists should be skillful with cleaning IOD, and finally comprehensive strength within the dental

office should be essential.

Summary

- IOD is specifically meaningful for the case of difficulty in the edentulous mandible. (Abe)
- IOD is especially effective in case when grave invasive intervention is to be avoided or when morphology provision would be difficult with a bone anchored bridge. (Maeda)
- Long-term maintenance of IOD requires comprehensive strength of dental office including dental technicians and dental hygienists.

4. What is the case of difficulty of complete denture that requires IOD?

Patient satisfaction of Complete denture / IOD is verified from chewing force.

Kameda: We are now going to discuss how IOD contributes to the complete denture case of difficulty from case presentation of Dr.Abe and myself. First here in my case, although the suction effect of the complete denture was attained, patient's satisfaction was low, and complained, "It cannot bite." And so IOD was provided to this patient's edentulous mandibular jaw. As Prof.Maeda already referred previously, recent studies of IOD demonstrated "patient satisfaction" as an important index. And so I paid attention to occlusal center of gravity and chewing force or bite force among many studies above. By using "Dental Prescale" and Occluser (GC), chewing forces were assessed. (Fig.4-15, Fig.4b-d, 5-8, 9b, 10-12, 13c, 14 photos excerpt by permission of Journal of PRACTICES IN PROSTHODONTICS 2009: 42(2): 196-211, Y.Kameda, "Functional Restoration with Implant Overdentures - Discussion on Desired Denture Border Configuration")

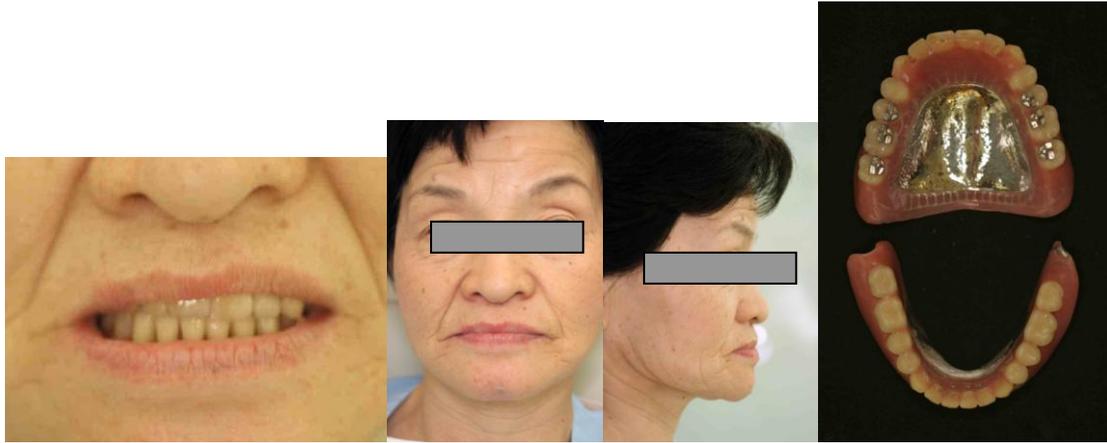


Fig.4 a~d

Presentation 1 Case where chewing force is verified using IOD on an edentulous jaw (Kameda)

① Initial visit

Fig.4 a~d The patient was a 69-year-old female, and her major complaints at her initial visit were mandibular denture pain and chewing disorders. First sight seemed to indicate decreased distance of vertical dimension and intermaxillary distance. Her old dentures (d) were joined with metallic bladed teeth and tapping was tested very stable. The mandibular denture was additionally retained by suction effect, and it made a sound when the denture was tried dislodged. But the patient was still not satisfied with them.



Fig.5 The panoramic radiograph at the initial visit revealed the alveolar bone in the posterior region almost reduced to the mandibular canal.



Fig.6 a~c Observation confirmed the reduced mandibular ridge and the alveolar mucosa almost mobile. Especially the alveolar crest on the left side was discontinued and not well defined.



Fig.7 a,b “Dental Prescale” assessment. Detected bite force at this stage was 43.5N, which was very low values.

Literature from Aichi Gakuin University reported that detected bite force of dentate healthy adults at the age of 22 were about 900N for males and about 800N for females. And another data reported approximately similar results for those who had achieved 8020 Movement. So this patient had only about 1/20 weaker bite force than normal healthy dentate mouth.

咬合力表示面積	Bite force display area
平均圧	Mean pressure
最大圧	Maximum pressure
咬合力	Bite force
全体	Total
右	Right
左	Left
咬合力表示面積	Bite force display area
平均圧	Mean pressure

最大圧
咬合力

Maximum pressure
Bite force

② Examination prior to implant placement ~ after placement

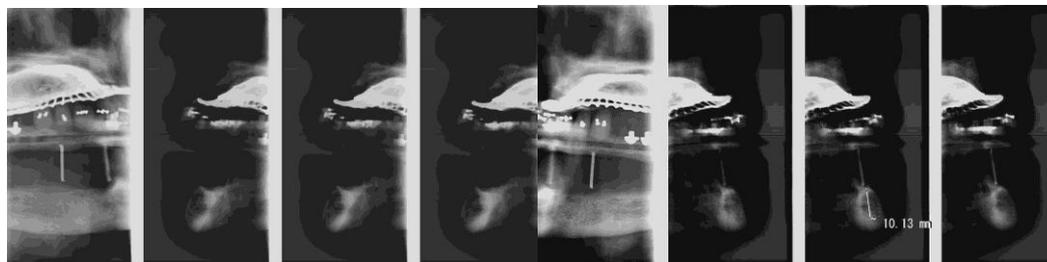


Fig.8 a,b In this case, as shown in Fig.4~8, it was viewed that it would be difficult to enhance patient satisfaction only with new construction of another lower complete denture. So a metal plate complete denture for the upper jaw and two-implant supported IOD for the lower jaw were designed as a treatment plan. But the tomographic images (a: right canine region, b: left canine region) showed the anterior jaw bone resorption was extensive over the left and right sides and at risk highly for surgical intervention. And the patient desired minimal invasive surgery. For these reasons, narrow type implants were introduced with the knowledge of the fact that their evidences were not yet established.

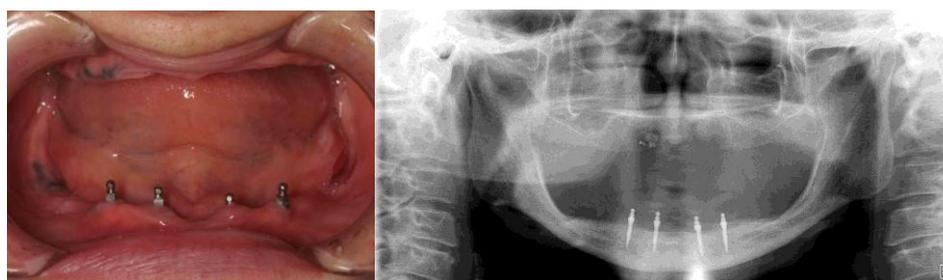


Fig.9 a,b Four units of MDI Mini Dental Implant (IMTEC Sendax MDI, IMTEC, imported by IS Corp.) in diameter 1.8mm x length 10mm were placed.

③ IOD construction through BPS procedures



Fig.10 a,b

Upper and lower jaws impression taking with custom trays mounted on Gnathometer M (Ivoclar Vivadent AG. Imported by Hakusui Trading Co.). On wearing IOD, denture mobility in function will not be preferable from reasons of damaging effects on implant bodies. So, BPS procedures were employed for proceeding functional impression taking under the closed mouth position.



Fig.11 a,b As above, Gnathometer M was used for Gothic arch tracing. In this case, the construction was based on the apex points because the apex and tapping points were both coincided.

④ Finish and insertion of IOD through BPS procedures



Fig.12 a,b Finished maxillary metal plate complete denture (a) and mandibular

IOD (b)



Fig.13 a~c Left side views on insertion (a) and facial views (b, c).

Fig.14 a~c

⑤ Postoperative bite forces evaluation by Occluser.

One week after insertion Two weeks after insertion One month after insertion

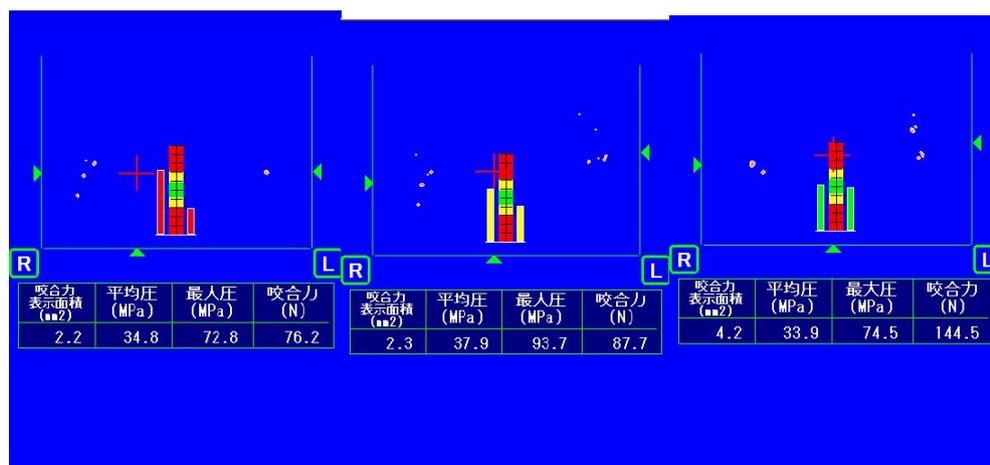


Fig.14 a~c Changes of measurement results by Dental Prescale over the periods

from one week after IOD insertion to one month. Note different changes from the course of Fig.8. In accordance, occlusal centers of gravity were being consolidated. Bite forces were, from 43.5N preoperatively (Fig.8), restored to 76N in one week and 144N in one month.

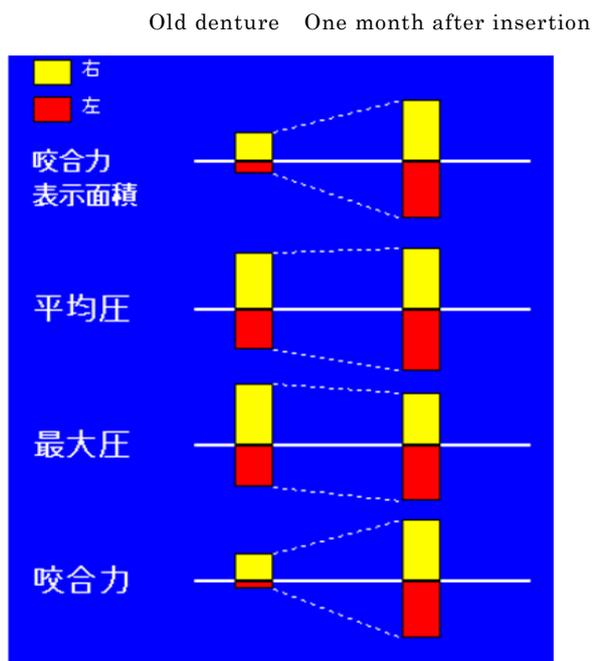


Fig.15 Data from parameters such as Bite force display area, Mean pressure, Maximum pressure and Bite force were taken and compared between old denture and one-month-period after IOD insertion. Significant improvement is noted. Increased bite force with left-right balance has suggested to the patient's well balanced bite habit.

Kameda: As described above I assessed the degree of patient satisfaction and actual feeling of practice by taking support from the Prescale unit. In the meantime, I think the data may be sufficient to support the assessment. How would you think about this kind of approach, Prof.Maeda?

Maeda: As for your trials to attest the variation of occlusal center of gravity^{*3}, studies are frequently reported using T Scan^{*3}. In those studies, dynamic

observation has confirmed that, if dentures are stable, functions are improving to achieve the right and left balancing, and occlusal center of gravity is shifting to the center. In this presented case, magnitude of bite force assessed by the Prescale unit and differences of right and left positions over the time changes have already proved it.

By the way, have you used Mini Dental Implant? The literature is limited with less evidence, but under condition of minimum space and volume of bone as well as patient's wish for minimally surgical invasion, this kind of option cannot be denied easily. There should be any solution for such a case. In the North American countries, it is very popular. Our concern is its number of distribution and strength. If this concern is well established, your present case will be acceptable and fulfilled extensively.

Possibility of IOD toward the case of difficulty of complete dentures

Kameda: Now we would like to have Dr.Abe's presentation.

Abe: This case is not joined with IOD, but this case suggests its possibility. (Fig.16 – 25)

Presentation 2 Case where a boundary of complete denture construction showed due to a case of “super” difficulty (Abe)

① Initial visit

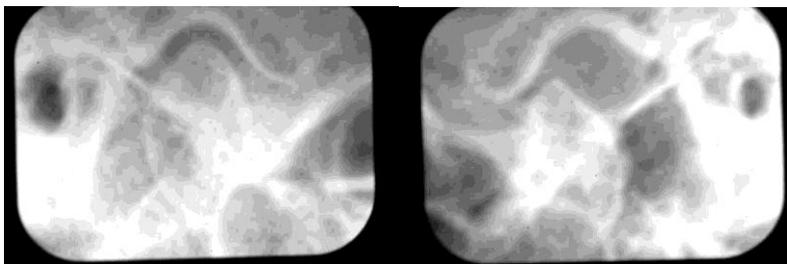


Fig.16 a,b The female patient became edentulous at the age of 26 years and her initial visit was at 36. Her major complaint was, “The facial distortion to the right, and the denture is painful.” Her desire was this major complaint improvement and making a non-covered palate denture. TMJ radiograph of rest position through Schuller method here confirms a remarkable deformation of the head of mandible

and an anterior displacement of the head of mandible.



Fig.17 a, b Mandibular movement disorders are shown here at the initial visit. The figure a shows the mandibular displacement to the right, and the figure b shows abnormal jaw movements. Contrary to these symptoms, however, restoration of chewing and esthetics would be easier to the author's mind as the patient was at younger ages and her QOL would be improved relatively at earlier stage. And then treatment procedures were initiated by providing a complete denture in mind, "Organic problems like TMJ will be restored through the process of remodeling, and, as a result, abnormality such as jaw movements will be better restored to normality."

② Correction of jaw positions through treatment denture



Fig.18 a~c Treatment denture delivered. As previously described, the patient was aged relatively younger and so easier correction of jaw positions and functional restorations are prospected at first. But, in fact, three years have passed after changes repeated several times every time treated but returned at once due to larger displacement of jaw positions.

③ Finish and insertion of newly made dentures



Fig.19 a~d Newly made dentures in the year 1999, three years after the initial visit.



Fig.20 The facial profile on insertion of new dentures. Although the treatment lasted over a long period of time, the author thought the final dentures of both upper and lower jaws with good suction effect and pleasant insertion. After treatment finished, the patient was happily married having a child birth, and the author was confident that esthetics and masticatory function were correctly restored according to her original wish.

④ Changes of mandibular jaw positions after one year of new dentures insertion.



Fig.21 a, b Changes of mandibular jaw positions after one year of new dentures insertion. The results were repeated displacement of mandibular jaw positions and

necessary correction of dentures.

⑤ Patient's assessment after one year of new dentures insertion.

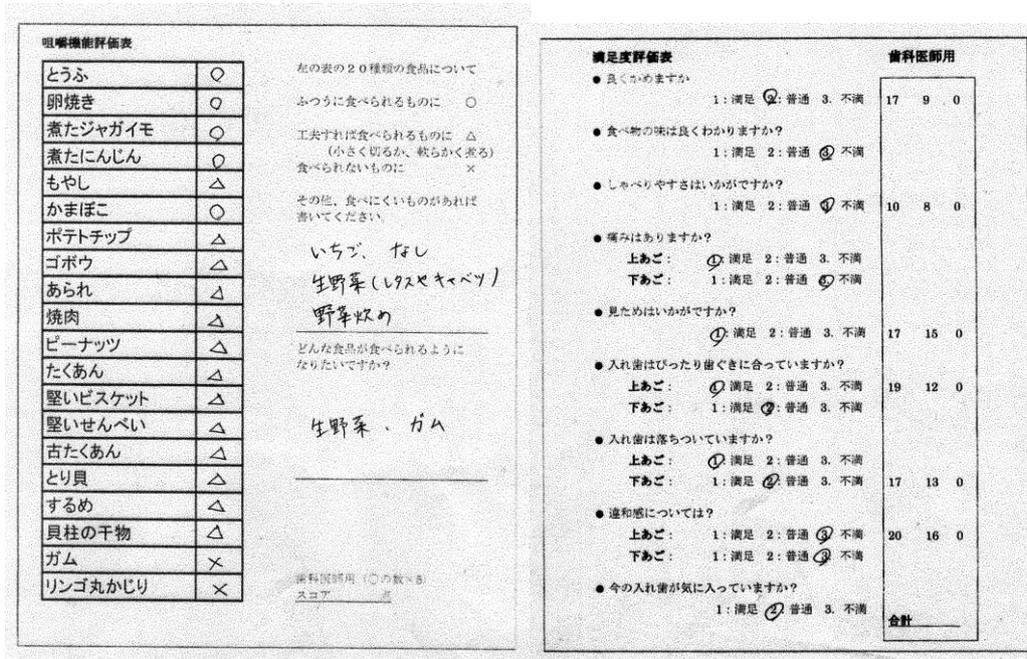


Fig.22 a, b Results of Sato's assessment method of denture satisfaction and chewing that was obtained from the patient after one year of new dentures insertion. Reality is severe, and, contrary to a dentist's confidence, it was known that the degree of patient satisfaction was considerably low.

Chewing Function Assessment Chart

豆腐	Tofu soybean curd,	卵焼き	Fried egg,
煮たじゃがいも	Boiled potato	煮たにんじん	Boiled carrot
もやし	Bean sprout	かまぼこ	Steamed fish paste
ポテトチップ	Potato chips	ごぼう	Boiled burdock root
あられ	Cubic rice crackers	焼肉	Grilled meat
ピーナッツ	peanuts	たくわん	Yellow pickled radish
堅いビスケット	Hard biscuit	堅いせんべい	Hard rice cracker
古たくわん	Old pickled radish	とり貝	Japanese cockle
するめ	Dried cuttlefish	貝柱の干物	Dried scallop ligament
チューインガム	chewing gum	リンゴ丸かじり	apple biting

Question about 20 different foods listed on the left

What is able to eat normally ○

What is able to eat with additional preparation (small cut or soft cook) △

What is not able to eat ×

Please write other foods that are hard to eat.

いちご strawberry

なし pear

生野菜 (レタスやキャベツ) fresh vegetable (lettuce, cabbage)

野菜炒め sautéed vegetables

What kind of food do you wish to become easy to eat?

生野菜 fresh vegetable

ガム chewing gum
For dentist's use, count number of ○
Scores

Degree of Denture Satisfaction Assessment Chart

For dentists use

- Can you chew well? 1.Satisfactory, 2.Neutral, 3.Unsatisfactory
- Can you test taste of food?
- How well can you talk?
- Any pain?
 - Upper jaw
 - Lower jaw
- How do you like appearance?
- Does the denture fit well to the gum?
 - Upper jaw
 - Lower jaw
- Does the denture sit well?
 - Upper jaw
 - Lower jaw
- Any ill-feeling with the denture?
 - Upper jaw
 - Lower jaw
- Do you like the denture now?

Totaled scores

⑥ TMJ, chewing force situations of 13 years after the initial visit.

Right opening Right rest position Left rest position Left opening

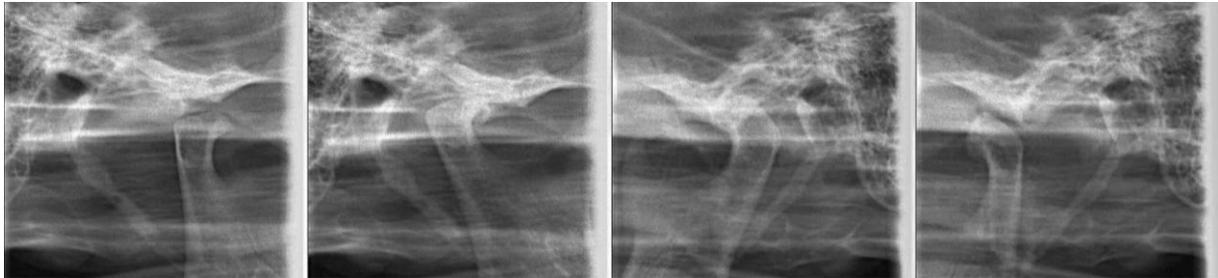


Fig.23 TMJ radiographs of 13 years after the initial visit. Significant change of the right TMJ, and displacement and movement disorders of both TMJ's were identified. Radiographs conditions were different from previous preoperative records of Schuller Method (**Fig.17**) due to digitalization, but deformation of TMJ and asynchronism movement situations on opening of the head of mandible are confirmed. "Remodeling of TMJ formation" that was originally hoped turned out to be failed, and mouth opening and closing paths have not yet been straightened.



Fig.24 Similarly, measurement data of Dental Prescale after 13 years from the initial visit are shown.

⑦ Ridge resorption after 10 years and 13 years from the initial visit

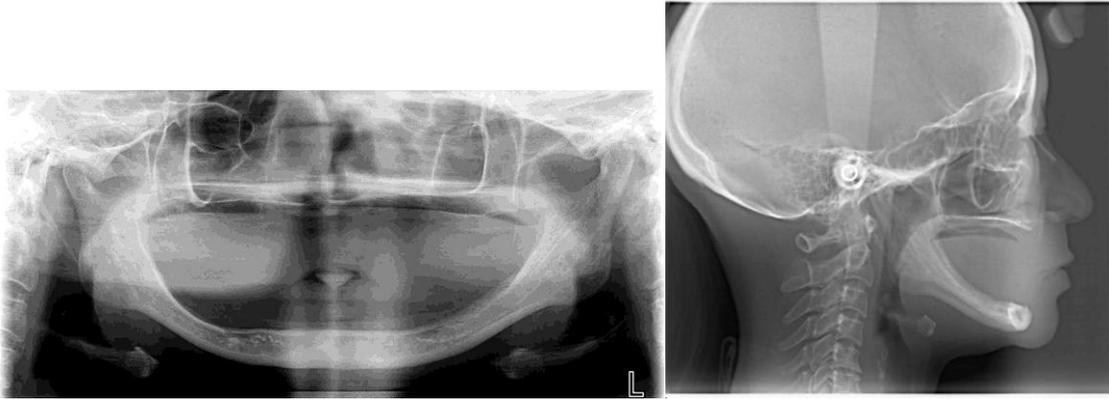


Fig.25 a, b Panoramic radiograph after 10 years from the initial visit (a), and cephalogram after 13 years from the visit (b). Although a therapy of complete denture was properly given, the photos demonstrate that the ridge resorption is not yet controlled.

Key Word for better understanding of this discussion

*3 **What is occlusal center of gravity?:** This is a method to determine the bite force distribution throughout the dental arch. Each tooth exerts its force, and from this force, comprehensive gravity center is determined. In case right and left balancing of bite force is developed, this center will be located often approximately in the center of antero-posterior and right and left of the dental arch.

*4 **What is T Scan?:** In 1980's Maness and others developed it in Boston. This is an occlusal force measuring system with a contact sensor sheet, and their dynamic changes can be observed in digital movies. Also changes of occlusal gravity center over time can be analyzed.

Abe: Looking back at this case, I find the patient still young and thought that any favorable recovery would be possible with a good quality of denture and every problem will be restored. With this hope in mind I entered into the therapy. But what I finally could achieve was quite limited to esthetic restoration, enhancement of chewing ability to a certain degree, and not complete but some extent of position normalization of the head of the mandible. As a dentist I could not solve the patient's confronting problem. In this case that confronting problem meant the normalization

of jointed structures. In fact, in this case what complete denture therapy I could treat was limited to ad hoc treatment ... I must say that the patient condition will be worsened stage by stage. (**Fig.26**)

The major reason for the failure of normalization of jointed structures was the weakness of bite force that could exert with wearing a complete denture. And this weakness made functional pressure weaker toward the temporomandibular joint area. And I think that this weakness inhibited remodeling*⁶ within the body. Undoubtedly an edentulous patient has porous quality of trabecular bone on the head bone of the mandible. It is said that, in comparison with a dentate jaw, functional pressure that is loaded to the temporomandibular joint area of complete denture patient is reduced to about 40 – 50%, and especially in a case of highly reduced residual ridge is limited only to 10 – 20% of whole dentate mouth. (**Fig.27**)

Fig.26 Boundaries that are shown from long-term prognosis of difficult case of complete denture therapy, and new hope for IOD.

Complete dentures have following ...

- Chewing capacity and esthetics will be restored fairly.
- Early correction of displaced mandibular position will be less possible.
- Paths of mouth opening and closing will be less possibly straightened.
- Bone remodeling of edentulous jaw patients will be little hoped.

Then and now, IOD will be hoped for ...

Fig.26 Boundaries that are shown from the case in **Fig.16 ~ 25**, and new hope for IOD.

Fig.27 Literatures that discuss over morphological abnormality and relative causes of edentulous TMJ and jaw bones.

- ① Kawashima T.: Study on structures of TMJ and surrounding bones, Shika Gakuho 1996; 96(9); 911 – 949 (Japanese)

- Tooth loss will cause to exert 20 ~ 50% less of pressure on the jaw bones.
- Morphological abnormality is confirmed in TMJ or jaw bone of 60% population over 40 years of age.

② Hongo T.: Morphometrical study on trabecular bone structures of Japanese mandibular articular process, Shika Gakuho 1987; 87(12); 1583 – 1611 (Japanese)



- Trabecular bone continuity of edentulous jaw is less compared to dentate jaw.
- Contributing factors of dynamic environmental changes loaded on the bone is greater than those of aging process as for trabecular bone structure changes of mandibular articular process in dentate and edentulous jaw bones.

③ Abe S., Ide Y.: Jaw bone changes by aging process, the 4th, TMJ anatomy and morphological changes after tooth loss, Shika Gakuho 1999; 99; 435 – 443 (Japanese)



- Abnormal deformation of the head of mandible will be caused in non-denture wearers or improper denture wearers.
- As a result of comparison in interior trabecular bone changes within articular fossa between 70-year-old dentate and 50-year-old edentulous patients, cortical bone of edentulous patient became thinner and interior trabecular bone became more porous in complementary density.

Fig.27 Literatures that discuss over morphological abnormality and relative causes of edentulous TMJ and jaw bones. Meanwhile, the reference in ③ where major cause of jaw bone changes are caused by tooth loss rather than aging process is consistent with the report from Iwakata et al. (Iwakata S, Nishi k, Kono S, Ishioka Y.: Study on the movements of head of mandible of aged population, Japanese Journal of Gerontology 1994; 9; 89 – 96 (Japanese)). This report has that, in

comparison of dentate aged and younger population, sagittal condylar paths decreased in $6 \sim 8^\circ$, while the mandibular movement paths showed little differences.

Does IOD promote remodeling of TMJ?

Kameda: Let me summarize roughly. You had a major object to stabilize the mandibular jaw position through the way of a complete denture toward a patient whose jaw position was irregular and unstable. But it did not result in normalization of jointed structures which was fundamental to stabilization of the jaw position because there were limitations of bite force increase by the provision of a complete denture.

Key Word for better understanding of this discussion

*5 **What is Sato's assessment method of denture satisfaction and chewing?:** An assessment method of both clinicians and patients toward denture wearing in the form of questionnaire and score sheet. It includes assessment of chewing function of the denture, of patient satisfaction and of QOL. For details of sheet and study results please refer to, Kohno M, Sato Y, Kitagawa N et al.: Outcome assessment immediately after insertion in the therapy of newly made complete denture, J the Japan Prosthodontic Society, 2007: 51(2): 260~269 (Japanese)

*6 **What is remodeling?:** Bone metabolism has repeated cycles of osteoclastic cells to resorb and osteoblastic cells to create bone, and in about 200 days, bone is newly formed. New bone formation will change shapes, and in this discussion, proper pressure loading on the TMJ region allows to restore proper bone shape formation, which means remodeling in this discussion.

Abe: Exactly. To stabilize the jaw position does depend on how we can increase bite force. In order to fulfill this object, an implant therapy can be added to treatment options for better increase of bite force. I think that IOD will contribute greatly for

that purpose. And then an increase of bite force will stimulate the temporomantibular joint and will bring an organic change to the trabecular bone.

What do you think about an idea around this, Prof.Maeda? By all means, stable removability of a mandibular denture has to be achieved in order to fulfill the methodology of normal restoration of jaw position, and if it is possible, this attainment may be easier.

Maeda: I once had a chance to construct a treatment denture in a case where a single denture^{*7} was inserted in the mandible while the maxillary was dentate but had tooth mobility due to periodontal disease. But we had a hard time to attain normal restoration of jaw position. And IOD was suggested, and finally this denture does protect the remaining teeth to the present. It is true that unstable mandibular denture will likely make the jaw position irregular. And so the implantation would stabilize a denture and eventually the jaw position will help some stability.

Kameda: What do you think with Dr.Abe's idea on improvement of bite force and functional pressure by means of IOD, and then on promotion of remodeling with the temporomandibular joint? Will it be possible? Is there any literature on it? We would appreciate your suggestions.

Key Word for better understanding of this discussion

*7 **What is single denture?:** One side of edentulous jaw while the other opposing arch is dentate. In this case of complete denture on one jaw is called "Single denture". This kind of pressure loading and its acceptance will cause frequently a denture base fracture or underlying ridge resorption.

Maeda: I think it is possible. Remodeling in the TMJ region is related with formation and resorption of the temporal bone or mandibular jaw bone. There should be certainly of consensus based on their extensive supporting literatures regarding facts that TMJ's are the loading joints that are to share some amount of loading. And they state that the magnitude of loading will maintain within the range of

homeostatis, in other words, within the range of balancing of formation and resorption.

As for the relation between its magnitude of loading and formation/resorption in the joint area, there have been some theories, and one of them is shown in **Fig.28** as an example. This idea was organized by ex-Prof.Tsutsumi from Kyoto University, who studied the behavior of experimental animal bones in the orthopedic field under Prof.Kummer, Germany. The vertical axis indicates bone volume change, showing bone formation in the positive area and resorption in the negative. And the horizontal axis indicates stress applied to the bone, showing tension of the bone in the positive area and compression in the negative. Here in this case, whichever stress, positive or negative, is to become more than certain degree of magnitude, resorption will occur, and even if the value is in the smaller range close to zero, resorption will occur again. Both in tension and compression of either case, bone will be added, if the value is within this range.

So when Dr.Abe mentioned, “An edentulous case would decrease bite force to lower strength, and the trabecular bone quality would become porous. This is because any mechanical stimulation (bite force) is decreased”, this value range would correspond to “the smaller range close to zero”.

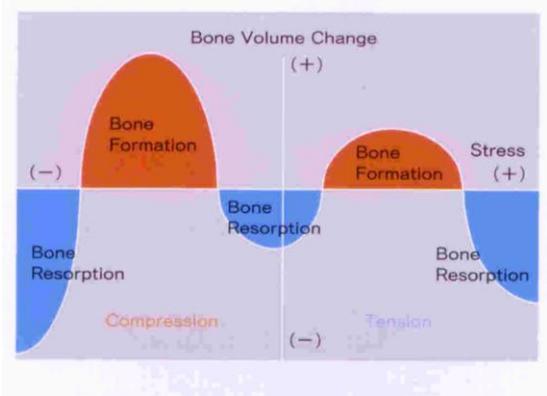


Fig.28 Relation of stress and bone formation / resorption

Fig.28 Relation of stress and bone formation / resorption. Vertical axis has bone

volume change, while horizontal axis show magnitude of stress on the bone. Whether tension stress or compression stress would create bone resorption when stress becomes greater than certain degree of magnitude, and, on the contrary, its stress value is, even within small range close to zero, resorption will occur again. In between these limited range of stress values whether tension stress or compression would create bone formation. (Quoted and modification approved courtesy of Prof.Sadami Tsutsumi.)

Meanwhile, in my analysis of the study on relation between the posterior occlusal support and TMJ loading, (Fig.29,30) the clenching of the remaining dentition after eliminating the most posterior region demonstrated larger displacement of the head of mandible within articular fossa, and pressure load increased accordingly. But, in reality, it is reasonable that muscle force should increase in response to the condition of missing dentition, and accordingly loading onto the temporomandibular joint turns out to be smaller.

For these reasons, in case of edentulous ridge, loading onto the joint area will become smaller, taking into consideration of lower muscle activity to exert bite force. On the contrary, application of IOD will increase bite force exertion and possibly raise the stress level of TMJ area into the range of bone formation.

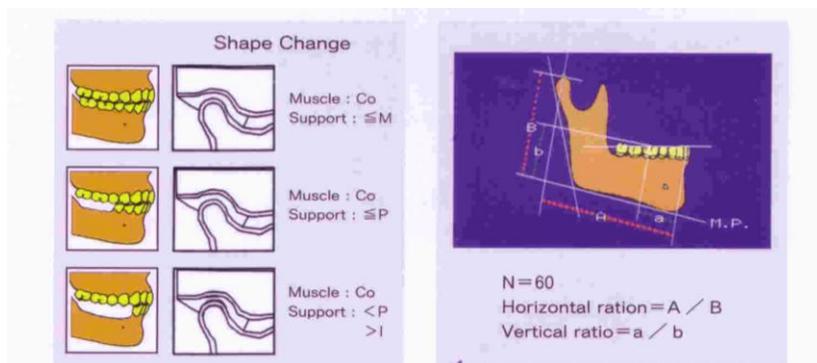


Fig.29 a, b Relation of posterior occlusal support and loading exerted on TMJ ①

Fig.29 a, b By the two-dimensional computer simulation using the concept of Fig.28, relation with the area of occlusal support and bone remodeling (resorption /

formation) of TMJ area was studied. As a result, here in this case, occlusal support was valid to the second premolar region namely in the case of shortened dental arch, there was no change seen in TMJ region (the left figure a in the middle row), and when the support was shortened than this, changes were seen as shown. (The left figure a in the lower row.) This model is based on mean values produced with the lateral profile standardized radiograph of 60 dentate subjects. (The right figure b) (The chart was quoted and modified from the literature, Maeda Y et al. Form and function of stomatognathic system in shortened dental arch situation: a biomechanical simulation. In: Morimoto et al (Eds). Brain and oral functions (International Congress Series 1079). Amsterdam: Excerpta Medica, 1995: 511 – 514)

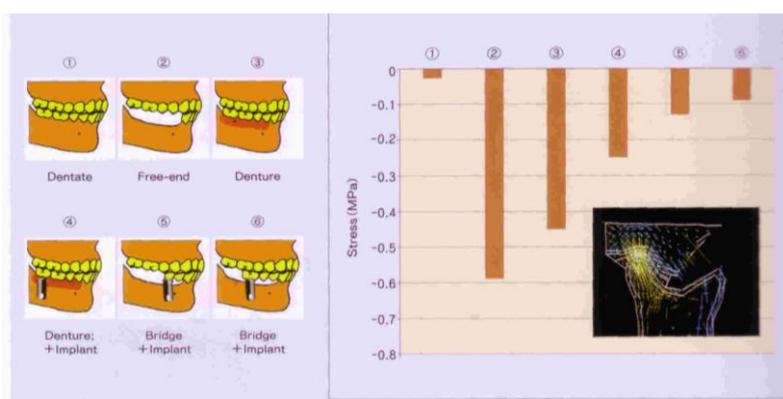


Fig.30 Relation of posterior occlusal support and loading exerted on TMJ ②

Fig.30 Relation with TMJ loading and treatment options of distal extension cases of only anterior arch remaining was studied. As a result, contrary to the case ① where remaining maxillo-mandibular jaws were valid in occlusion to the second molars (chart ①), loading is greater with a mucosal born denture (chart ③), but in case with implants placed underneath the denture base, loading was decreased (chart ④), close to the values measured in a case of fixed prostheses supported by implants (charts ⑤, ⑥). (The chart was quoted and modified from the literature, Maeda Y, Sogo M, Tsutsumi S. Efficacy of a posterior implant support for extra shortened dental arches: A Biomechanical Model Analysis, J Oral Rehab 2005: 32(9): 656 – 660)

Does an implantation on edentulous ridge delay ridge resorption than complete denture?

Abe: Now this patient is still 48 years old, but cephalogram and panoramic radiograph confirm advanced ridge resorption. (**Fig.25**) As a matter of fact, my denture construction in this case was found of unstable occlusion, denture collision, chewing difficulty due to displaced mandibular position, and so on. I think I had tried many various possibilities.

This case story is not exclusive to IOD, but I think a priority to implantation is given here in an implant case so that the mandibular position should be stabilized and that the ridge resorption should be controlled. In other words, minimizing denture mobility will possibly delay the speed of ridge resorption to some extent. A book written by Prof.Maeda ^{*8} has already referred, “Finally it will absorb but can delay it.”

Kameda: I admit that resorption of residual ridge or jaw bone of a complete denture wearer cannot be stopped in the process of change over time. And it is almost true that ridge resorption of a denture wearer may be larger than that of an implant placed patient.

For this purpose, I have researched reviewing literatures on the resorption of complete denture wearers. (**Fig.31**) Among them, Tallgren observed complete denture wearers over the period of 25 years and concluded that the denture wearing period had definitely played decisive roles on resorption of alveolar ridges. Atwood suggested that factors of ridge resorption were complex with factors of both general body system and local regions. And factors of local regions might be likely to some amount of force factors that work on underlying denture bearing ridges.

And Kalk concluded from various studies that ridge resorption of edentulous patients were extensively influenced by very existing dentures. So wearing denture itself might be involved with ridge resorption.

Maeda: As far as ridge resorption is concerned, extensive researches are being made to detect any promoting factors of bone resorption on a genetic level. That is, even under similar denture wearing condition, any individual who carries such promoting

genes would likely proceed the resorption while another who has no likely genes will reduce the change. If this study is advanced, one can take blood sample from a patient's tooth extraction site and inform, "Your risk of bone resorption will be high in the future and need any preventive measure from now".

Fig.31 List of literatures on discussion in reference to relation between ridge resorption of edentulous patients (complete denture wearers) and dentures.

① J Prosthet Dent. 1972 Feb;27(2):120-32

The continuing reduction of the residual alveolar ridges in complete denture wearers: a mixed-longitudinal study covering 25 years.

Tallgren A.



- Over observation period of 25 years, duration of tooth missing time (denture wearing period) has played decisive roles in the alveolar ridge resorption.

② Prosthet Dent. 1971 Sep;26(3):266-79

Reduction of residual ridges: a major oral disease entity.

Atwood DA.



- Ridge resorption is consequences of various factors including those of both general body system and local regions.
- Factors of local regions include that of force exertion toward the residual ridge (dentures and others).

③ Dent. 1989 Aug;17(4):162-5. Links

Some factors connected with alveolar bone resorption.

Kalk W, de Baat C.



- Ridge resorption volume is proportionate to duration time of edentulism and of denture wearing
- The very existence of denture itself influence on the degree of ridge resorption.

Fig.31 Literatures above referring to causes of ridge resorption of edentulous patients (complete denture wearers). Literature ① has been derived from the long-term follow-up of complete denture wearers over the period of 25 years. And the literature ③ refers to the results of investigating 92 edentulous patients with connections of ridge resorption and age, duration of edentulism, number of remade dentures, and denture wearing habit of day-and-night.

Key Word for better understanding of this discussion

*8 **What is Prof.Maeda's book?:** "Overdentures applied to clinical cases" written by Y.Maeda, 2003 published from our publishers, B5 size edition in 120 pages, price ¥6,200. Overdentures have different advantages and are applicable to various clinical scenes. So the author describes basics and applications of design and construction of overdentures supported by natural teeth or implants, as well as significance of maintenance. He also adds a series of necessary information on reference books.

*9 **What is Kelly Combination Syndrome?:** In 1972, Kelly E published paper "Changes caused by a mandibular removable partial denture opposing a maxillary complete denture, J Prosthet Dent 1972: 27(2): 140 – 150. Five clinical signs are seen in a case where maxillary jaw is edentulous and mandible has remaining anterior teeth exclusively. The signs are ① hyperkeratinized maxillary palate, ② increased fibrous tissues in maxillary tuberosity, ③ inflammation of maxillary anterior ridge, ④ elongation of mandibular anterior remaining teeth, ⑤ Distal extension bone

resorption in the mandibular partial denture. These conditions are called as Kelly Combination Syndrome

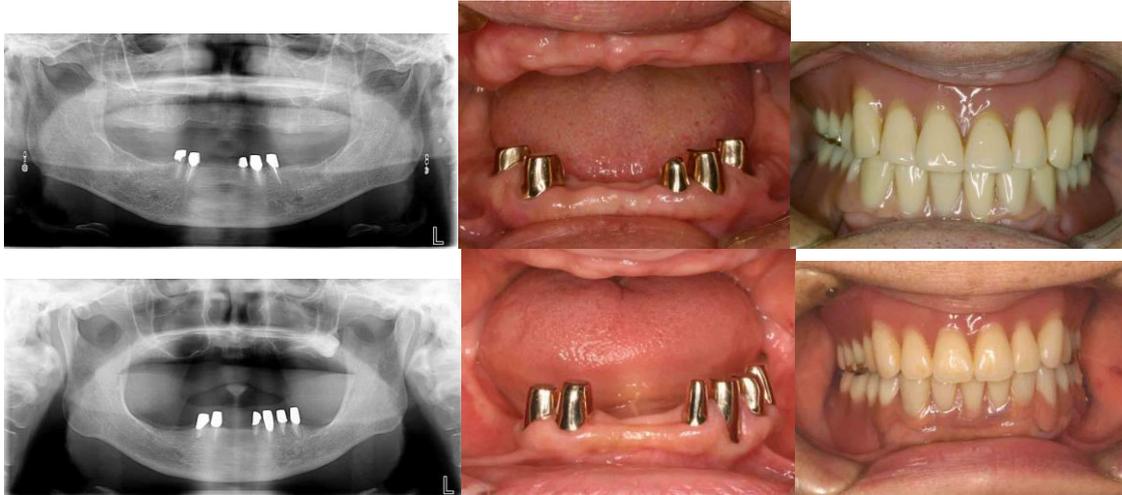
Unfortunately until present it is not yet well defined, and current tendency suggests that resorption occurs in the case of loading with a denture from above without any established evidence. This might lead to the notion that a complete denture should be to blame. Is it truly bad to wear a denture? Never, I say. Some patient is triggered with a complete denture to induce displacement of mandibular position or bone resorption, and some are not after all. There is no way to validate it at the moment but only misleading complexity.

IOD is beyond indications when the maxillary arch is anteriorly open and reduced.

Abe: In another case, there will some great problem be raised, when an implant is placed in the mandibular anterior region. Cases shown in **Fig.32** are all with edentulous in the maxillary and with a partial denture in the mandible. One of the upper two cases of three, namely cases ① of the maxillary single denture plus the mandibular AGC-made telescopic denture is seated on a good ridge form in the mandible posterior region, expecting significant mucosal bearing capability in the posterior region. And, as you may call, a stable posterior bite habit is established.

On the other hand, the lower case ② in **Fig.32** shows an extensive ridge resorption in the mandibular posterior region, while the maxillary ridge is reduced in the anterior and superior direction.

Fig.32 Cases that are prone to Kelly Combination Syndrome and that are not.
(Abe)



① The case where the mandibular ridge condition is good in the posterior region and the posterior bite habit is established.

☞ Not prone to Kelly Combination Syndrome → Indicated for IOD



② The case where the mandibular posterior ridge resorption is extensive and the maxillary arch is anteriorly open and reduced.

☞ Prone to Kelly Combination Syndrome → Beyond indication for IOD?

Fig.32 Like in this case of missing arch pattern with implant placement in the mandibular anteriors, the anterior bite habit is easily formed with the lower anterior implants because the maxillary jaw is open and reduced. This is prone to Kelly Combination Syndrome.

This kind of patient, as Prof.Maeda describes, has genes potential likely to induce ridge resorption. Since the posterior alveolar ridge does not accept the loading force, this patient tends to bite in the anterior region as the teeth are planted exclusively in the anterior arch. This tendency promotes rapid resorption in the maxilla

anteriorly to reach a state of flabby gum finally. This extreme case is called Kelly Combination Syndrome^{*9}, and nothing can be done to most serious case.

So, even in a case of IOD in the mandible with upper-lower edentulous ridges, when the maxillary arch is anteriorly open and reduced, mandibular anterior implantation has tendency to bite in the anteriorly and to transfer to a flabby gum of the maxilla to a worsened condition. So, what is important is that a supporting implantation in the posterior region should be given in an early stage in order to establish the posterior bite habit. For this reason, therefore, a case with anteriorly reduced maxillary ridge might be excluded from indications of IOD.

Kameda: As for this case of Kelly Combination Syndrome, I think, for example, in an edentulous mandible case, IOD would be better than a bone anchored bridge because the maxillary anterior bone resorption will be controlled with less pressure loading factors. How do you think?

Maeda: Yes, this is what I have been wondering about its validity. There might be no researchers who have determined in the process change over years. How about over years the upper case in **Fig.32** presented by Dr.Abe? Has the maxillary anterior turned out to be flabby?

Abe: No, in this case it has not. That is because any possible valid schemes of occlusion have been designed by giving metallic occlusal surfaces limited to both upper and lower second premolars and first molars, and by giving high strength of intercuspatation there, while leaving the rest teeth untouched and guiding to the posterior chewing. Sometimes there is a contact to the maxillary anterior arch, but there is no sign of flabby gum. This patient might belong to one whose osteoclast activity is low.

Maeda: There might be some extent to relieve onset of Kelly Combination Syndrome by changing a case into an overdenture. But this is an empirical rule and there is no definite evidence here to support. Now in a case of a mandibular implantation with fixed superstructures, there may be strong possibility of Kelly Combination Syndrome in the maxilla. There will be possibly natural.

Abe: As a conclusion, if multiple numbers of implants are placed in the mandibular

anterior region, there may be created conversely the trend of anterior biting habit. After implantation, patients are likely to bite in the front with less mobile implant site rather than on the mobile distal extension of denture base. So in due course of forming chewing habit, bodily system will respond to the implant support area and not to the mucosal support of denture base. So this discussion will raise a question of how many implants and what part of region should be placed after all.

Kameda: Now our next discussion will go to proper implant placement site, design of superstructures and, moreover, to maintenance of them in the next issue.
(continued)

Summary

- It is suggested that use of IOD would improve bite force and occlusal center of gravity. (Kameda)
- It is our feeling that IOD may be possible in case when bite force restoration is not predicted with a complete denture and when remodeling of the head of mandible is not available. (Abe)
- IOD is potentially promising for stable occlusion and residual ridge maintenance in a difficult case of establishing mandibular jaw position or of single denture. (Maeda)

MONTHLY FOCUS

Considering prosthodontics in the aging society

Round-table discussion

Implant Overdentures for mandibular edentulous patients

- Second part: Considering its design and cleaning performance



Yoshinobu Maeda



Jiro Abe



Yukio Kameda

Introduction

Kameda (Moderator): In this discussion, implant supported overdentures (hereafter called IOD) will be focused on as a new treatment option for the mandibular edentulous jaw especially concentrating on its possibility and practice. In the first part, we discussed on general idea of IOD, indications depending on different cases, and implant placement regions. Now in this part, as in the second part, practical implant placement for IOD, design of superstructures and maintenance will be featured..

Objects designed for this discussion (Second part)

- ☞ To search commonness and difference in designing complete denture and IOD.
- ☞ To discuss prosthodontics in dental implants based on periodontics.

5. Implant placement in the edentulous mandible. Where and how many should be placed?

One implant in the median of the mandible is the point of starting IOD.

Kameda: Now we would like to discuss an implant placement site for IOD.

Maeda: When we discuss over placing implants in IOD in the edentulous mandible, one piece of implant placement will be a starting point. And its placement site will be in the median line. Reason for this is that, according to our research, rotation is minimum in the midline of the mandible about mobility of denture in back and forth around. And deformation of denture body as well as jaw bone is least in the midline.

In other words, it is in good reason for dynamics science and realistic according to our research. Apart from our research study, similar reports have been common recently. This should be, of course, presumed to remain with some amount of bone volume in the anterior implant site. It may be impossible with extremely resorbed jaw bone. But anyway the final denture will be retentive with this support and also stability will be added.

Ideal pattern will be two in the posterior and another two in the anterior regions.

Maeda: For the purpose of established occlusal support and long-term stability, minimally essential number of implants will be different from above.

In another research results from ours, when the last ultimate ideal of occlusal support is conditioned under the clenching of 14 pieces of implants in the mandible, it is studied how situations are accordingly by reducing its number of placement and what minimum number of placement is valid for maintaining stable occlusal support. **Fig.1** shows the mandibular jaw bone deformation in this research, and **Fig.1 a** is a deformation with the 14 pieces of implants placed. Then afterward its number is reduced. **Fig.1 b** indicates 8 pieces, **Fig.1 c** shows with 6 pieces in the anterior portion. In **Fig.1 c**, the jaw bone also deforms a little as expected. **Fig.1 d** is at the time of only 4 pieces, or 2 in the posterior and 2 in the anterior regions.

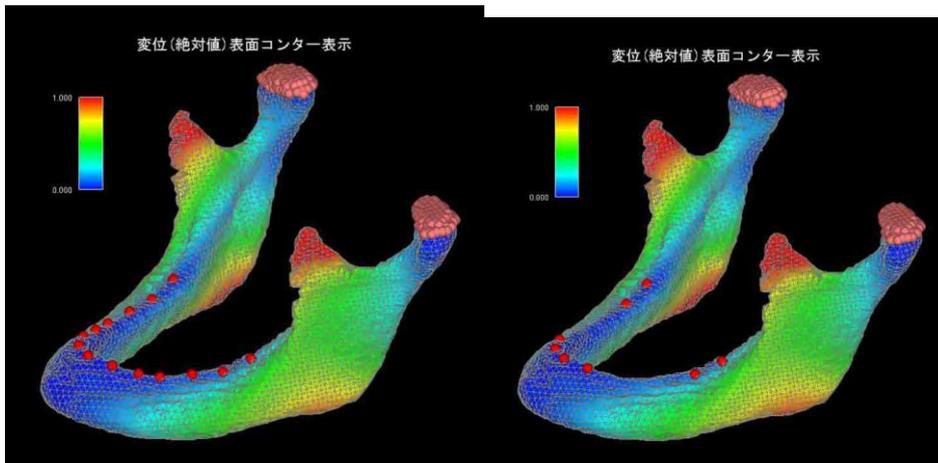
In comparison of **Fig.1 a** to those of **Fig.1 b~d**, 14 pieces may be ideal to our mind. With less deformity, stable biting is established. And situations of 14 pieces placement may be comparatively close to 8 pieces or 4 pieces of placement. But in case of 6 pieces, although the deformation is less, the posterior region is knowingly deformed.

Interestingly, a bone anchored bridge, as it is often true to design the posterior portion as cantilevered, would reportedly create new bone under this cantilever. This means in reality that the jaw bone there may be formed through remodeling after the jaw bone deformed. We think this is only an occasion of new bone formation through remodeling in an edentulous ridge. But this does not always mean that another new stability of occlusion could be obtained through this process.

From this discussion, it should be definitely effective in the sense of occlusal support that 2 pieces in the posterior and 2 in the anterior regions are placed. This, however, is absolutely a theoretical matter, and some would have a question, for instance, "What happens if all forces are down to these implants only?" Now we are researching with our graduate students regarding force distribution on implants and bearing mucosa of IOD. Until now it is evidenced limitedly, but the research suggests 30 or 40% of mucosal bearing will be effective. In case of IOD with 4 pieces placement, the base area is bearing in effect. With this effect, although they are only 4 pieces, loading onto the implant structures might be relieved and they are supportive to each other.

In case of 14 pieces of implants

In case of 8 pieces of implants



In case of 6 pieces of implants

In case of 4 pieces of implants

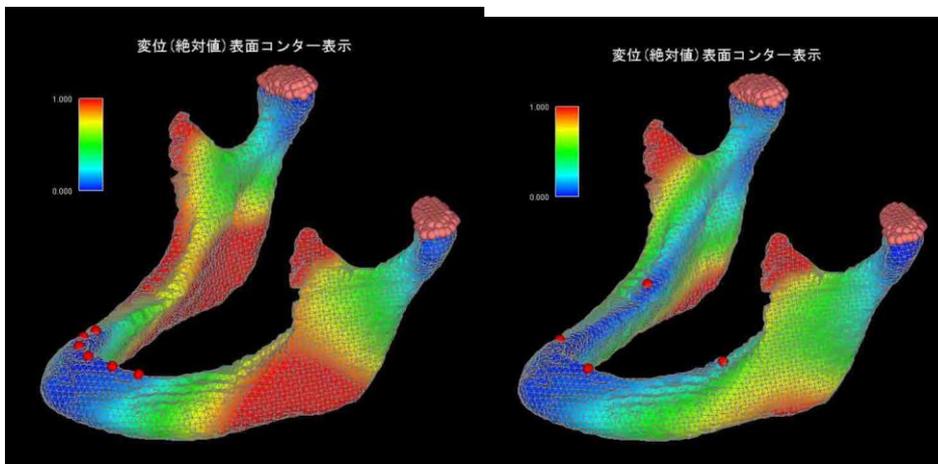


Fig.1 a~d Mandibular jaw bone deformation depending on implant number and placed site (Maeda)

Fig.1 a~d Data collected of jaw bone deformation through clenching muscles force as vectorial component exerted onto the occlusal support of assumed implant placement. As the color is reddened, deformation is larger, and bluish smaller. Cases are when the support is valid till the second molar in this control model (a), when 4 pieces in the anterior and 4 pieces in the posterior (b), when 6 pieces in the anterior according to Branemark original protocol (c), and when 2 pieces in the anterior and 2 pieces in the posterior (d). They are compared and deformation is largest for condition (c).

So, 2 pieces in the posterior and 2 in the anterior regions totaling 4 pieces of

implants might be basic and minimally essential. When we counsel with our patients, therefore, if conditions permit, our suggestions be, “Totaling 4 pieces at least in the anterior and posterior regions will be ideal. Then a denture will be stable, less changeable in the future and ideal.”

Nevertheless it is absolutely ideal. In our present discussion over the case of difficulty for IOD, even 4 pieces will be difficult to be placed. In such a case, 2 pieces in the anteriors are advisable. If a patient declines even to this, I would suggest, “Even one piece would be worth trying.”

So in this case one piece in the median line will be decided. Even with this, as we suggested before, the case will be effective enough.

Abe: The truth is that there are many dentists who can do nothing to prevent a mandibular complete denture from lifting up, not even its suction effect. In the previous part I mentioned, “A complete denture must be mastered first, then IOD comes.” But, although contradicting to this, if such a dentist above could keep his denture from lifting up by placing an implant in the middle, it cannot be helped as long as patient satisfaction is improving.

If two implants in the anterior arch, then where in the anterior to be placed?

Abe: In an edentulous case of difficulty, there will often be limited clinically to place implants in the anterior arch. The question would be to place them at the site corresponding to the lateral incisor site or the canine site. Where to be best placed? This is what most readers will be interested in.

Kameda: For example, as the McGill Consensus Statement has 2-implant as first choice standard of care, where should be the placement site? Also what attachments would be better to be used together?

Maeda: As Dr.Abe already discussed, there may be any question raised in the anterior arch, whether be at the lateral incisor site or the canine site. Some consideration will be possible to this question.

First, consider the curvature of an arch. In case where the ridge between both canine sites is straightened, or a type of rectangular arch, it can be placed within the

arch and retained by a bar attachment. But in a curved arch between them, implants are placed at the canine sites and then, if retained with a connector, the tongue space will be interrupted. So a single retainer will be given independently. Or otherwise, they will be placed in the lateral incisor areas. (**Fig.2**)

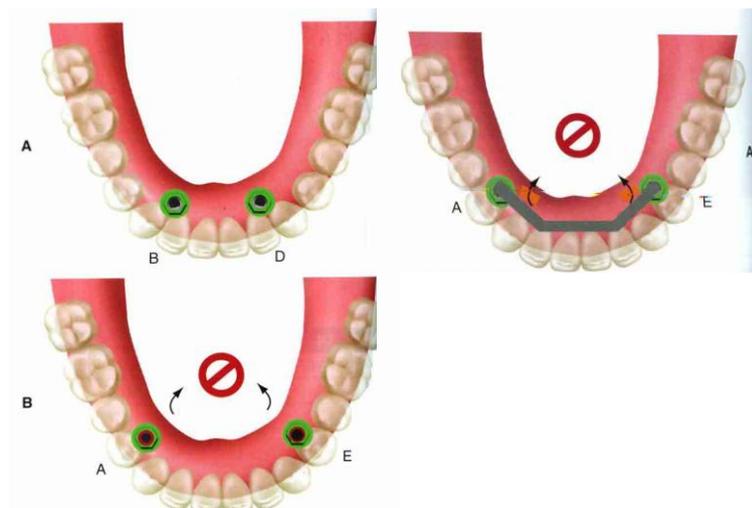


Fig.2 a~c Bar connection with two implants in the mandibular anterior arch is of most advantage in between the lateral incisor and the canine. (Maeda)

Fig.2 a~c Placement of 2 implants in the mandibular anterior arch becomes advantageous in between the lateral incisor and the canine (**a**). When placed posterior to the premolars, bar itself narrows the tongue space and promotes denture rotation (**b**), creating troubles of bending moment on the bar.(**c**) (Quoted and modified from the literature, Misch CE, Dental Implant Prosthetics. St.Louis: Mosby 2004: 214 – 216)

Next, what we often discuss is about lateral force. This depends on the distance of implants in between. **Fig.3** is also from our research results, and C refers to the sites corresponding to both the canine teeth, and LI refers to the lateral incisors. There, when the ball anchors were joined, the lateral force was greater as distance is farther.

And denture retention should be discussed. This also depends relatively on the distance of implants in between. The research demonstrates that, if both implants are farther in distance, retainers are abrasive and less retentive due to incorrect parallelism. There is a report that refers to the relationship of attachment distance and retention, or implants distance in between. Overall studies of them indicate that the shorter distance will help the case easier like in the lateral incisor sites on both sides or in between the lateral incisors to canine teeth sites. If the distance is given more than that, they will become less useful for dentist and patient.

Kameda: In the McGill book (ref. to No.5, p.15), 2 implants are placed after all at the sites corresponding to the lateral incisors. They reason that, if placed at the canine teeth sites, the bar connector would become a cantilever toward the anterior direction.

Maeda: Yes, I think so, too.

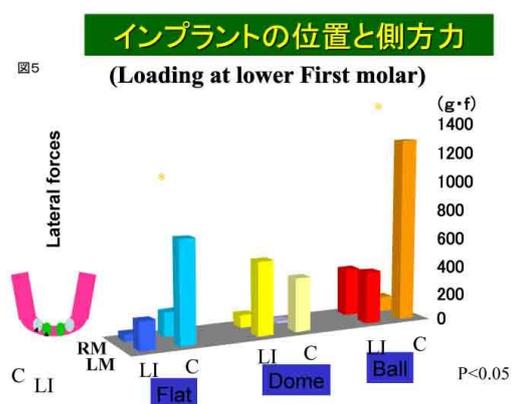


Fig.3 Relation of implant site and lateral force (Maeda)

Fig.3 IOD with 2 implants is assumed, and placed at the lateral incisors on both sides (LI) or the canines (C) retained with magnets (Flat and Dome types) as well as Ball, and occlusal force is given on the first molar area for measurement of lateral forces on the models. Results indicated the placement on the lateral incisor is likely known to create less lateral force. (Chart drawn from the literature, Horisaka M, Maeda Y, Sogo M, Okada M. Overdenture movements and lateral forces to non-splinted implant abutment with different types of attachment: A model study,

Selection of implant fixtures and insertion.

Kameda: What about an implant body selection for IOD case? Does it have to be longer and thicker as everyone expects?

Maeda: It should not be confined to the matter of IOD, but it was originally thought that any one thick or long as possible had been advised in the limited bone volume as a basis reason that one as long and as thick as available may be safer.

But recently it does not necessarily mean that a longer one is always better, but some report has that there might not be any difference from some certain length. As a matter of fact, in a fixed type of implant prosthetics, too short of length will be disadvantageous due to the question of crown to root length ratio.

As for the case of IOD, so called the question of crown to root ratio is improved by use of attachment in order to control the lateral force, and even a shorter one will be acceptable. Note, however, that there is an issue of initial fixation, some amount of bearing space area will be needed. This will therefore be likely to become a shorter and thicker one.

Kameda: For example, when multiple number of implants are placed, their parallelism is important, and how do you think with them?

Maeda: Yes, it is important. But in case of two implants placement at the lateral incisors site, precise parallelism of two implants will not be effected. Theoretically it may be possible, but in fact the jaw bone anatomy is inclined, and so the inserted direction is somewhat angled finally. This can be compensated within a certain level by a technical device of machine-made attachment and hand skills of dental technicians. But if the degree of inclination is too much excessive, correction will not be possible. Various problems have been potentially raised for this reason, and so, it should be in advance prepared how best could it be responded.

Kameda: How do you think it should be prepared?

Maeda: For example, when two implants are placed in the anterior arch and they are inclined, they can be helped by connecting the implants with a bar attachment. But this kind of connection is not possible with placing at the canine site on both sides but possible with the incisor area. If a bar attachment is used on the canine teeth area, the denture base coverage will become bulky at the lingual surface. But this problem will be kept in minimum if they are connected on the lateral incisor basis. Even if they are not parallel, they can be helped by all means. In this sense, placement at the lateral incisor area can be useful. What is more, one single implant placement at the midline is easy without paying attention to parallelism.

Factors of attachment selection to think about

Kameda: What about selection of attachments? Previous discussion on bar attachment selection is related with some recovery solution of implant placement angles. Now what are basic considerations?

Maeda: Our initial object is to finish a denture base and we first try to arrange artificial teeth without relation of implants. From this stage we start to select a proper size of attachments that can be accommodated within this denture base. In addition to this, in case of one or two implants, any rotation should be a matter of consideration, and so the selection of attachment depends on the rotation mechanism of attachment design. (Fig.4)

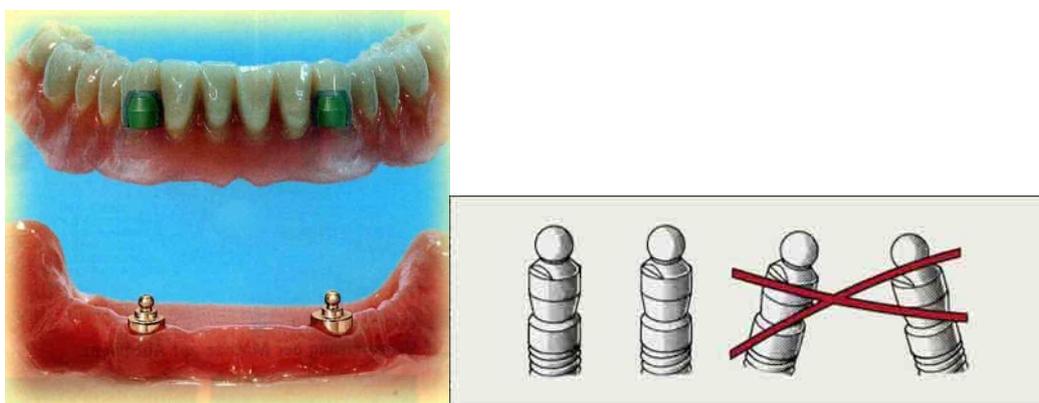


Fig.4 a, b Parallelism must be secured for setting up of 2 ball attachments. (Maeda)

Fig.4 a, b In order to realize primary rotation allowance with 2 ball attachment, they should be set up in parallel (**a**) to establish one single rotational axis. Otherwise inclined, rotation allowance is limited (**b**). (**a** is from Bredent AG, **b** from Astratech co. Quoted and modified from brochures.)

And its selection will need to consider patient's jaw position and age. Some patient would say, "I do not like any tightly assembled attachment. Even if it is not so strongly retentive, I would prefer simple denture seating." But any patients who cannot stabilize the jaw position have no ways to keep the denture stable if its attachment assembly is weakly retentive. In such a case some high attachment, a bar or a ball, should be used to be retentive against the lateral force. But an old patient cannot put off a denture with a bar attachment because of manual dexterity. For such a patient, magnetic attachment would be better as they are retentive at the final instance of denture wearing but easy to take off. And attachments should be easy for maintenance, replacement and relining for both a patient and an operator. Otherwise it will be in trouble, later on.

In this way, attachment selection criteria must have many considerations.

Kameda: How do you think about types of dental attachments, for example, magnetic retention is given or simple support is given without any retentive mechanism? In such a case, simple type of attachment design is given in a way. A root cap type may be possible. Otherwise, a domed type or inner crown telescopic type may be possible.

Maeda: For retention of IOD, an ideal type should be a spherical one, or a perfectly half of a ball. This type will permit any directional forces to distribute toward the axial direction of implant bodies, but machine-made attachments are limitedly available. So, for that purpose, I modify the shape of healing abutments and polish them in round type when a coping root cap is needed.

Another IOD advantage is flexibility of implant insertion and prosthetic design.

Kameda: Now let us return to the previous discussion on placement site. According to the McGill book, if only placement is done at the site of the lateral incisors on both sides, another 3 implants will be available totaling 5 pieces to accept the fixed type restoration against any patient's complaint. I think that IOD design should have an insertion surgery plan that is flexible about patient's differed wishes.

Abe: This is a good offer to a patient. Once a good denture is established, and then even better one is proposed.

Maeda: Yes, certainly. I have just referred to one single implant placement. Even if one piece is accepted, any patient would like to have another function with another implant insertion. Just one piece of insertion is easy to accept for a trial, saying, "Just try to find whether or not it is improved with one insertion." When a patient is satisfied with improvement, another 2 pieces are advised to retain IOD with 3 pieces of triangle formation. Otherwise 4 pieces are added to shape in pentagonal formation. We are now trying to respond to patient's wish to increase insertion pieces. Of course it is a matter of ridge conditions and patient's desire. An aged patient is only acceptable with one piece, and this is a sufficient reason. **(Fig.5)**

In order to avoid misunderstanding in advance, increase of implant number is not to place 14 pieces, but to set up a goal by placing another ones on one piece jaw to form a pentagonal shape with 5 pieces, or by placing another 2 pieces on already insertion of 2 pieces to shape in rectangular form. I learned this idea from Dr.Yataro Komiyama, an implant expert.

Also Dr.Misch has demonstrated similar ideas. He started with 2 pieces. Now he started with a minimum number that is needed, and if needed more, the case will turn out to be a fixed type possibly. This way of thinking is very important because so many cases are shown finished up with implantation for a fixed type. I worry about future outcome of these fixed type restorations. If any problem is raised with a fixed type case, where will this case go to end? Will this end in backward direction? Namely using 5 pieces for a fixed case, and, granting that one or two pieces happen to fail, will this patient accept another additional pieces of placement? Probably not.

Whether will any prosthetic design case be ready for transferring to IOD or not, and how will it be done otherwise? I have no intention to deny designing of a fixed type implant superstructure at all, but it is more important rather than IOD that any prosthetic design should be planned through calculating risks carefully.



Fig.5 Staged increase of implant numbers coping with patient's desire and condition (Maeda)

Fig.5 Minimum limit number of implants for implant supported overdenture is one for mandible and two for maxillar. But depending on patient's wish and circumstances, staged addition of implants will secure occlusal support. Or alternatively can be changed to fixed superstructure design is possible. In case of mandible, you can first start from 2 pieces.

Summary

- From the viewpoint of occlusal support in a mandibular IOD, 2 pieces of implants in the anterior and another 2 pieces in the posterior region is an ideal implant placement. (Maeda)
- In a case where no implant placement is possible in the posterior region due to extensive ridge resorption, when IOD is to be introduced here, it is important in the anterior arch to know how many implants and where to be placed. (Abe)
- Selection of attachments for IOD should not be done uniformly but different uses be selected depending on cases. (Kameda)

6. IOD design – From comparison with complete dentures

Denture base design of IOD

Abe: As Prof.Maeda has explained before that 30 or 40% of mucosal is born by the denture base. In other words, about two thirds will be born with implants, and one third of division of role is taken care of by the denture base.

Meanwhile, there are roughly two different ways of thinking about impression taking of denture base shape. (**Fig.2**) One method is, as taught in dental schools, the way to take impression in order to obtain the denture base area as broad as possible. This idea is based on myology that no pain is raised as long as a denture base does not push on the muscles attached to the bone. In other words, the base can be extended as far as to this pain free range. While thinking over muscle movements individually, impression compound is parted to build up to shape the impression. I think this method is essential to school education because students can learn prosthodontics in relation to such basic sciences as anatomy and histology and can improve chewing function even for beginners. But when it is too much extended beyond the limits of reason, such a denture will flip up and dislodge by the movable mucosa through the mouth opening. And some patient will feel about mouthful within the oral space to complain ill-feeling. This will be experienced by anyone after graduating from school education.

Now the second way of thinking is to take a shape of the mouth at once in functions as accordingly as the mouth is molded and folded with oral mucosa layers, there on the muscles, then on blood vessels and nerves, then on fat tissues, connective tissues and on. As discussed before, it includes muscles to be added with another factor of submucosal tissues. These overall tissues on the muscles move together in function, and so the total sum of these movements are all to be taken impression. In practice, in an object to permit the oral movements under the closed mouth condition, using a custom made tray joined with wax rim, the patient is advised to follow “pronouncing woo”, “pronouncing eee”, “tipping the upper lip with tongue”, “pushing the back of lower wax rim with tongue” and “swallowing”, and all of these are for taking

impression of functional shapes. The suction effective impression taking for a mandibular complete denture, which I have been introducing, is also one of these impression taking. IOD, however, can prevent from dislodging with an implant, and there may be no need of suction.

Details will follow later but here let me summarize that, as a conclusion, these two impression taking methods, provision of outlines for custom trays are different. One disadvantage of my idea of outline of functional impression taking is to lose the surface area of buccal shelf a little. On the other hand, advantage is that the lower denture would hardly flip up during functions. In overall considerations including artificial teeth arrangement, the issue would be whichever is better for impression taking of IOD from these two methods.

①



②



Fig.6 Which should be appropriate for impression taking to determine IOD base

border mold. (Abe)

① Muscle trimming border molding impression

② Functional impression

Fig.6 Impression mold morphology differences are shown performed on an identical patient through border molding impression and functional impression. Border molding ① is developed to secure stable occlusion (in major consideration of muscle activities) by extending denture base near around the muscle attached area. Functional impression ② is an impression taking method of oral cavity shapes that are composed with muscles and movable mucosal tissues by way of patient's functional activities. The impression mold develops shapes of largely displacing movable mucosa, too.

Kameda: I do not mean that I have nothing in common to share ideas with Dr.Abe, but I think that IOD impression taking should take priority of functional impression taking. This is because, according to a literature using testing units like Sirognathograph, there can be any changes of chewing patterns and functions by changing a complete denture to IOD.

Also changing a complete denture into IOD can increase bite force, and so my practical feeling is that there may be relatively changes of movements of surrounding tissues and tongue. Supporting ideas are here shown. **Fig.7** ① shows an old denture that is previously referred about that patient, and the lingual surface of the denture base is made of a metallic plate. The patient was advised to use an old complete denture as temporary denture in the healing period after implant insertion. At this instance the lingual frenum was damaged in decubital ulcer from the denture base margin, and so the metal plate should be cut shortened. (**Fig.7** ②) Then after tissue conditioning, impression was taken. At that time the denture base border around the tongue frenum became clearly settled in different position and shape from the old denture. (**Fig.7** ③)

The reason that I used BPS for constructing a superstructure is that there should be some sort of denture base is needed after taking careful considerations of functions in this case. In this occasion I learned an experience that the shapes of tongue frenum area became a similar shape after tissue conditioning at the time of final impression taking. (**Fig.7** ④)

And moreover, I tried to find out from experimental stone models how much different the denture border positions and shapes were, when complete dentures were transferred to IOD. Cut section samples of each test model at the median line and approximately at the first molars were compared in **Fig.8, 9**. Denture base morphology observed over the time process of change showed that its width became a little shorter at the time of tissue conditioning. When these are tested for identification at the alveolar ridge crest, our finding confirmed that the lingual side denture border became shorter rather than the buccal border. At the same time, changes in the posterior region were measured, but changes of the width was found minimum in this case.

For reasons above, impression taking procedure will have to be changed from those of complete dentures. There is no objection that the border seal of complete denture is majority for retention, but in case of IOD, some idea should be close to partial dentures and there may be no need of sealing for the border seal.

Meanwhile, my idea is attained through the findings of this present case and I think that IOD denture base border itself should be extensive enough on the alveolar ridge with minimum compression loading displacement and that broad mobile mucosal area should be avoided.



Fig.7 Case example where enhanced function after wearing IOD indicates an altered denture border mold. (Kameda)

- ① Old denture at the initial visit.
- ② Temporary IOD ① was used but decubital ulcer developed at the tongue frenum area and the border was cut reduced.
- ③ Temporary IOD during process of tissue conditioning.
- ④ Final impression taken.

Fig.7 Alteration of denture border mold at the tongue frenum developed from an old denture through final impression taking in case of IOD that was presented in the last issue. Following the implant placement, the old denture was used as temporary IOD, but decubital ulcer developed frequently and reduction was made accordingly. (Photos ②,③, are taken quoted by permission, from the literature, Kameda Y, Functional restoration with implant overdentures – Discussion on desired denture border configuration. Practice of prosthodontics 2009: 42(2): 207)



Fig.8

- ① Old denture insertion
- ② At the process of tissue conditioning
- ③ Final impression of IOD

計測点	Measurement baseline
本図での計測点	Measurement baseline in this photo
舌側	Lingual side
唇側	Labial side
歯槽頂	Alveolar ridge crest

Fig.8 Each denture impression taking through stone model fabrication as shown in Fig.7 were observed at the median line cross section. The labiolingual distance at the lower denture median line is clearly decreased after IOD insertion. The area indicates the tongue frenum area and especially decreased distance refers from the alveolar ridge crest to the lingual base border. (Photos are taken quoted by permission, from the literature, Kameda Y, Functional restoration with implant overdentures – Discussion on desired denture border configuration. Practice of prosthodontics 2009; 42(2): 209)

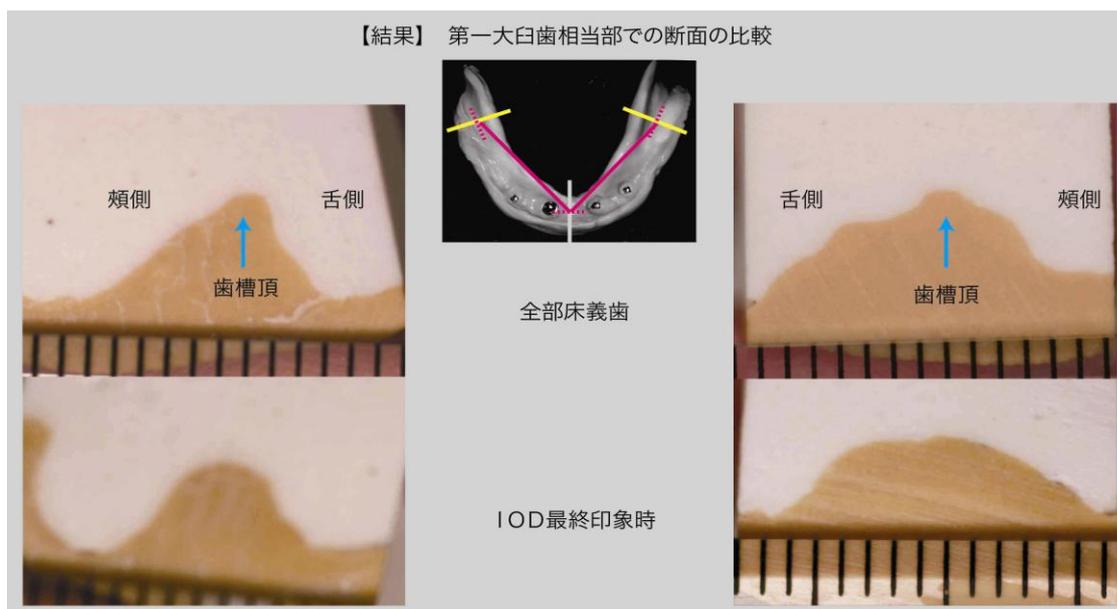


Fig.9 Case example where enhanced function after wearing IOD suggests altered border mold. (Kameda, continued from previous page)

- ① Old denture insertion
- ② Final impression taking

計測点	Measurement baseline
右側	Right side
左側	Left side
舌側	Lingual side
頬側	Buccal side
歯槽頂	Alveolar ridge crest

Fig.9 Stone models taken in Fig.8 is the cross section at the molars. The buccolingual distance alteration at the molars was not confirmed. (Photos are taken quoted by permission, from the literature, Kameda Y, Functional restoration with implant overdentures – Discussion on desired denture border configuration. Practice of prosthodontics 2009: 42(2): 209)

Abe: As stated from Dr.Kameda as above, change from complete denture to IOD promotes muscle activities, and thereby interfering contacts are developed here and there. Although this time of impression taking was never tried to force down the muscles under, functions are enhanced to exhibit new interferences. Based on this observation, I think that it might be proper to use a method of functional impression to take a whole body at once. So you might say, “Otherwise, you cannot do better with the border molding impression using compound material.” (laughter)

Now, humans have their own functions that are built-in with everyone. The function that I am specially paying attention to is the following function, that is, “Whether or not edentulous or dentate, posterior border seal can be accomplished by contacting closely with the buccal mucosa and the tongue on the retromolar pad at the time of closed mouth.” (Fig.10) Thanks to this function, food bolus is not carried over beyond the second molar. This close contact is termed by myself as “BTC Point”, namely, the abbreviation of Buccal mucosa and Tongue Side wall. This physiologically natural function should not be inhibited, and the factors that inhibit the creation of BTC Point will become a dislodging force of denture at the time of mouth opening. There is a literature that says, “Even if the border is extended to the outside beyond the bone external oblique ridge line at the buccal shelf region, it will not work as a denture dislodging force”. This literature suggests that an increased surface area of denture base would stabilize it, but the literature does not refer to the creation of BTC Point. Factors that will inhibit creation of BTC Point are;

- ① Overextension of denture base toward the buccal shelf.
- ② Overextension of denture base toward the retromylohyoid fossa.
- ③ Too much thickness of denture base existing in the retromolar pad.
- ④ Artificial teeth arrangement distributed to the area where BTC Point is to be inhibited.

The endoscopic video (Fig.11) explains how BTC Point is created by extending excessively the denture base intentionally with utility wax toward the buccal side direction and toward the direction of the retromylohyoid fossa region. As expected, overextension of denture base inhibited creation of BTC Point.



BTC Point

Fig.10 Buccal mucosa and tongue contact on the retromolar pad at the mouth closing whether or not edentulous / dentate. (Abe)

Fig.10 The posterior denture border seal is accomplished with the buccal mucosa and tongue contact on the retromolar pad as shown here. This function is common to dentate and edentulous jaws. (video image excerpt)

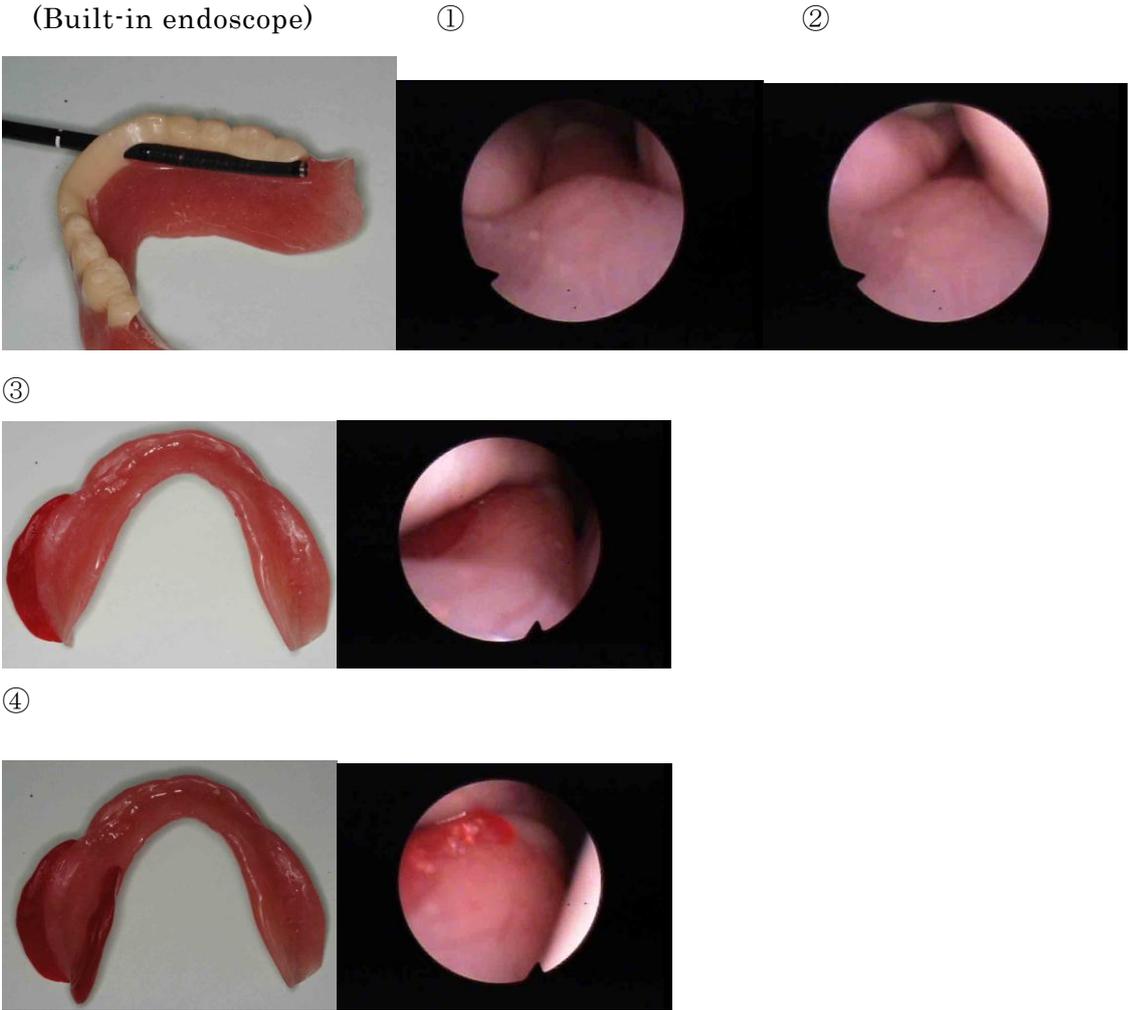


Fig.11 Overextension of denture base will inhibit creation of BTC Point. (Abe)

- ① Denture base not extended: at the mouth opening
- ② Denture base not extended: at the mouth closing
- ③ Denture base extended (buccal side): at the mouth closing

④ Denture base extended (lingual side): at the mouth closing

Fig.11 Photos show the endoscope observation over influences on BTC Point creating (posterior border seal) from denture overextension. Photos ① and ② show the mouth opening and closing with the denture that patient found no problem. On the contrary, photo③ shows an extended base to the buccal side with utility wax on the denture shown in photo ①, and photo ④ also with an extended base to the buccolingual side with utility wax but knowingly inhibited BTC Point creation.

In this sense, in case of IOD, too, in order to allow these inhibiting factors to be excluded at the stage of impression taking, custom tray design and wax resin position and fabrication must be modified innovatively. In other words, it is important to fabricate a custom tray that enables us to create BTC Point easily at the time of impression taking. For instance, outline of custom tray should be given as follows:

① Follow the retromolar pad as it is shaped as an outline of custom tray, and then cover it thinly with a resin base. The buccal mucosa should not be prevented from trying to cover the retromolar pad. Also, if the retromolar pad is thickly covered with a resin base, the buccal mucosa cannot contact with the tongue on the retromolar pad. (Fig.12)



Fig.12 a~c Custom tray construction that does not inhibit BTC Point creation ①
Outline faithfully according to the retromolar pad.

Fig.12 a~c In order not to inhibit BTC Point creation, it is important to trace the outline of retromolar pad contour faithfully as the outline of custom tray. And in the photo **a**, white dotted line shows a border line of ridge mucosa and buccal mucosa. From this line, the buccal mucosa turns to cover the retromolar pad. At the stage of designing a custom tray, it is important not to cross over this line in order to establish the BTC Point.

- ② The function should be arranged necessarily so that the tongue side wall is to suppress the lingual side polished surface of the denture. So, outline a custom tray over about 2-3 mm beyond the mylohyoid ridge line. Whether the line is possible to be extended beyond that or not will depend on the space room allowable at the retromylohyoid ridge fossa of individual patient. Even if you could take deeply enough there, you do not have to fix the outline of custom tray accordingly as deeply as it was. Overextension of denture base pushes the tongue root area strongly, and the tongue is difficult to contact with the buccal mucosa. (Fig.13)



Fig.13 a~c Custom tray construction that does not inhibit BTC Point creation ②

Outline should be about 2-3 mm beyond the mylohyoid ridge line.

mylohyoid line

from 2mm below

avoid Someya's sinew string

frenum is variable to movement

bottom of mucobuccal fold

shallowly in 2mm

Fig.13 a~c In order to fulfill a function of suppressing the denture polished surface with the tongue side wall, outline should be given about 2-3 mm beyond the mylohyoid ridge line. And in general, custom tray outline is taught to be given in the middle or outside of external oblique line, but, in order to accomplish a function of containing a denture with the buccal mucosa, it should be standardized to give the line inside of external oblique line or the lowest point of buccal side mucobuccal fold.

Next, as for the arrangement position of the artificial teeth, which should not inhibit the movements of the buccal mucosa and tongue, it is important to take impression by building up the wax rim in the middle of ridge width where the molars and premolars are to be occupied. The idea is based on the rules of teeth arrangement of Pound Line that represent former positions of natural teeth, as well as other concepts of Piezography*¹ or Neutral zone. These ideas and concepts are originally different from one another, but final arrangement will become approximately close to others. Dental school education in majority seem to take priority of controlling denture from dislodgement and keeping stability, teaching, "Teeth should be arranged within common zone that cross the allowances of mandibular and maxillary common zone", rather than teaching negation of inhibition of physiologically natural functions. (**Fig.14**) Some are still teaching the arrangement along the alveolar ridge crest. But the arrangement along the ridge crest in the mandibular denture would deviate to the lingual side and narrow the tongue space. As a result the tongue would be retruded and inhibited to create BTC Point.

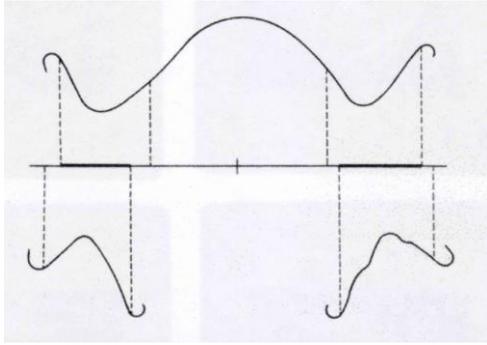


Fig.14 “Common zone” is called for the area where teeth arrangement is allowed on both upper and lower alveolar ridges and is overlapped each other. (green line area in the chart) By arranging teeth within this belt zone, denture stability is considered. The idea is based on the study of Takanashi and Yanagawa. (Takanashi K : Study on criteria of posterior artificial teeth arrangement of removable partial dentures from clinical case analysis, *Shika Gakuho*, 68 (6): 855, 1968 (Japanese), Yanagawa H : Condition of alveolar ridge about criteria of posterior artificial teeth arrangement of removable partial dentures, *Shika Gakuho*, 69(5): 721, 1969 (Japanese))

Kameda: Precautions are almost same with suction of lower complete denture, are they not?

Abe: Yes, they are. Denture border seal in the posterior region will be established by controlling inhibition of physiological functions. It means immediately to minimize any possible denture to flip up at the mouth opening.

Kameda: What schemes of occlusion do you think to provide?

Abe: As far as the lower IOD is concerned, provision of balanced occlusion is general and fundamental. It may not be much difference whether this occlusion refers to the lingualized occlusion with contacts of only lingual cusps or the full balanced occlusion with multiple cusp contacts. In consideration of tolerating human errors, I think the lingualized occlusion would be easier with minimum chance of error.

Summary

- Contouring and occlusion of IOD should be based on those of complete denture. (Maeda)
- When we consider the fact that implant will bear more than half of pressure loading, impression taking of IOD is desirable to take a functional impression from patient's movements rather than with the border molding impression using compound material for expanding the denture base area intentionally. As for designing a custom tray, attention should be paid not to damage BTC Point so that flipping up of denture will be prevented from the strength of the movable mucosa at the mouth opening. (Abe)
- Application of IOD will enhance functions with the tongue and surrounding tissue activities. Therefore the denture border morphology should be reflected from the enhancement. (Kameda)

Key Word for better understanding of this discussion

*1 **What is Piezography?:** Piezography is a term proposed by Dr. Pierre Klein of France in 1970, a kind of impression taking method in a complete denture therapy mainly using patient's speech and articulation in order to mold the denture base border, and denture base polished surface, and furthermore to mold labial, buccal, and lingual surfaces of artificial teeth. Features are that any functional pressure on speaking is taken with highly flowing impression material to mold denture base.

7. IOD maintenance

Prosthetics is destroyed with periodontic care.

Kameda: Now we would like to discuss IOD maintenance. It has been long discussed over the issue, "Overdentures are poor in cleaning as the supporting abutments are covered with denture base and so contraindicated."

Abe: Nowadays patient's hygiene level is improved as well as operator's standard of periodontic care level, that is no comparison with previous years. Situations are

same with overdentures and not same as in the past.

But it never changes in a sense that dental therapy itself will fail unless prosthetics is to be taken care of on the basis of periodontic care. This is no exception with a case of IOD. Although prosthetic design based on dynamics is important, first we must handle the priority of periodontics. For example a magnetic retention is selected as a retainer for partial denture, then it should be as high as 2.5mm for dynamics reasons, but actual causes of case failures are attributed to periodontic or caries problems.

Kameda: In previous years, overdentures were contraindicated for reasons that the abutments were supported with natural teeth. We have two risk factors of losing natural abutments, namely tooth root caries and periodontic disease. The literature says, “Fair number of teeth have been lost from secondary caries.”

Naturally we have no secondary caries on IOD, but periodontic involvement is as ever problematic.

IOD from periodontic issues

Abe: Now we would like to see each patient of IOD in question of periodontics.

Kameda: This patient had an IOD retained with bar attachment at the initial visit, but it showed poor plaque control. Surrounding tissues around the left lower canine implant exhibited already extensive bone resorption. This is a matter of time for implant failure. (**Fig.15**)

Abe: Let me organize the issues of this patient as follows. ① Implant surrounding tissues is covered with denture base. ② The oral vestibule is narrow and shallow and minimum volume of attached gingiva (volume of masticatory mucosa). There are two major problems.

If not only implants but also surrounding tissues of residual ridge mucosa are covered with denture base, the implants are unclean and the surrounding tissues are susceptible to inflammation. The case in **Fig.16** shows “non clasp denture” and good looking without visibility of clasp retainers. Now it is fashionable. When the denture is taken out of the mouth, the tissue is reddened and inflammable as you see.

Fundamental requirement of denture that should not touch the periodontal tissues is lacking here. IOD, too, has no other ways than to cover the peri-implant tissues with denture base.

Next, this case shows an implant failure indicated for extraction finally as the oral vestibule was shallow and narrow to prevent brushing. (**Fig.17**) This case shows no oral vestibule or attached gingiva, and the movable mucosa is proximally neighboring to the implant. In this case you must pull open the lip for making room of brush cleaning. Compared with anterior remaining natural teeth, cervical line runs low in level and is difficult to accept the brushing. There are many difficult conditions for cleaning in this case.



Fig.15 a~c Prognosis of IOD case with poor plaque control is difficult. (Kameda)

Fig.15 a~c At the initial visit, IOD was already inserted, but plaque was deposited surrounding the implant with gingival inflammation. Radiograph c indicates bone loss. It is difficult to design an open type base to IOD on an edentulous ridge as it covers fully surrounding the implant in not only this case but also in any case. For this reason, thorough and efficient control of plaque is definitely needed.



Fig.16 a, b “Principles of cleaning performance” viewed from prognosis of non clasp denture. (Abe)

Fig.16a, b Gingival inflammation caused from wearing non clasp denture. Principle is that an abutment surrounding should not be covered with denture base as much as possible in order to avoid periodontitis caused by denture. This kind of denture is lacking in this sense. But IOD ought to be designed like this, and so thorough attention should be made to cleaning performance.



Fig.17 Reasons for created difficulties of cleaning surrounding implants. (Abe)

Fig.17 The oral vestibule is so narrow and shallow that brushing cannot be effective, finally leading to an implant failure in this case. Photo shows problems, ① the oral vestibule is narrow and shallow, ② loss of attached gingiva, and ③ low level of cervical line. Difficult conditions are already there for cleaning surrounding implants.

In fact, a patient in this case is my hygienist’s father and she devoted her efforts to his plaque control, but finally the implants were forced for extraction at a dental

school hospital because pus discharge did not stop. In this regard, clinic environment that can maintain both patient's self care and professional care must be established. Otherwise future of IOD will be in danger.

Next we would like to see Dr.Kameda's case of Mini implant. (**Fig.18**) The drawback of the implant body include, in addition to two drawbacks previously described, have a shorter radicular attachment. A shorter radicular attachment has been long complained for brushing difficulty.

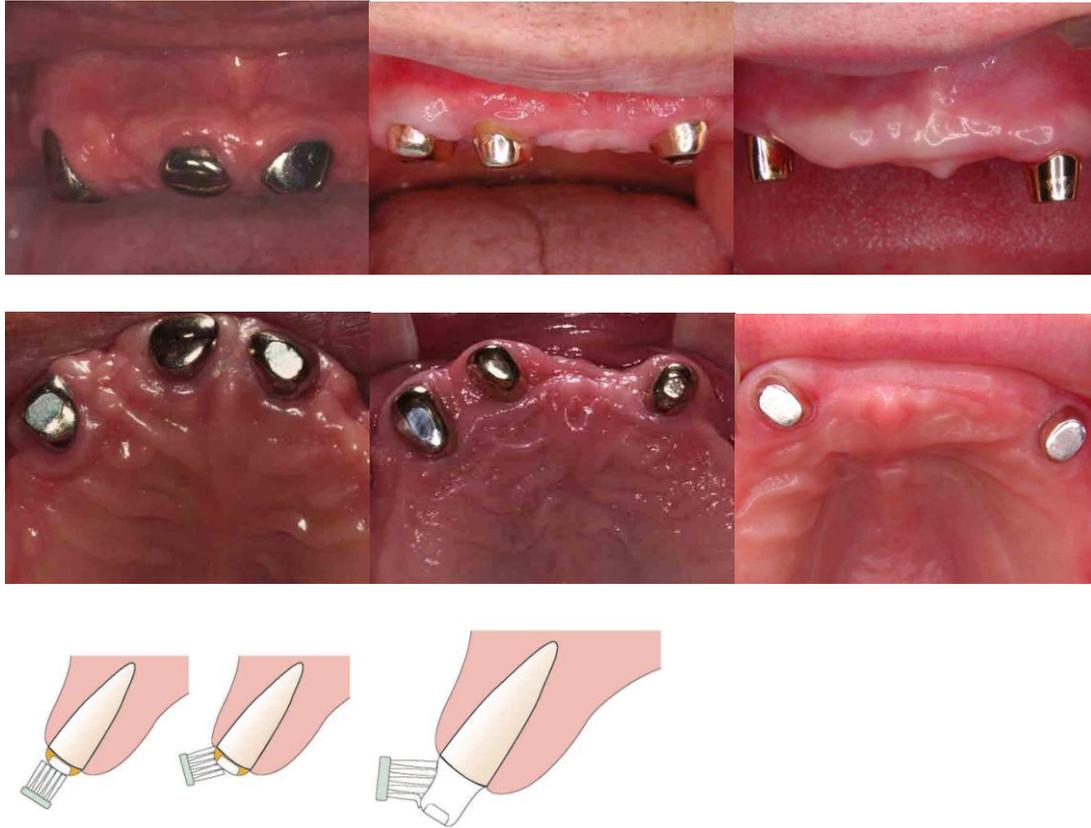
In order to overcome this drawback, height of abutment has been becoming higher gradually and so an inner crown like the height of conical crown has been developed. It is clear that this inner crown type of abutment is easier for brushing. (**Fig.19**) As this vertical height is increased, another dynamic problem will be raised. But as I described it before, I think that lacking of plaque control should be prior to dynamic problems and that as high attachment as possible should be used.

Maeda: It is a shame that prosthodontist including myself is limited in the knowledge of periodontal care. At our prosthodontics department, even at the time of prosthetics therapy, a probe instrument is always near at hand in an instrument tray, keeping in mind, "Thorough probing for periodontic treatment should be verified for its necessity." We think we are in the process of improving, although some difficulties are still present.



Fig.18 Particular attention to Mini Implant is needed for cleaning performance. (Kameda)

Fig.18 Mini Implant has the merit of minimal intervention, but necessary height cannot be gained for attachment female part and hard to be cleaned.



Hard to be brushed. Easy to be brushed

Fig.19 Relation of radicular attachment height and brushing capacity. (Abe).

Fig.19 The chart shows relations of radicular attachment height and brushing performance. Like most left ones with low radicular attachment, brush bristle ends are not fixed well and hurt as the ends directly pushed inside the gingival pockets. On the contrary, like most right ones, conical crown copings can help stabilize the bristle ends and brush well and consequently reach to the cervical areas to clean.

Even so in fact, the IOD base coverage of abutments cannot be avoided although it is true that cleaning performance is definitely limited. Therefore, unless patient can clean for oneself, IOD is not indicated.

Under this assumption, I advise my patient to perform 3Ds. For example, preventive medicine for periodontal disease is applied to the attachment retained surface.

By the way, as Dr.Abe said previously, how high of radicular attachment should be

proper. One collaborative study joined with a preventive surgeon indicated a result, that is, “Minimum height with easy cleaning under brushing pressure should be over 2 mm and more.” I keep this as a rule of more than 2 mm for a long time. And in case of overdenture supported with natural support root length, I try to make it longer enough to that measurement.

Abe: Background support from literature is important and IOD patients are likely in advanced age with less dexterity of fingers and hands, and so it may be the higher the better.

Kameda: Yes, it may be. I also have a sour memory when a magnetic attachment was given to a coping without sufficient height, I advised the patient to brush thoroughly, but this patient complained, saying, “Brush bristle ends hurt, and I cannot brush well”. Low height coping and attachment cannot be cleaned by all means before we discuss over cleaning performance on this attachment. We believe we need to prepare good environment for patients to clean well. Also regular cleaning performed by hygienists must be essential after insertion.

In this opportunity, let us discuss over cleaning method of attachments and retainers. For example, how do you advise patients to clean a ball attachment?

Maeda: A cleaning brush is difficult to use. We think better to use clean gauze. A ribbon-like gauze may fit well. No specific cleaning item is not available.

Can any post-operative periodontal risk with specific case be prospected in advance at a pre-operative stage?

Kameda: In case of overdenture supported by natural tooth abutment, it is said that, for a patient of strong caries tendencies, tooth loss is attributed to secondary caries even after wearing overdenture. IOD is caries free as it is, but is there any risk of periodontal disease to an IOD patient even after tooth loss from periodontal disease?

Maeda: Yes, there is. It is reported recently that not only IOD but also implant insertion case of 10 years or 15 years happened to start bone resorption suddenly within last years. Those patients have been traced back of disease history to indicate

the tooth loss originally from severely advanced periodontal disease, although the causes were not all of them.

In other words, it is not exactly wrong to prospect future disease depending whether the patient is of caries type or of periodontal disease type. Therefore, IOD is on a patient of tooth loss from periodontal disease, there may be higher risk of peri-implantitis or bone resorption than a caries type patient, and this must be prepared.

Abe: I hear that, even after becoming edentulous, P.g. is still there inactively.

Kameda: In previous years, total tooth extraction would clear out A.a. or P.g., but they are reportedly found in the back of tongue or buccal mucosa even in edentulism. At the stage of denture insertion following tooth extraction, is there any procedure of sterile filtration of pathogens that are of high risk of periodontal disease?

Maeda: On the contrary, it is not yet effective. Those attached may be part of microorganism resident inhabitants, and if they are forced to change, others will grow like microbial substitution. But when microbial kind is established at early stage, specific sterilization on this microbe is reported recently. Any possible support will be necessary.

How to deal with need of nursing care.

Kameda: IOD patients are at any rate of advanced age, and there may be situations when they will be possibly bedridden in the near future or contraindicated to surgery procedure. What do you think, Prof.Maeda?

Maeda: This story is not only about IOD but also about any implant therapy. It may be difficult for neither dental maintenance nor implant extraction is available. Even IOD wearer happens to become in need of nursing care, there may be another problem raised.

But as far as IOD is concerned, there may be small possibility of coping with such a problem. Because IOD is, in comparison with various prosthetic means of implantation, to deal with changes easily as its implant number is small. And also its basis of removability is easy for cleaning. Even if a patient is in need of nursing

care, its maintenance is taken care of similarly with maintenance of conventional denture.

In my opinion, those patients in need of nursing care will be difficult for cleaning, and IOD will need additional care to control plaque. But not all cases happen to be involved with inflammation and to permit rapid changes. There may drastic change occur when some unknown factor extra is added. Some systemic change may change metabolism to induce rapid bone resorption according to my feeling.

Kameda: The aging society is not easy with full of mixed problems. (laughter)

Maeda: This morning I already visited a hospital and treated an old aged patient there. More number of patients has more remaining teeth than before. Thanks to the “8020” Movements, which are grateful both to dentists and patients.

Another reality also has that a patient with multiple remaining teeth turns out in need of nursing care with extensive of carious lesions, but fails to communicate in vain for treating. In this sense, only remaining teeth are not always good. Yes, losing teeth is not welcome, or denture trouble is not welcome, either. Even more troubled is maintenance for the remaining teeth.

Abe: No conclusion may be reached whether we accept implants for present days in healthy and happiness, or we do not accept it for future safety.

Kameda: Now in this age, I think it is important to discuss over these realities as dentists.

Summary

- In case of IOD, regular checkup and maintenance on implant abutments and denture base are essential. (Maeda)
- Not only IOD but also every prosthetic treatment should be based on periodontal cares. Establishment of healthy surrounding tissues will contribute to long-term stability of prostheses. (Abe)
- In case of IOD, morphology should be given to accommodate easy cleaning for patient oneself, and regular cleaning by hygienists is needed. (Kameda)

8. Future of IOD

In case of partial missing arch, IOD be given with Minimal Intervention

Kameda: As for future outlook of IOD, how will it be developed and promoted in your opinion?

Maeda: Currently an implant therapy performed on an edentulous jaw would design fixed implant superstructure very frequently. But in future, as I described before, minimum number of implants will be placed for gradual improvement, increasing implant number depending on patient's personal wish. This way of treatment will be valid with thanks to IOD.

And in case of dentate jaw, in order to control increasing number of missing teeth starting from the stage of free-end arch, future outlook will include the application of IOD as a strategic implant prosthetics for preventing expansion of tooth loss. Of course, in order to inhibit defect expansion, fixed type implant structure can be an alternative option, too. But this modality requires more numbers of implants and the ridge bone augmentation needs more extensively. I personally am free to advocate, "Minimal intervention be promoted with implants". (laughter) Simply speaking, this is a way of idea to convert a free-end denture to an intermediate denture. (Refer to a column at page 34.)

Background of this idea is derived from the fact of recent years that implant prosthetics accompanied with large scale of bone augmentation has been presented luxuriously, but the truth is that no bone is created at the site of no reason for bone growth.

As a result, there seems to be many people are becoming to realize that removable type of prosthesis like IOD is better for restoration and is easier to cope with patient's fundamental desire. Future will be prospected in this direction.

Abe: It would be necessary for those who view from restoring with implants to visualize from another angle of restoring with dentures. Those viewers in the past were extremely deviated giving weight on implants. This will have to be neutralized in the future.

Kameda: From the dental practitioner's view point, there are overwhelmingly more patients of partial missing teeth than edentulous patients. So if we could reach a certain amount of consensus as practitioners when detailed studies are conducted in this regard at dental schools. For example, implant length or diameter is not yet established in consensus, taking time before conclusion. How progressive in dental schools in Japan regarding IOD studies like above.

Maeda: As I demonstrated it before, IOD's basic, dynamic and biomechanical studies have been conducted extensively, including myself. In other words, theoretical studies are fairly well advanced, such as, "Where to be implanted, how to be developed". But here in Japan, clinical researches are still a few, and multiple long-term results are not available. This differs largely from other countries. Clinical cases themselves are not presented well.

Kameda: Is IOD introduced into school education now?

Maeda: As far as dental schools are concerned, dental implants are taught at almost all dental schools among totaling 29 schools nationwide, but IOD may not be included yet. Osaka University has a course of implants joined with crown and bridge restorations, and, from last year for the first time, theory and practice of complete denture course is followed by IOD, which is converted from the previous complete denture. This is an idea to invite students to think over an implant as a new current source coming from complete denture.

Summary

- Using the advantage of ideas on IOD, a strategic treatment is possible for controlling expansion of missing arch. (Maeda)
- IOD is demanded in the aging society. The key to success is the combination of implants with periodontics and denture prosthetics. (Abe)
- From now in Japan, IOD application is expecting in the partial missing arch. (Kameda)

Conclusion of our discussion

Kameda: We are now concluding our discussion. To summarize, could we have your comments for readers?

Maeda: In summary, as for the case of mandibular edentulous arch, as you both suggested mainly in the last part, so called a difficult case where the mandibular edentulous ridge resorption will be best opted. When a complete denture does not work well, any implant presence will make a considerable difference.

And as I mentioned in the last chapter, IOD is potentially possible to apply not only to an edentulous ridge but also to a partially missing arch. In whatever the case is, most prerequisites are basic knowledge and skills of complete denture construction, and we would be happy if we could convey proper information to our readers.

Abe: I have the same idea. I sincerely hope that our readers would appreciate implant therapy from a basis of complete denture therapy. Again my emphasis is on periodontal care that has to go together. If these two are not taken care of rightly as a dentist, a patient will be in disaster as a consequence. And we wish to our readers that these two basics are learned well and practiced successfully.

Kameda: Today we think we have been able to deepen our discussion about IOD that is attracting both overseas and domestic attention. When general idea of implantation is combined with denture construction, specific cautions of IOD have been highlighted. In contrast, facts are about many unresolved issues. We are looking forward to new researches continued for years to come. Thanks for your attendance.

(end of discussion)

【Column】

Suggestions to Minimal intervention (MI) procedures with dental implants

In case of mandibular distal extension missing case with occlusion effective to the second premolars, concept of shortened dental arch is valid and so conditions are comparatively stable. But once any premolar bone support is deteriorated or lost, the

circumstances will become destabilized immediately.

Fig.30 at page 30 of last issue shows research results based on stresses loaded on TMJ regions of computer simulated models depending on different occlusal support following various prosthetic options, once they are lost like above. In case of fixed type prostheses supported with implants, it is known that occlusal support can be restored effectively equivalent with those of the second molars. On the other hand, only with mucosal born prostheses, larger stress will be loaded, but this stress will be eased when implants are used underneath the base for support. This is an effective idea of conversion of intermediate denture with the help of implants.

If this idea is used as a strategic plan, as shown in **Fig.20**, an implant is inserted in the molar region if the case becomes a free-end missing arch in order to control another tooth loss and to convert it an intermediate denture. And even if the tooth loss becomes extensive unfortunately, another implant is added like one in the anterior and one in the molar regions together with denture base, totaling 4 pieces on the both sides to secure the occlusal support.

This idea is not new, and reportedly another implant is inserted under a free-end saddle. It was started around in 1993 and is increasing in these two years. This, however, is being ready for the worst final case, and it is important to conserve remaining teeth with conversion of intermediate denture from lateral free-end saddle.



Fig.20 Implant application sequence in order to control increasing missing arch.

Fig.20 Concept of controlling expansion of missing arch by using implant and denture jointly. In case of distal extension missing case with premolar tooth loss, an implant is inserted in the distal region strategically and preventively, and it can be converted to an intermediate missing arch. If tooth loss is extended to the anterior

arch, another implant is in the canine region for support in order to control expansion of tooth loss and bone loss.

(end)