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Extra Special Article

Practical points in making complete dentures suction effective and functional – General views on edentulous ridge characteristics and denture movements



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Introduction

It would be much to their delight for dentists and dental technicians that they could finish complete dentures with satisfying results and that patients could enjoy using them.

Once Abe ¹⁾ explained the suction effect of mandibular complete denture theoretically, many practitioners have followed this modality in practices extensively throughout the profession. Take an example around the author of this article, when once one could finish a successful suction effective case of mandibular complete denture, such a dentist or dental technician would be likely to design another case for more effective suction thereafter.

Why is the suction in denture making so much attractive like this for many? The major reasons may be because, for patients, eating meals would become more enjoyable only by having a denture firmly seated with suction and because they can become more easily convinced of its excellence to a less suction effective denture. In contrast, for practitioners, by having goals “effective suction = entire denture border sealing”, they can be easily convinced of “goals achieved” only from obtaining effective suction results. Furthermore, because this impression taking method is more clearly defined than

conventional border molding impression taking, it is more attractive for them to introduce it and continue practicing it in daily clinical cases.

This article, titled “General views on complete dentures”, will refer to the following items for better understanding of making a suction effective denture.

- 1) Characteristic oral environments involved with edentulous patients
- 2) Denture movements while in function
- 3) Suction effective in mandibular complete denture

Making a suction effective complete denture is, although such a case belongs to a clinically difficult case, an extremely simple case procedure. It must be emphasized that, by setting out an impression taking with a frameless tray or Frame Cut Back Tray (FCBT) in all cases, better quality of impression can be achieved (**Fig.1**).

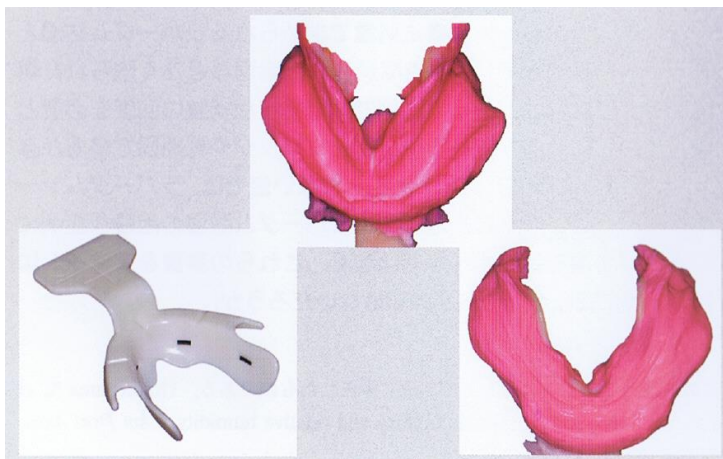


Fig. 1 Impression taking with Frame Cut Back Tray

Q: What is an accomplished image of complete denture therapy?

A: It is a denture that helps chewing well in good stability.

It should be aimed at “a denture that helps chewing well in good stability”.

Complete denture therapy, if specified from patient’s viewpoint, all depends on the fact of “a denture that helps chewing well in good stability”. It also should include “functional beauty” in good harmony with living body (1-1).

The idea might be broken down like “stability” = ”suction attained” or “chewing well” = ”proper occlusion”. But “chewing well in good stability” cannot be simply broken

down in easy formula, because complete dentures, upper and lower, are demonstrated in one unit of structure. Complete dentures should work together to satisfy many different requirements in order to attain good harmony with an individual living body, and their functional performance should be increased by realizing suction and occlusion simultaneously.



1-1 Complete dentures that help chewing well in good stability are equipped with functional beauty.

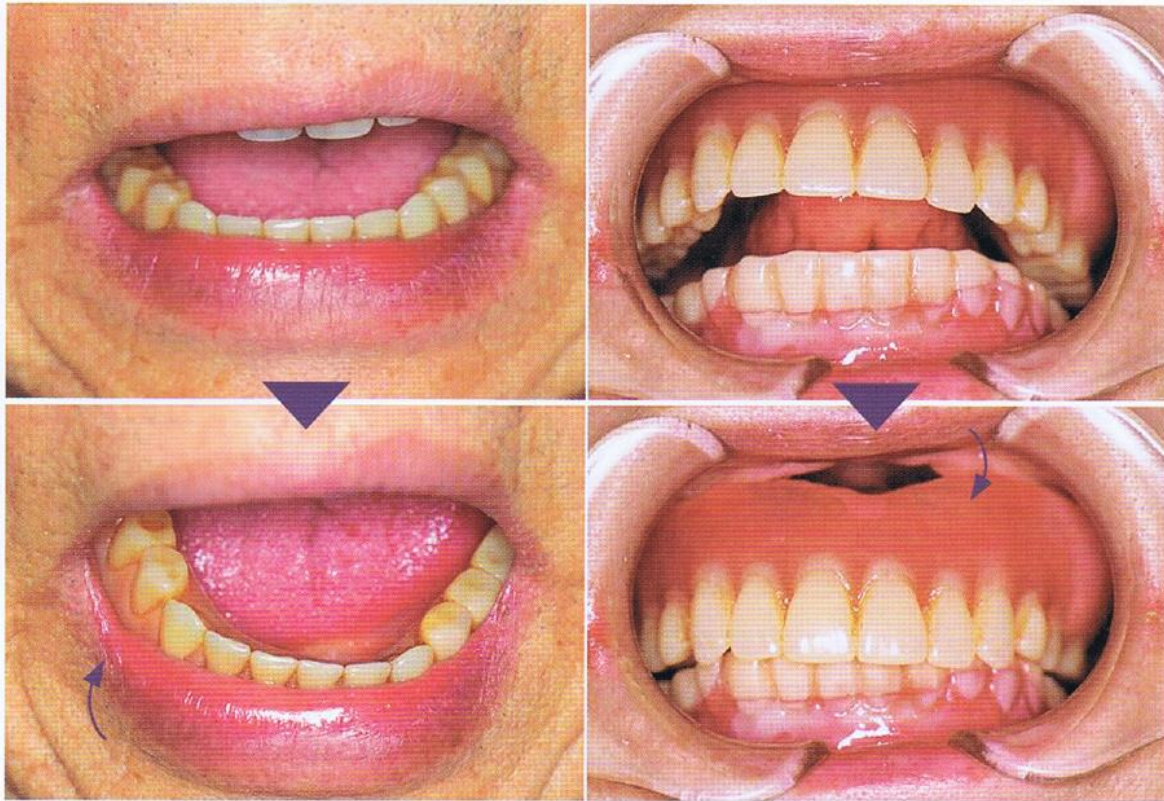
All should contribute to patient's quality of life (QOL).

All dental therapies are intended to improving patient's QOL with no exception of complete denture therapy.

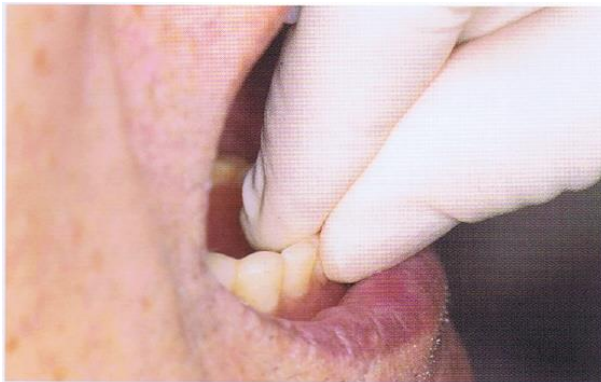
Wearing complete dentures, patients will be stressed from discomfort of a maxillary denture that will drop from the mouth immediately before speaking or of a mandibular denture that will dislodge on the spot of opening the mouth trying to convey food (1-2).

The first step toward contributing to QOL from complete dentures would be that they should stay in good suction and stability, upper and lower, in the empty mouth (1-3). And then, if food intake is well done into the mouth with smooth chewing movements while in denture stability, patient's stress will be released and one's life will turn out to be comfortable and joyous.

There are many elderly people who are taking actions for karaoke singing, volunteer activities, and so on, and everyone wishes extending healthy life expectancy. Complete denture therapy can improve patient's QOL by contributing to accommodating facial appearances, assisting better speech and having good time with meals.



1-2 If a large mouth opening lifts up the dentures, speeches are troubled, singing karaoke is spoiled or conveying larger food bolus to the mouth is prevented.



1-3 Status of strongly effective suction.

Q: Please explain about characteristics in the edentulous oral cavity that should be realized with us in making complete dentures.

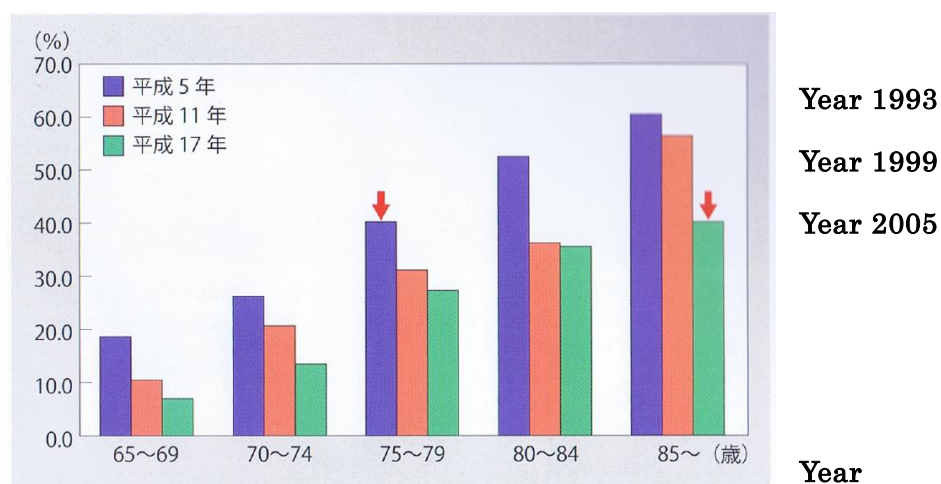
A: In the edentulous oral cavity, changes are progressive simultaneously including changes accompanied with tooth loss and changes caused from aging. And, major changes will be involved with functions, soft tissues shapes and bone shapes.

Consequently, in complete denture making, the oral environments must be observed closely in different individual patients. And degree of difficulty on each oral part must be assessed in advance.

Changes of functions

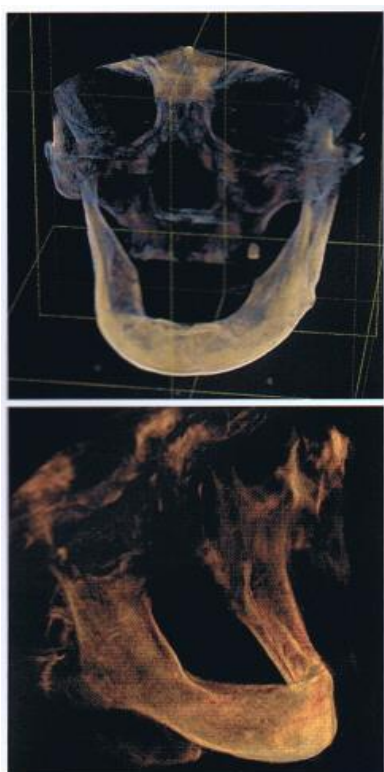
In recent years, edentulous patients are advanced in ages (2-1)^{2), 3)}. Most edentulous patients are aged, and they are frequently medicated from internal medical problems. They walk slowly in hospital corridors accordingly as they are aged and they become inactive. In the oral region, swallowing performance and occlusal strength are decreased and facial expressions muscles are less active. Also it is known about reduced movable range and control force of mandibular jaw movements, compromised immunity, and adaptability failure to new encountered circumstances⁴⁾. Decreased bone density from osteoporosis is particularly remarkable in the maxillary jaw (2-2).

Meanwhile, dry mouth caused from reduced salivary flow as well as aphtha or candida disease are common to develop and their highly sensitive mucosal membrane are frequently posing drawbacks in complete denture making (2-3). As for the problem of this limited adaptability, even if an old denture is limited in vertical dimension, aged patients are not well accustomed with dentist's offer of new alternative treatment modality of increasing occlusal vertical dimension or of mandibular new jaw position. So circumstances will have to be compromised with lower occlusal vertical dimension than it should be (2-4).



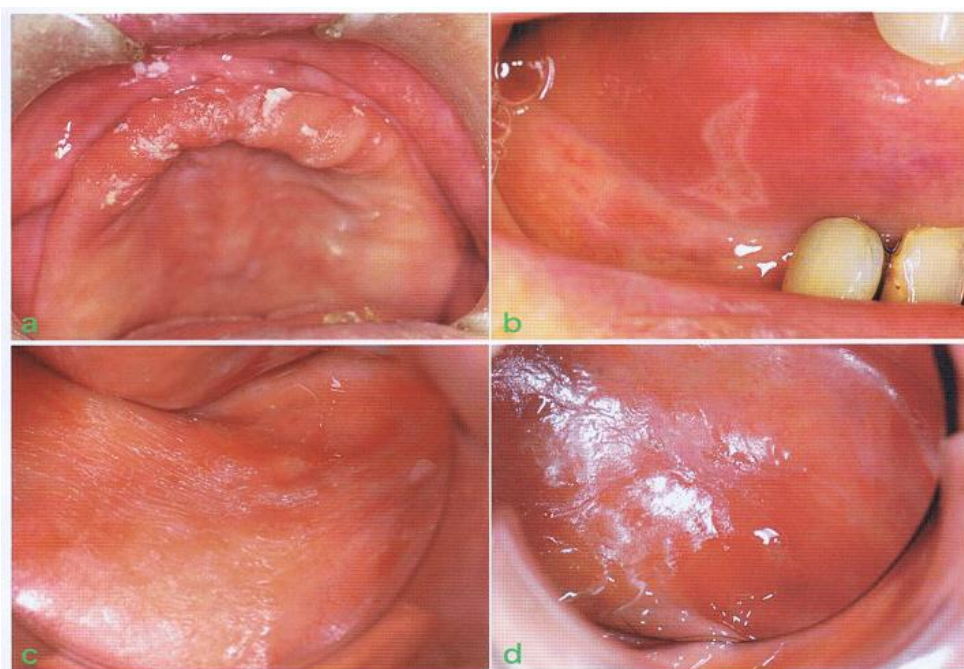
2-1 Advanced aging of edentulous patients

Percentage rate of edentulism statistics are almost same at age 75 in 1993 and those over age 85 in 2005. Although yet unknown whether or not total number of edentulism has decreased on the whole, the graphic chart does show shifting the average value to the right hand, indicating advanced aging of edentulous patients. (Kanehira 2009 ²⁾, Statistical analysis committee on the Survey of Dental Diseases 2007 ³⁾)



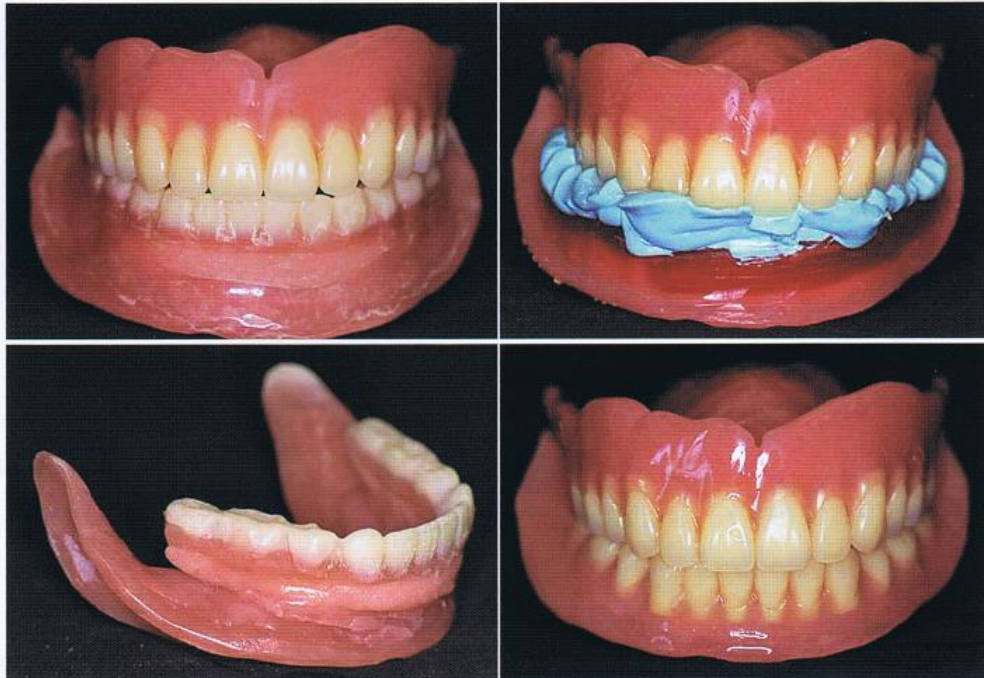
2-2 Osteoporosis patient with edentulous skull bones

Contrary to the mandible, maxillary bone is less dense.



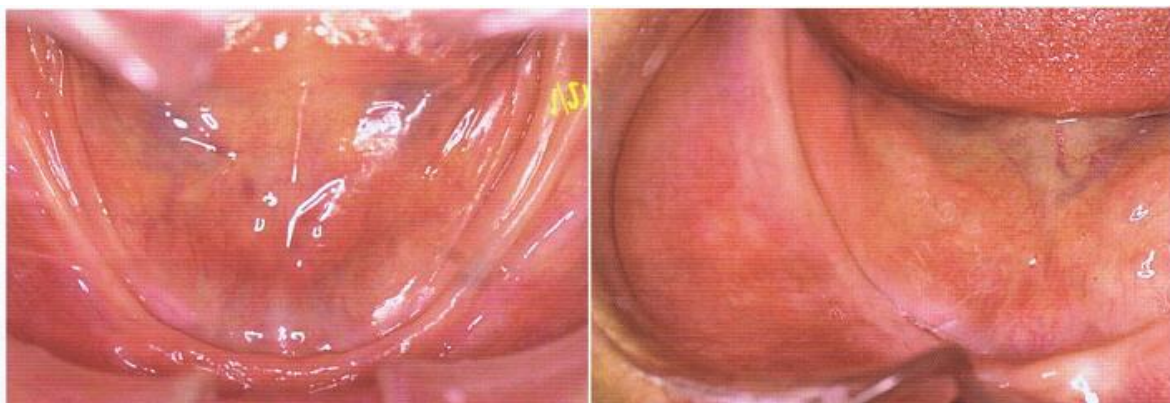
2-3 Disease disorders to inhibit making complete dentures

a: Candida disease in the maxillary anterior region , b: Recurrent aphta (anterior side of tongue, multiple missing teeth case), c: xerostomia, d: buccal mucosa erosion (pain sensitivity)



2-4 Case of reconstruction after having decreased occlusal vertical dimension

Once the vertical dimension is found short after denture finished, occlusion was raised to the average value and a treatment denture was made. But it was not accepted in good adaptation (left above, below), and final denture was reconstructed at the level slightly raised from old denture (right above, below).



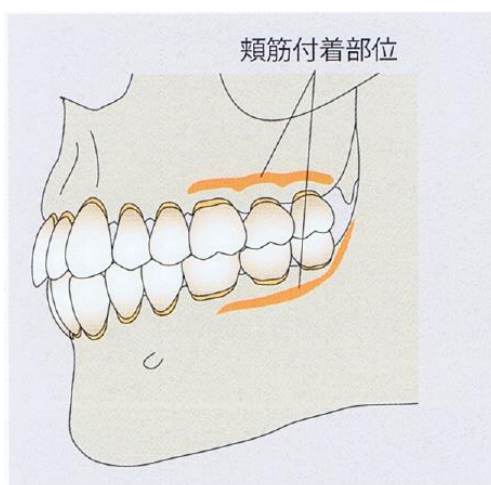
2-5 String-like residual ridges

Changes of soft tissues in the mandible

1) Decreased immobile soft tissues and Double tongue

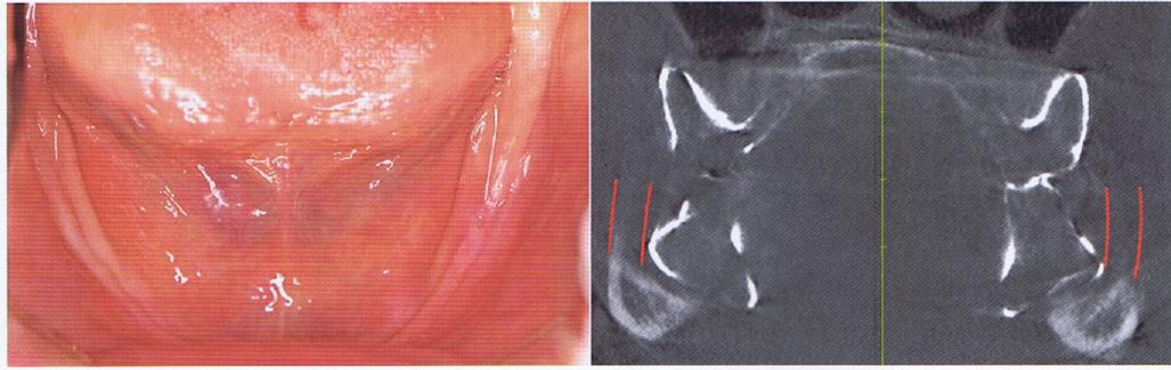
As the residual ridge is reduced progressively, immobile mucosal membrane cannot be seen on the buccolingual sides of the alveolar ridge crest in some case (2-5). As long as sufficient volume of immobile mucosa is present, denture peripheral outlining can be more easily established for denture support area. But in case like so called “String-like residual ridge” as shown in 2-5, the ridge crest appears to be already reduced lower in the level of buccinator muscles attachment region, the buccal mucosa is raised directly from the string-like ridge crest. And so the denture base cannot be extended enough into the region of external oblique line (2-6, 2-7). Furthermore, on the lingual side, the ridge mucosa is in transition directly into the mouth floor mucosa, and at the same time this mouth floor mucosa is largely projected into the oral cavity, exhibiting so-called Double tongue in some cases (2-8).

This kind of folded mucosal layer will not only inhibit taking a clear impression, but also will make a final denture insertion difficult. And this folded mucosal layer will make a denture unstable and painful even when this folded layer is worked into the denture base. In this case, a denture border would be suggested to cut back largely (2-9), and a treatment denture can be indicated using tissue conditioning material for taking precision impression taking.

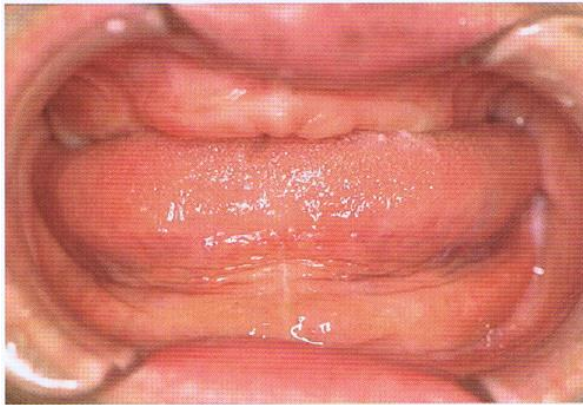


2-6 Buccinator muscles attached regions

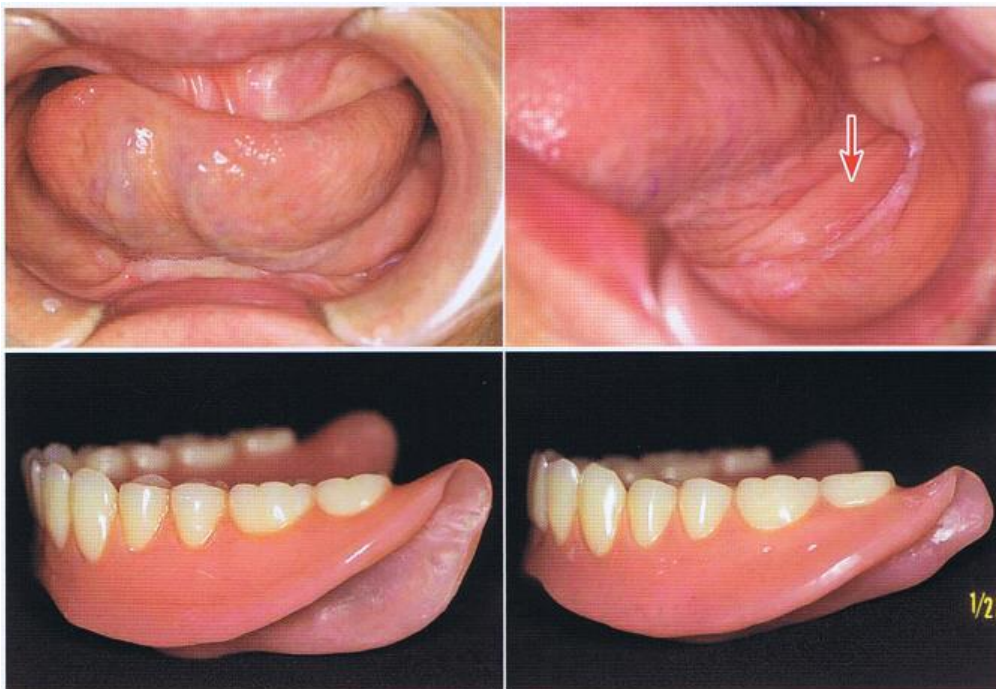
→Buccinator muscles attached regions



2-7 In the oral cavity, buccal mucosa is raised directly from the string-like residual ridge. In the molar tooth regions, denture base cannot be extended to the external oblique line.



2-8 Double tongue with projected mouth floor mucosa



2-9 The mouth floor mucosal region (↓) in folds cannot accommodate the denture

peripheral border, and so in this case the denture base is cut off to the mandibular mylohyoid line region.

2) Atrophic sublingual folds

While Double tongue is present among aged people, ridge resorption and decreased salivary flow will be accompanied with getting the sublingual folds unclear. Sublingual folds are clearly defined among a child and dentulous adult, but aged people are not clear in many cases. In this case, the mouth floor shows in tension like a tent and it makes difficult to establish denture base border extension and shape, which will also make difficult to attain border sealing for effective suction (2-10).



2-10 In dentate alveolar ridge, the sublingual folds are clearly defined, but in edentulous ridge, many cases have no clear definition of sublingual folds. Depending on cases, alveolar lingual sulcus is not clear, and the mouth floor is elevated in tension like a tent, and so this will become a difficult clinical case.

3) Indistinct retromolar pads

As the immobile mucosa decreases in volume, the retromolar pads become indistinct in shape. Non-use of denture insertion for a long term or use of denture with reduced occlusal vertical dimension will demonstrate the pads in long and thin pear-like shape. In this case, the pad shape is thinned making the posterior denture border difficult (2-11).



2-11 Retromolar pads are clearly defined (a), and less clearly defined (b).

4) Retracted tongue root

The tongue root is visibly retracted in frequent occasions among aged patients when the mouth opened. The swallowing performance is known to be deteriorated with old age, because negative pressure for swallowing cannot be created easily. It is reported that the oropharyngeal cavity is enlarged among edentulous patient decreasing the standby capacity ⁵⁾. Retraction in the tongue root region might be a kind of living body adaptation for closing the pharyngeal region. Retracted tongue root will make the lingual denture border sealing difficult and unfavorable for attaining denture suction (2-12).



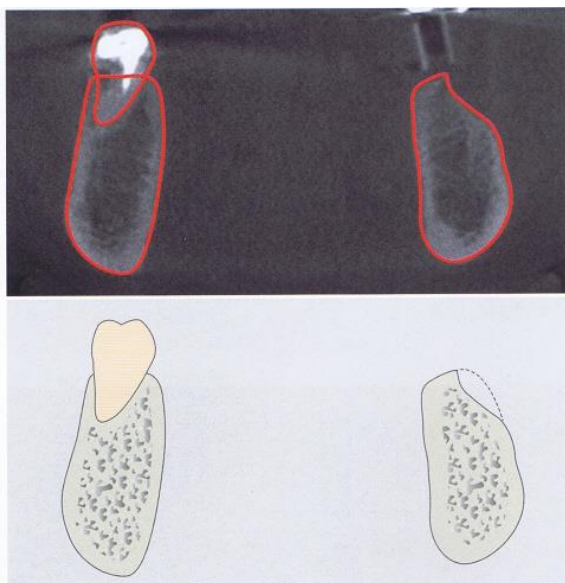
2-12 Significantly retracted tongue root. Especially in b, back of tongue is different in height bilaterally. It is quite impressive to know that the oral cavity environments are gravely different among individuals.

Changes of mandibular bone shapes

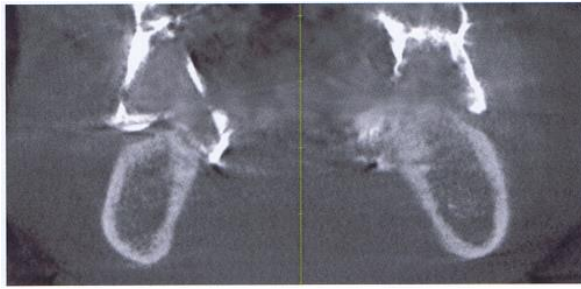
1) Where is the ridge crest in the posterior region?

In general after teeth are lost, the alveolar bone remnant is understood to shape the residual ridge crest. In a unilateral free ended partially edentulous case, however, when compared with teeth remaining side and teeth missing side, major part of the alveolar bone is lost, and the ridge crest is formed with the lingual cortical bone region and the alveolar bone remnant connecting to the internal oblique line of the jaw bone (2-13). For this reason, the residual ridge arches may be presented rather in smaller size internally first than dentulous time, and then, as the mandibular jaw bone is developed externally and inferiorly, joined with losing ridge height as conventionally acknowledged, the mandibular residual ridges are expanded externally in the course of advanced resorption (2-14).

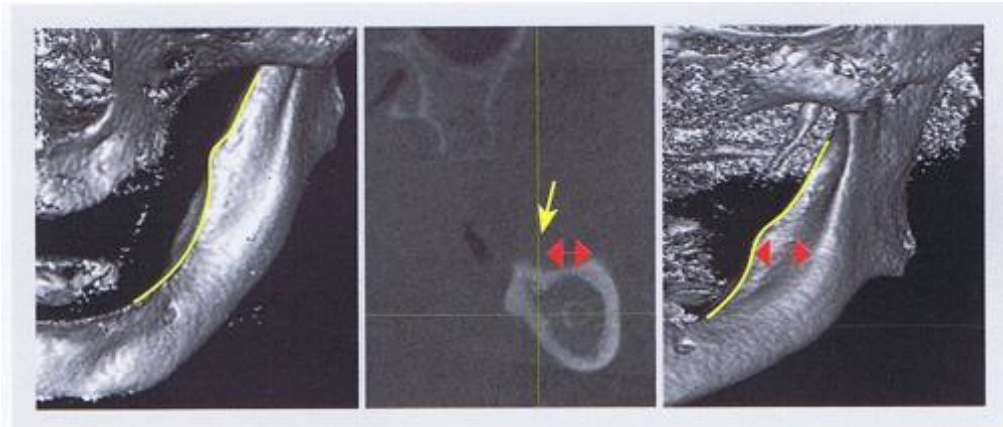
Along with the alveolar bone resorption, the buccal shelf region is expanded sufficiently in the area where the buccinator muscles attachment and the buccal nerves are running in between the alveolar process and the external oblique line. By this way, this area becomes clear for the first time and can be available for primary denture bearing area (2-15).



2-13 After tooth loss, buccal alveolar bone will be resorbed and the residual ridge crest is formed with the lingual cortical bone region and the alveolar bone remnant connecting to the internal oblique line of the jaw bone. In this case, the buccal shelf is clearly defined and can be available for primary denture bearing area.



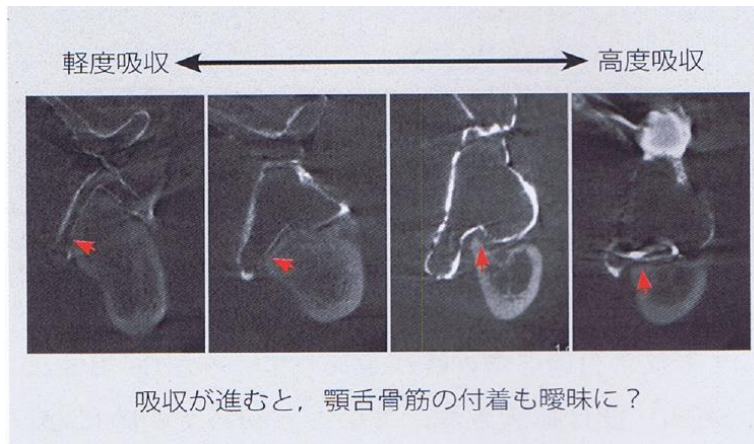
2-14 As the mandibular jaw bone is developed externally and inferiorly, the mandibular residual ridges are said to be expanded externally in the course of advanced resorption.



2-15 Denture border shapes will change depending on degree of bone resorption.

- Residual ridge crest → Lingual cortical bone crest in connection with internal oblique line (yellow line and arrow)
- Buccal shelf → Between internal and external oblique lines (red arrows)

Furthermore, if the resorption is advanced remarkably as the inferior alveolar canal is exposed, the resorption on the lingual side is advanced to the mylohyoid line region, and the height level is almost same with the buccal external oblique line (2-16). In case where the resorption is highly advanced, the mylohyoid attachment region is lost, and so any functional changes will follow, but the rational is not fully clarified (2-17, 2-18). In this occasion of oral cavity, the residual ridge is slightly formed with string-like keratinized mucosa and is found almost flat (2-7).



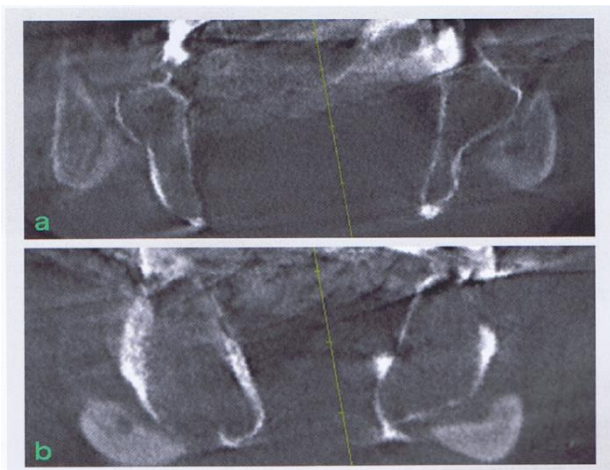
« Mild resorption

« Advanced resorption »

« As resorption is advanced, does mylohyoid muscle attachment become unclear? »

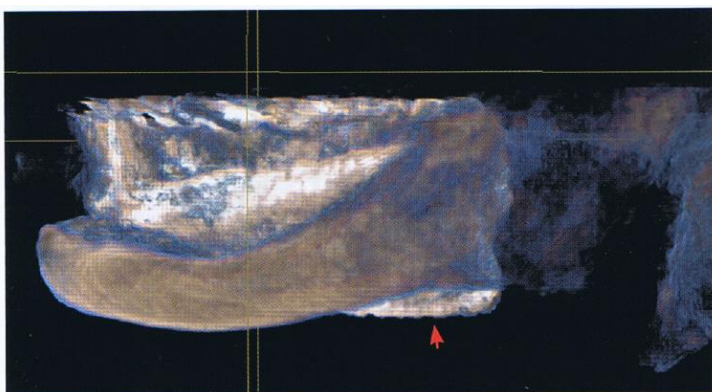
2-16 Mylohyoid line

Ridges resorb gradually, and the inferior alveolar canal will be exposed, reaching mylohyoid line region on the lingual side. Mandibular bone shape will be maintained only with cortical bone on the external oblique line.



2-17 Case with highly advanced bone resorption

a: Retromolar pad region, b: Molar tooth region

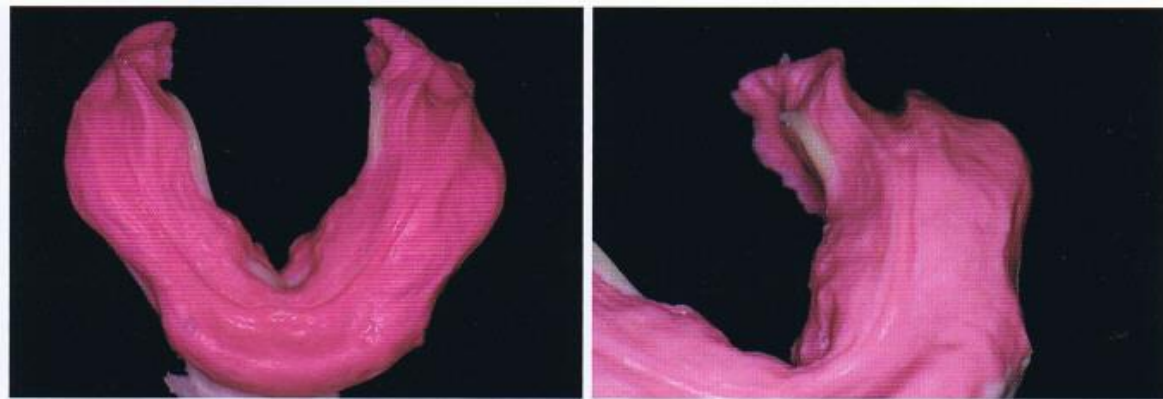


2-18 The case 2-17 is observed through volume rendering image from the lateral view, and

it shows the lingual denture border crossing over the mylohyoid line region largely and

being extended far below than the mandibular inferior border (↑). In this case, how is going with the function of mylohyoid?

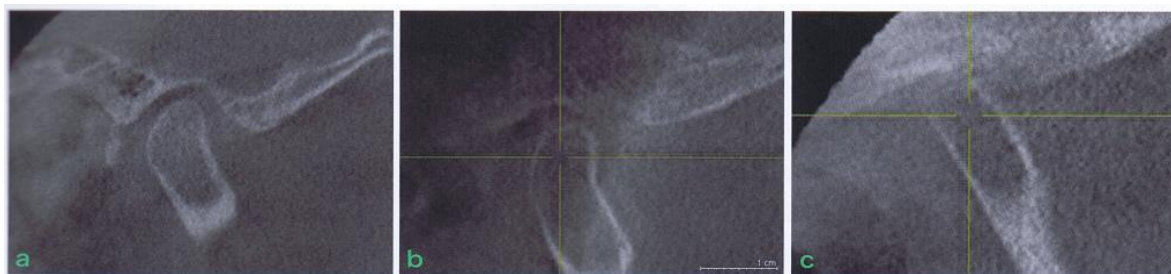
In a case like this advanced resorption, the lingual side cortical bone will continue to resorb, and the mandibular bone shape will be maintained with the help of the buccal side cortical bone that is connected to the mandibular bone external oblique line. The oral cavity views will demonstrate a shape of cooking bowl, and the impression body of the residual area will be taken in concave fashion (2-19).



2-19 Impression taking in case where resorption is advanced (2-7 case)

2) Flattened articular tubercle

After losing teeth, the temporomandibular joint (TMJ) changes in shape ⁶⁾. In general, the articular tubercle will become mildly angled in comparison with dentulous patients (2-20). Mild inclination of the condylar guidance is favorable for provision of bilateral balanced occlusion according to Hanau's Quint.



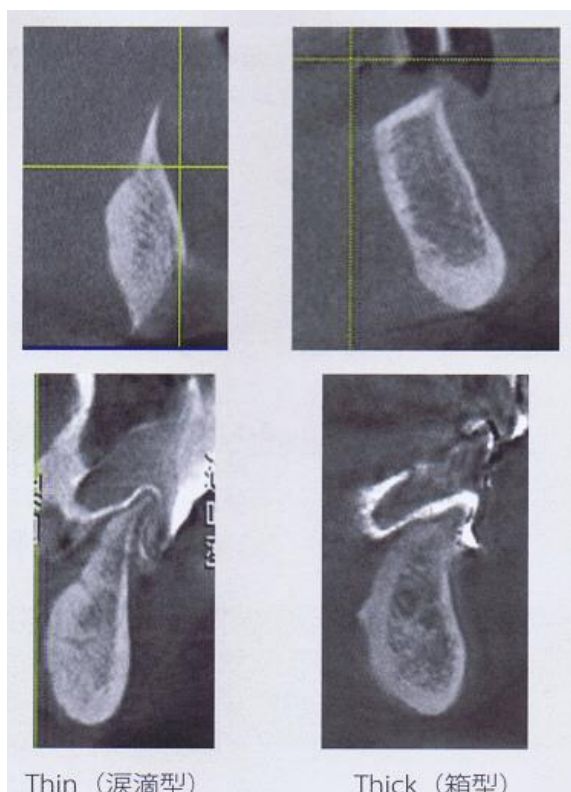
2-20 Different TMJ articular tubercles

a: Dentate jaw, b: Edentulous jaw; the articular tubercle angles become mild.

3) Types of residual ridges

Even in dental implant therapy cases, there can be instances when the bone width is sufficiently indicated or limitedly indicated from CT scanned radiography. Especially in case of lady patients, thinned jaw bones are more frequently seen in many cases, and there is a difficult case of inserting implants of even 4mm diameter by normal procedures.

Consequently, in edentulous patients, there can be instances of jaw bones of thickened type of the mandibular jaw bone cross section in a shape of tear drop, and the thinned type in a shape of box (2-21). Also the ridge crest of a tear drop type shows like a knife edge easily causing pain from micro bone fractures. And in case of the box type, the denture border cannot be established easily on the labial side. Two pieces insertion in the mandible with implant supported overdenture will need prior clarification over the bone type, bone width, inserted direction and site with the help of CT scanning.



2-21 Biotypes in the anterior region of mandibular bone.

In Thin type, bone edges happen to suffer from micro bone fractures

Even though repeatedly adjusted, pains are persistent for about 3 weeks, and then relieved naturally.

Thin(Tear drop type)/Thick (Box type)

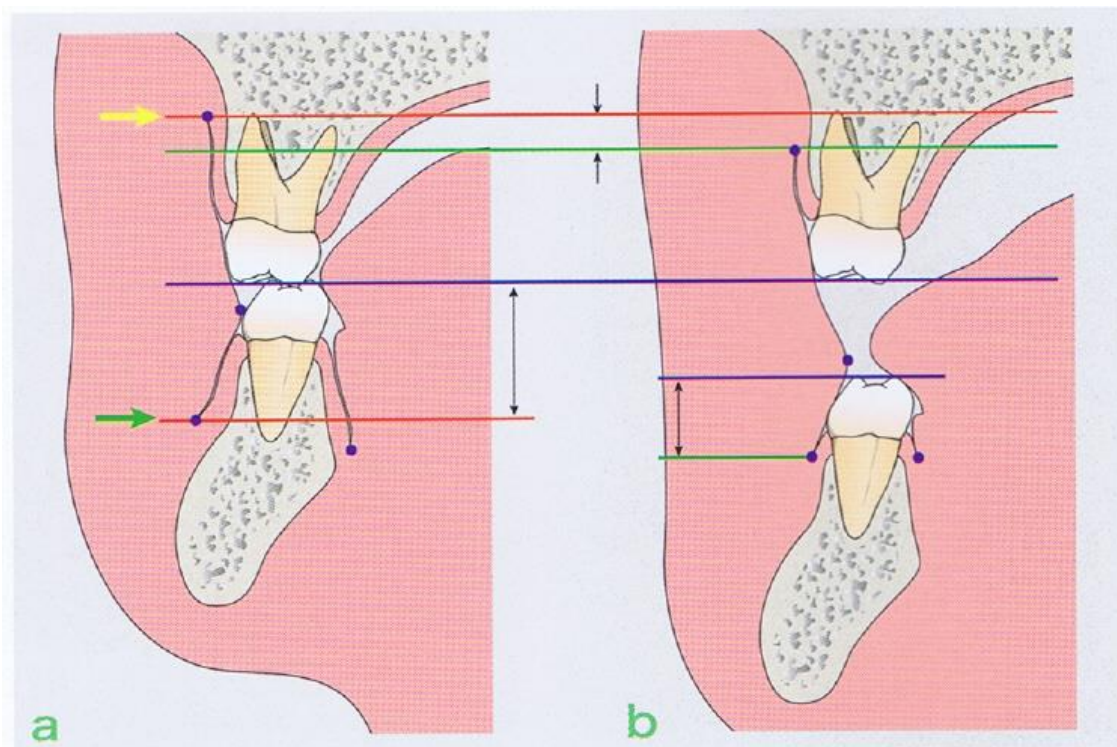
Q: What makes a denture unstable?

A: The oral cavity continues to move while in function. Since the lips, cheeks and tongue continue to move when singing a song, talking, taking food and chewing, they will make a denture unstable, being applied with functional pressures from all directions. And a denture is made unstable too from direct pressure of food bolus in chewing.

Changes in oral shapes in function will make a denture unstable.

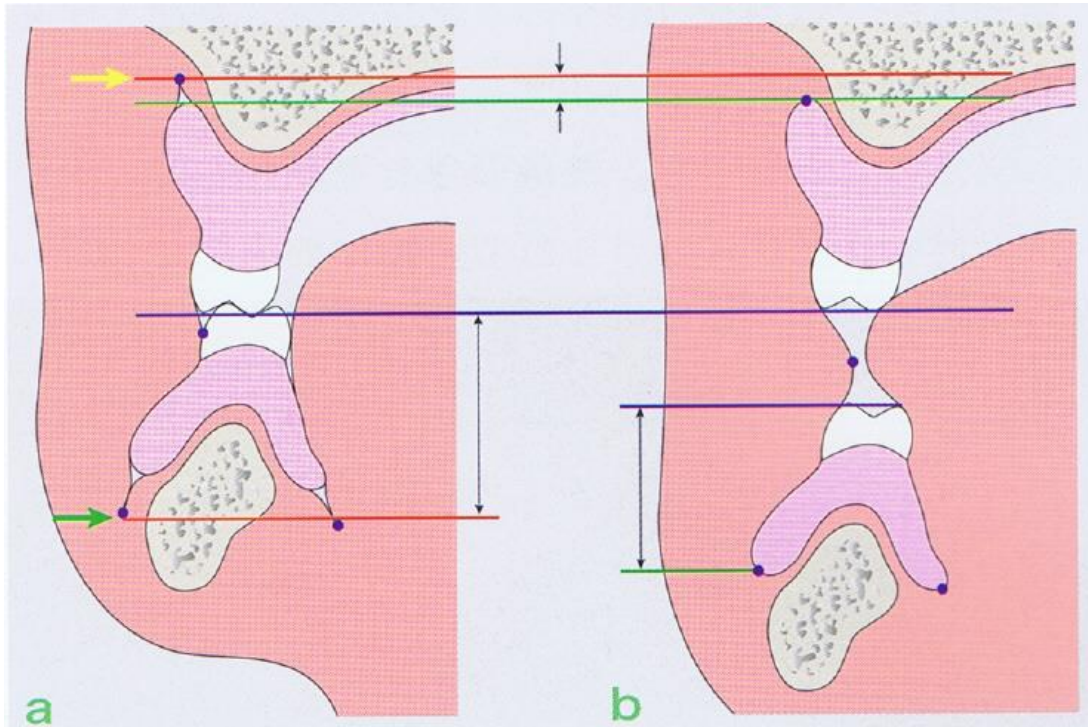
On trying to take food, the denture surrounding oral mucosa which keeps at rest position before that trying will start to change in shapes with the mouth opening action and the lips movement (3-1)⁷⁾.

If the denture border is extended too long, the denture will be lifted and dislodged in this instance (3-2, 3-3).



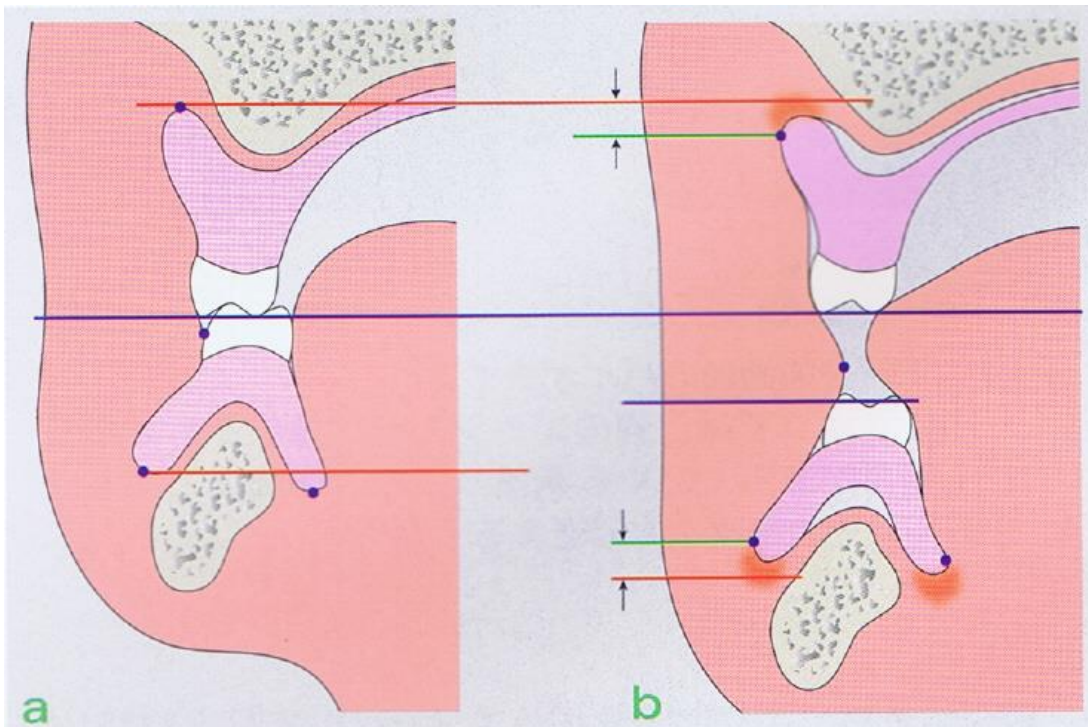
3-1 Mucosal shape changes while in chewing in dentate jaw (Abe et al. 2011⁷⁾).

a: While mouth closing, b: While mouth opening



3-2 Mucosal shape changes while in chewing under proper denture border extension.

a: While mouth closing, b: While mouth opening, denture will not be lifted up.

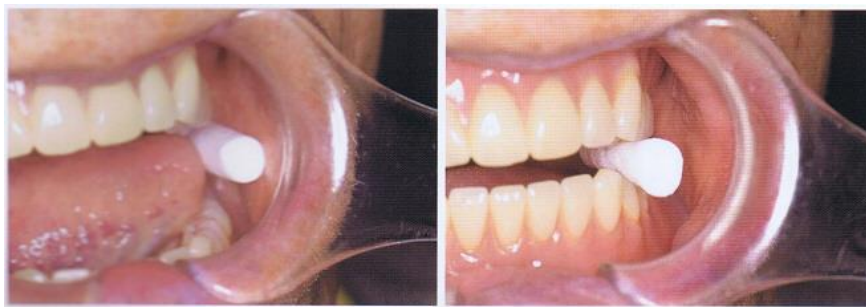


3-3 Mucosal shape changes while in chewing under too long denture border extension.

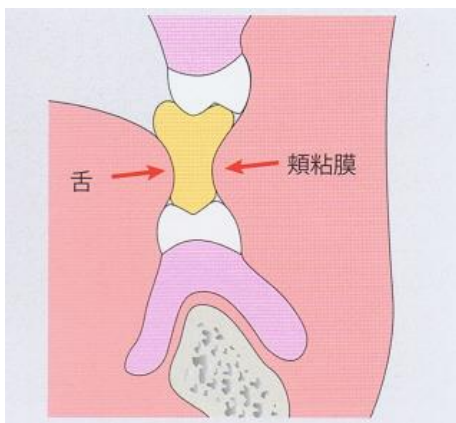
a: While mouth closing, b: While mouth opening, denture will be lifted up.

In the chewing phase, likewise with a dentulous case, food is taken into the mouth

and the tongue carries it onto the dental arches skillfully, exerting occlusal forces (3-4). Soon afterward food is crashed and dispersed into both the lingual and buccal sides and escaped from upper and lower denture teeth. These food pieces are again carried onto the arches with helping movements of cheek muscles and tongue for further crashing repeatedly. While in these movements, food pieces are mixed slowly with salivary flow being ready for swallowing into the stomach. During the mastication, tongue and buccal mucosa are moving continuously, and functional pressures are definitely applied from the surrounding tissues (3-5).



3-4 Tongue conveys food onto the denture.



3-5 Status while chewing.

Tongue → ← Buccal mucosa

The tongue will move to change the chewing side in the middle of mastication, sorting food pieces to directions of right and left. The tongue movements will elevate the mouth floor superiorly, which causes denture dislodgement (3-6).

As above, while in masticatory functions, the tongue, cheek mucosa and mouth floor are continuously changing in shapes. These movements are involved involuntarily and work immediately on a denture as mucosal changes in shapes that are major factors of denture instability while chewing. If the denture border is extended too much for taking greater importance on denture support, it cannot cope with various shape

changes of oral mucosa during functions, leading to patients complaints: “Denture lifts up and cannot chew” and “Food pieces stray underneath the denture base and are painful”. Therefore it is necessary to establish the denture border length and shape depending on patients, and this is a major rationale for giving an advantage of taking a patient-driven impression taking method. The closed mouth way of functional impression taking method for effective denture suction has a rationale for determining denture border length and shape on patient’s own.



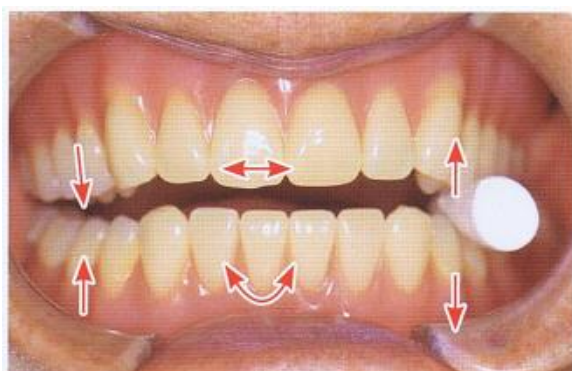
3-6 Translation of the chewing side with tongue.

The tongue movements will elevate the mouth floor superiorly, which causes denture dislodgement.

Chewing force itself makes a denture unstable

As described previously, chewing force that crushes food will cause denture tilting directly and will make unstable.

A denture that is present on the mucosal surface makes a small boat assumed just like floating in the waves, and one way of pressure loading will lift it up the other way. Joined with rotational movements, a denture moves three-dimensionally (3-7). For this reason, a denture will need to be controlled for better movement in the mouth, and for this clever device, the occlusal scheme, “bilateral balanced occlusion” should be suggested as advantageous.



3-7 When pressure is loaded unilaterally, denture will move three-dimensionally.

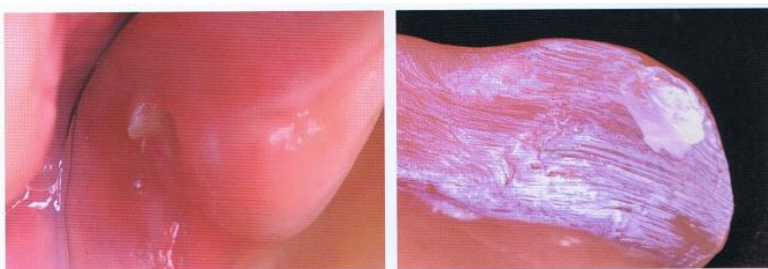
Q: As long as complete dentures are effective with suction, is it stable enough even while in chewing?

A: Not correct. However effective they may be with suction, they are continuously made movable while in function.

Even a suction effective denture will move while in function.

Once a new denture is inserted for the first time, does anyone have an experience that an upper denture cannot be taken off because it is adhesive strongly? It is a situation where an operator cannot take it off or patient cannot, either.

In this case of upper denture with full suction strength, anyone can be confused with definitely fixed without any movement even while in chewing as firmly as in the natural dental arch. But even when a new denture is inserted for the first time of eating meal, this denture is still movable from pressures of masticatory movement, and the patient comes again to visit with complaints of erosion or pain around the external surface of maxillary tuberosity (4-1). When first inserted, fitness is good and no pain is confirmed only with fitting. It makes often do without primary fitting adjustment, but once any hurting damage is felt, a large amount of adjustment will be often needed (4-2). Denture movement loaded under masticatory functional pressure is larger than one's imagination.

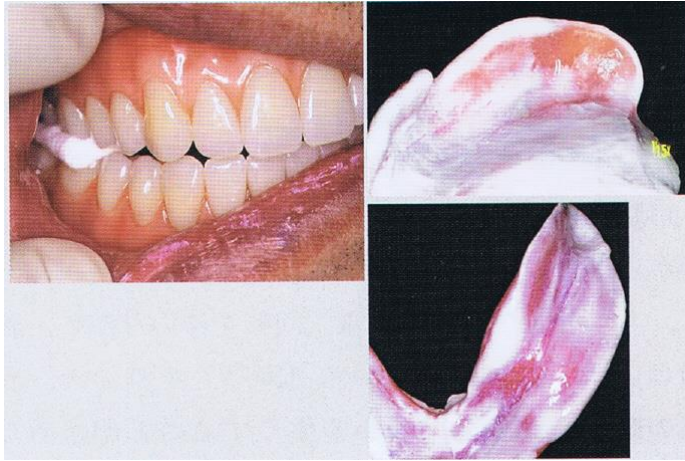


4-1 Erosion around the maxillary tuberosity

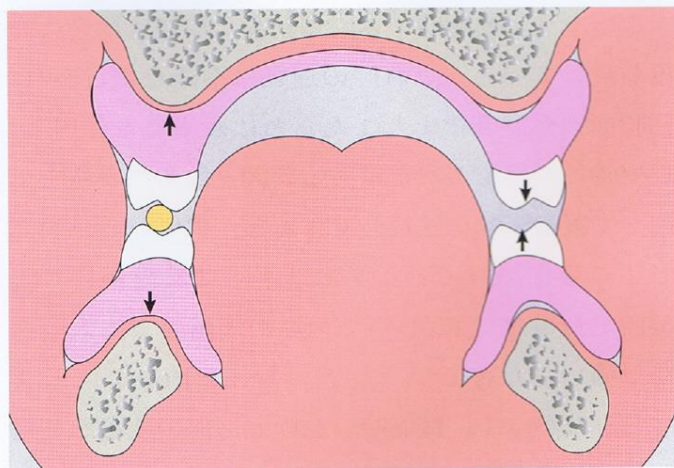
caused by denture border. Even when a newly finished denture is inserted without pain, the movable denture while in chewing will cause erosion in some case.

Now what is the situation with a lower denture? Anyone can easily understand from experiences that a lower one is more movable than upper. In fact, many dentists would like to master the techniques of denture suction in the hope that a denture which is as

least movable as possible should be supplied, because denture mobility is the larger for a case with progressive ridge resorption. Even if a lower complete denture is given in full strength of suction, the denture is after all mobile under functional pressure (4-3).



4-2 While chewing, denture will tilt and hit the maxillary tuberosity or mylohyoid line region, causing pain.



4-3 While in chewing, they sink on the working side and lift up on the balancing side, and they move eventually.

Denture moves while in function.

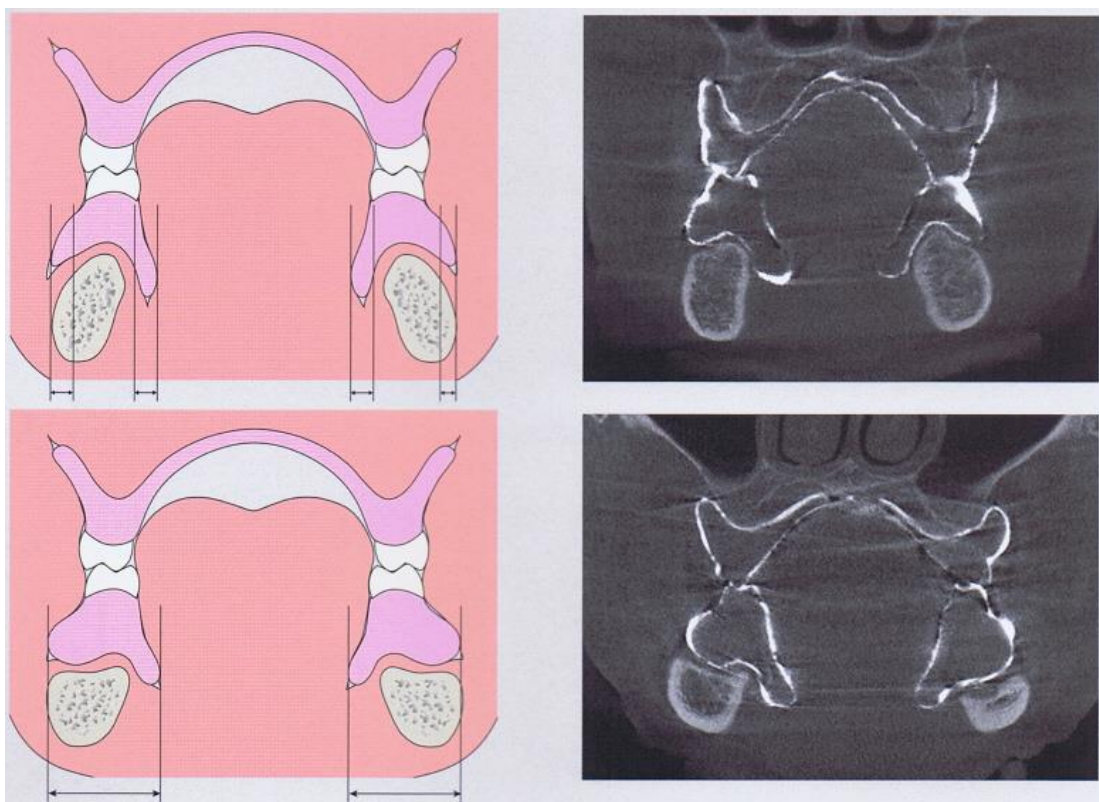
Major factors that cause denture instability are, as described above, the buccal mucosa, tongue, mouth floor while in function that move the denture continuously. And, the muscle activity exerted in function will work as chewing pressures by way of food, and it works to dislodge denture in every occasion. A denture while in function is found in the situation where it is made movable from mucosal changes in shapes and chewing pressures in order to work functions while moving.

Designing partial removable dentures include considerations of support, retention and bracing respectively, but complete dentures require simultaneous attainment of

support, retention and bracing with one unit of denture body.

In case of favorable residual ridge condition, the denture base can attain sufficient bracing as it rides over the ridge crest, while, in reduced ridge condition, the denture base is displaced laterally as it cannot attain sufficient bracing (4-4). The cheek mucosa and tongue work to move the denture base inherently, but, on the other hand, as long as the denture base is properly extended and shaped, the surrounding pressures can oppose in a way in order to work as bracing.

For this purpose above, a denture body is definitely essential as a structural unit that should be capable of coping with oral functions under balanced condition.

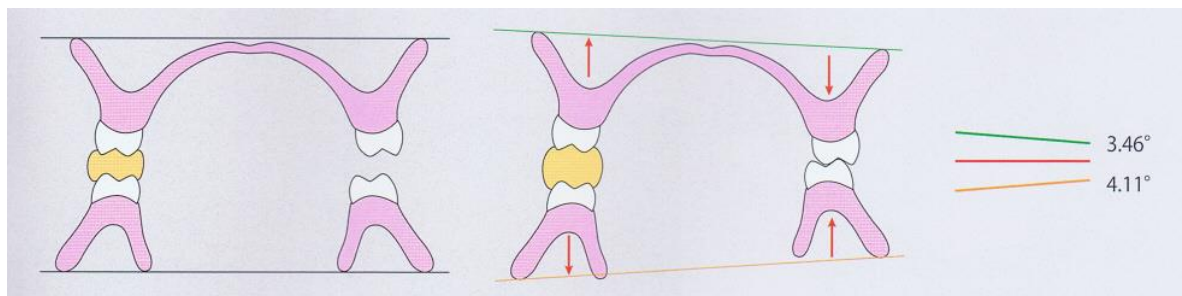


4-4 When ridges resorb, reciprocating walls will be reduced and bracing performance will be lost. And so dentures will be displaced horizontally.

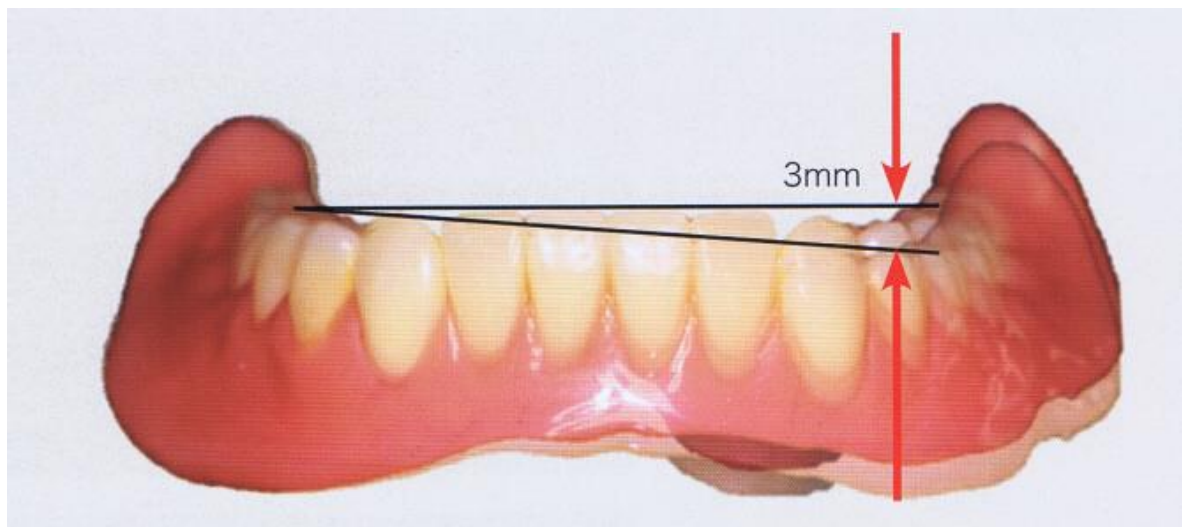
Denture mobility is 10 times larger than mucosal compressed displacement.

According to Miyashita's report, a maxillary denture is movable enough as maximally 0.78mm only under tapping motion and as much as maximally 1.32mm under chewing motion. And as for denture tilting while in chewing, it showed maximally 3.46° in the

maxilla and 4.11° in the mandible⁸⁾ (4-5). When the tilting is presumed as 4° in the mandible denture, and when the disclusion clearance is presumed as 45mm at the central grooves of mandibular right and left first molars, then, the vertical mobility on the balancing side can be calculated as about 3mm (4-6). As far as denture mobility is concerned so far conventionally, it has been understood about almost as much as mucosal compressed displacement ($200\sim300\mu\text{m}$) in general, but the fact has shown remarkably 10 times larger in motion.



4-5 Denture tilting while in chewing



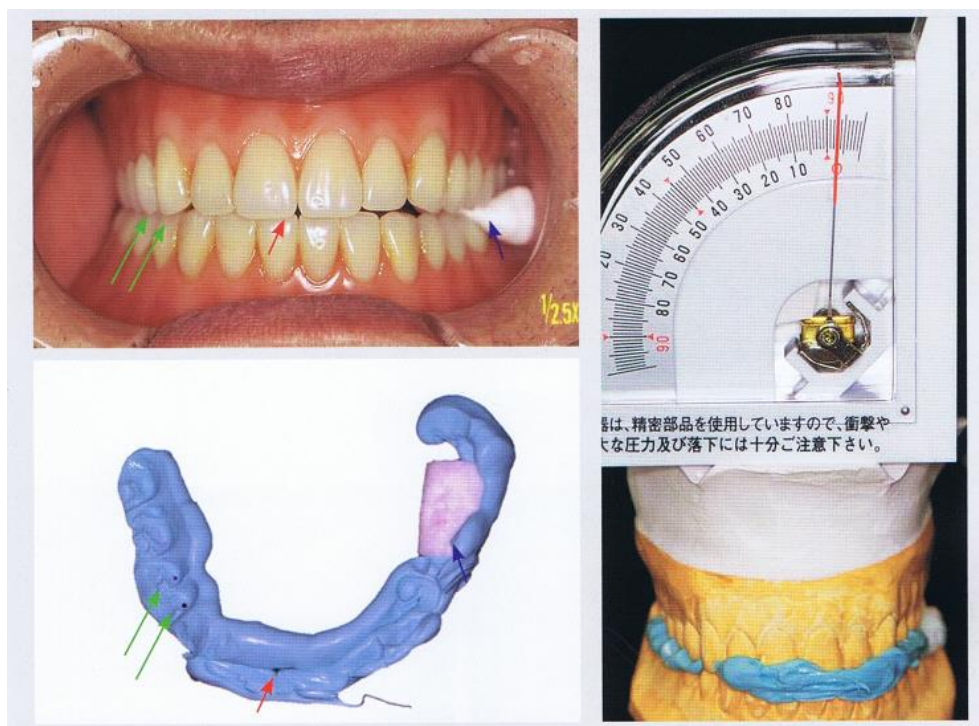
4-6 When the clearance distance is presumed as 45mm and the tilting as 4° at the central groove of the first molars, then, the vertical mobility can be calculated as about 3mm.

Denture tilting test

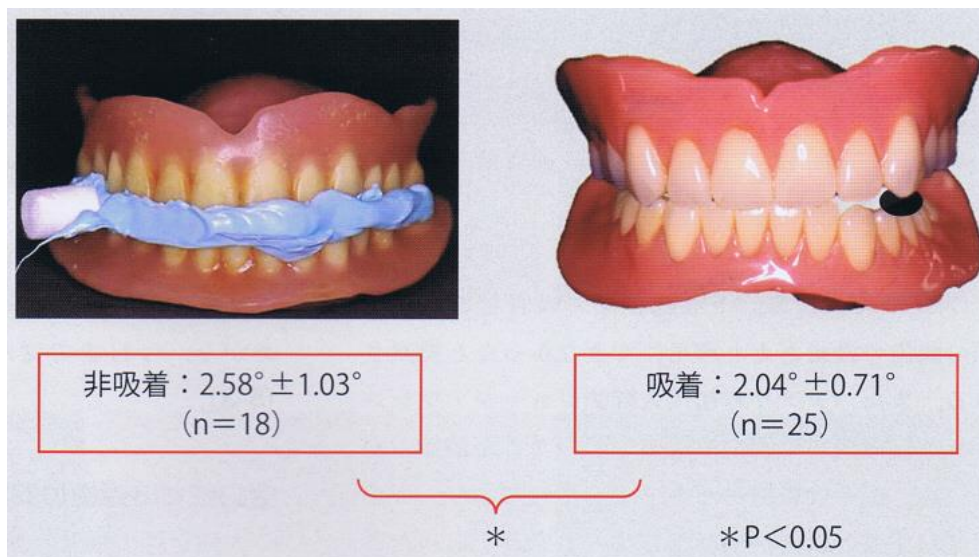
An experimental patient of maxillomandibular complete dentures is advised to chew a

piece of cotton roll unilaterally around the second premolar and first molar, and the empty space between these dentures is filled with silicone bite registration material for measuring the tilting (4-7). This silicone bite material is remounted on the duplicated casts that are mounted on an articulator for measuring the tilting (n=43), and the measured values are $2.58^{\circ} \pm 1.03^{\circ}$ (n=18) for denture without suction and $2.04^{\circ} \pm 0.71^{\circ}$ (n=25) for suction effective denture (4-8).

From this test, even a suction effective denture is known somewhat tilted between upper and lower dentures depending on masticatory forces. But when compared with denture without suction and suction effective denture, the suction effective one shows less tilted significantly but slightly. The suction effective one is about less than 0.5° for the tilting degree, and can reduce about 20 ~ 25% in tilting and it is suggested that it is advantageous for denture stability while in function.



4-7 Measuring denture tilting

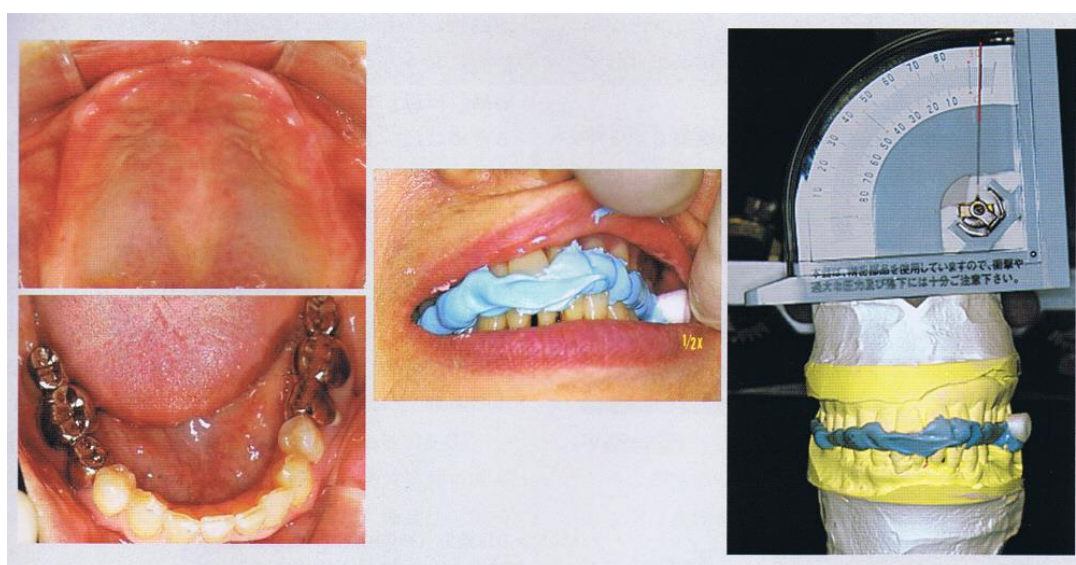


《without Suction》

《Suction effective》

4-8 Different tilting values under chewing force for denture without suction and suction effective dentures.

Also, this kind of tilting has same tendency with a maxillary single denture (4-9). In this instance, single denture is mobile than upper and lower complete dentures, and single denture is more likely unstable. In general, the ridge resorption is more progressive in single denture, and an accidental base fracture or artificial teeth abrasion is more frequent. In case of highly advanced ridge resorption, it is commonly understood that such a case belongs to a clinically difficult case



4-9 In case of upper and lower complete dentures, mobility is at about 4° vertically, and

yet even with a maxillary single denture case, denture tilting is at 4°. In single denture case, even one piece of denture is almost at same mobility as upper and lower dentures.

Q: What is denture stability while in function?

A: It is three-point support by artificial teeth during the lateral displacing movement, and dynamic equilibrium of a denture from bilateral balancing.

History of searching denture stability

In Gysi's ages, it is supposed that even an upper complete denture, instead of a lower complete denture, could not attain adhesion satisfactorily. And the first U.S. President, George Washington, is well known as a wearer of upper and lower complete dentures in edentulous jaws. They were connected with coil spring tension, and they could pop out of the mouth at any time when the mouth opened largely, and so he always closed the lips firmly to keep them in the mouth (5-1). In those ages, it can be interpreted that this kind of denture was unstable enough even with the mouth empty without any food.

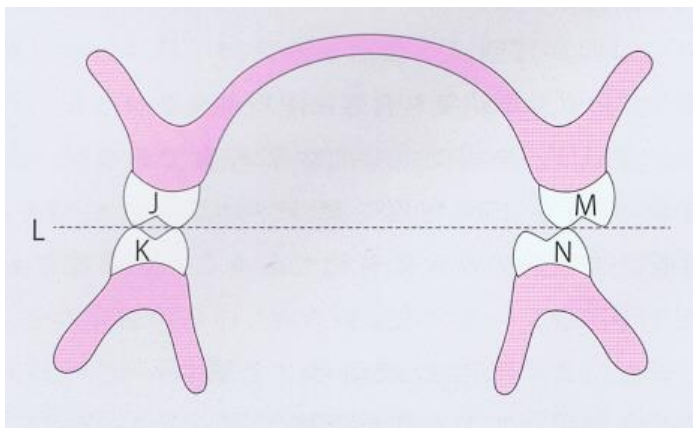
Bonwill advocated that contacting 2 cusp points on the working side while lateral sliding movements and 1 cusp point on the balancing could make up three-point-support of bilateral equilibrium for establishing denture stability (5-2). It was the advent of the idea "provision of contact on the balancing side". Later, Gysi added the condylar guidance inclination to the axis theory and the spherical theory and attained bilateral balanced occlusion that was better adapted to the living body. And then afterward Hanau and others have advanced the studies. Through this way of researches, basis of this idea that "bilateral balanced occlusion will stabilize dentures" is founded and running on until today (5-3).



5-1 Complete dentures of George Washington

(Kanagawa Dental Association, Dental Museum website:

www.dent-kng.or.jp/chishiki/museum/hakubutukan/seiyougishi/seiy3.htm)



5-2 Bilateral equilibrium with 3-point-support advocated by Bonwill.



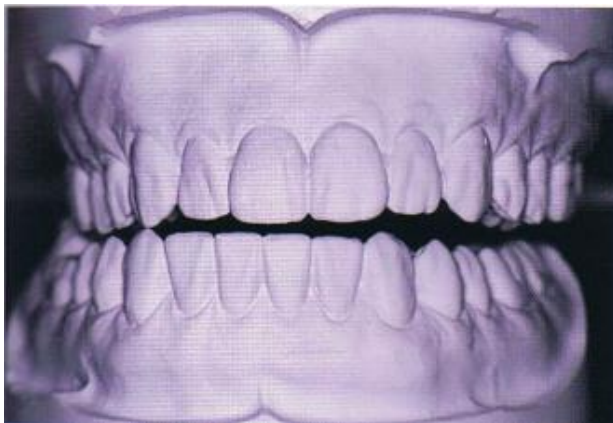
5-3 Bilateral balanced occlusion in the empty mouth

Denture stability in an empty oral cavity = Bilateral balanced occlusion

In case of canine guided occlusal scheme, Christensen's phenomena will be presented on the lateral movement and the posterior disclusion will be developed. For this reason, upper and lower artificial teeth are separated in distance, and if the maxillary denture is not seated in suction, it will easily dislodge and drop. In order to attain the

balancing side contact, the upper and lower dentures should be tilted largely (5-4).

On the other hand, in case of bilateral balanced occlusion, the upper and lower artificial teeth can originally slide laterally while in contact, and so the dentures will not dislodge and stability can be maintained. Furthermore, if, so called, full-balanced occlusion can be provided, theoretically speaking, these upper and lower artificial teeth are kept in contact in all eccentric positions, back and forth or right and left, and so the dentures will not drop and will maintain stability (5-3).



5-4 Without any denture tilting, there is no chance of bilateral balanced occlusion. In case of canine guided occlusion, there develops posterior disclusion in the balancing side. With complete dentures, they should be tilted largely in order to attain the balancing side contact.



5-5 Unilateral balancing.

To attain unilateral balancing is to make chewing possible to resist denture sliding, and is effective for stabilizing dentures while in function.



5-6 Bilateral balancing

Bilateral balancing is attained with food on the working side and upper and lower artificial teeth contacts on the balancing side.

In order to attain balancing side contact, there are differences in degree of tilting of dentures between the canine guided occlusion and the bilateral balanced occlusion, and the bilateral balanced occlusion is easier to attain balancing condition with less tilting, and so the unstable time can be shortened slightly while in chewing and more comfortably stable for patient. Therefore this kind of denture is hopefully better acceptable for patients handling.

Currently, thanks to advanced material science and techniques, quality of impression taking and polymerization is highly precise, and most maxillary dentures are successful for effective suction and will not dislodge easily. So it tends to take less importance from provision of the bilateral balanced occlusion. But the bilateral balanced occlusion does not only work on eccentric positions under empty mouth but also, in reality, works to contribute to “denture stability while in chewing”. Therefore this is an important factor for making successful denture.

Denture stability while in chewing = Bilateral balancing (Bilateral equilibrium)

Currently, stability while in an empty mouth is taken as a matter of course, but how should it be understood about denture stability while in function of chewing food?

As stated above as “denture functions while moving”, denture stability while in function means the condition where chewing performance is most potential with least denture movement. For this purpose, this condition should be like achievement of “unilateral balancing” where unilateral chewing would not dislodge a denture (5-5), or alternatively, it should be like achievement of “bilateral balancing” generating the balancing side contact by some degree of denture tilting (5-6).

Even in unilateral balancing, chewing force will sink on the working side by way of food bolus and will create lift up on the balancing side, which will tilt a denture in some way.

Bilateral balancing is like under any condition where denture dislodgment has ceased being generated by the upper and lower artificial teeth contact on the balancing side. The key is to attain the teeth contact of the balancing side as early as possible. For this

purpose, the bilateral balanced occlusion is more advantageous than the canine guided occlusion because their upper and lower artificial teeth contact is already arranged in zero on the balancing side. With teeth contact on the balancing contact, tilting will be prevented and a denture will be stable and settled better for food crushing. Ironically enough, “bilateral balancing” is such a kind of stability as gained from mobile dentures.

Dentures while in function are made movable continuously, and they, equipped with bilateral balanced occlusion and suction, move in regular cycle and rhythmically for efficient mastication⁹⁾ trying to keep stability in good function while allowing mobility. This kind of condition might be called as “dentures dynamic equilibrium”.

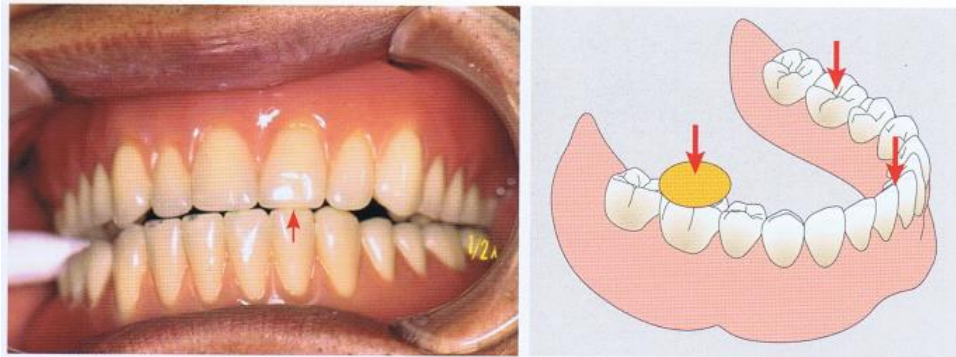
Three-point support while in function from anterior balancing contact

Among different dentures that are attained with bilateral balancing, some cases indicate masticatory function being joined with continuous anterior contact. In case when shiny facets are found on the incisal edges of mandibular anterior teeth and on the lingual surfaces of maxilla anterior teeth, they are considered in positive service during function (5-7). In addition to obtaining the right and left balancing by the posterior balancing side contact, anteroposterior balancing supported by the anterior contact is attained. This kind of contact in the anterior region is called the anterior balancing contact ¹⁰⁾. And then these dentures, while in function, are supported in three points together with food balancing and the balancing side contact. And they are all considered to contribute to denture stability while in function (5-8).



5-7 In case of masticatory function accompanied with continuous anterior contact, shiny facets are observed. In this case, facets are detected in the course of the right and inferior direction in the anterior teeth region, and other facets are seen on the

balancing side contact in the left posterior teeth region, and so this patient appears chewing on the right side.



5-8 Anterior balancing contact (↑)

Dentures move to attain food balancing, anterior balancing and lateral balancing side contacts in three-point-contact that contributes to stabilizing dentures

Food bilateral balancing

Two pieces of cotton rolls are simulated of chewing food and are used for adjusting dentures, and it is comparatively often observed that these cotton rolls (food) are sorted into the right and left posterior regions (5-9). And, the chewing pressure is equally sorted to the right and left directions by chewing bilaterally and simultaneously in order to prevent denture dislodgement effectively. This kind of bilateral chewing confirms patient capability of adaptation in order to attain bilateral balancing using food chewing, and it is called “food bilateral balancing” ¹¹⁾. Food bilateral balancing can make stronger chewing force while maintaining denture horizontally during function.



5-9 When two pieces of cotton rolls are simulated of chewing, they are often sorted into the right and left posterior regions.

Hanau Quint prepared for bilateral balanced occlusion in clinical practice

Hanau presented interrelationship of 5 factors for attaining bilateral balanced occlusion.

- ① Sagittal condylar guidance inclination
- ② Incisal guide angle
- ③ Cusp angle
- ④ Occlusal plane
- ⑤ Spee's curve

Among above, some can be modified by clinician's judgment in making a denture and some cannot.

The sagittal condylar guidance inclination is shown milder than while patient used to be dentate and this will make advantageous for bilateral balanced occlusion, but it cannot be modified because it is inherently patient's own.

As for cusp angle, it can be limited to some extent, although it varies from artificial teeth selection.

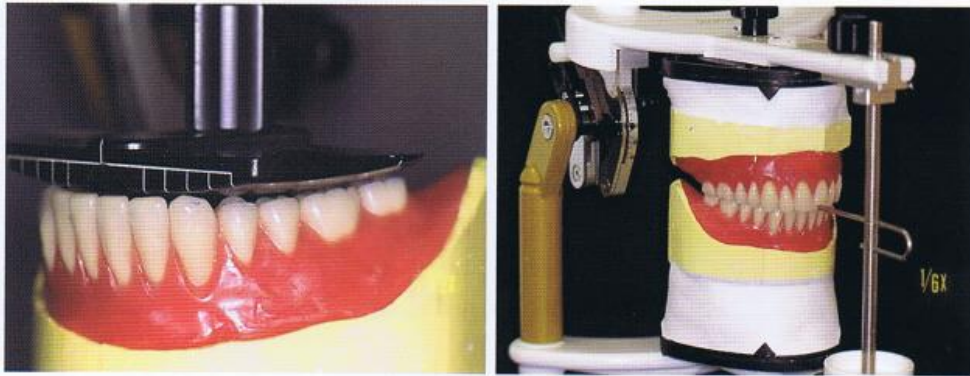
As for incisal guide angle, it can be modified depending on artificial teeth arrangement, allowing some degree of judgment reserved for clinician. But in case of complete denture, principles are non-contact anterior relationship or equal to posterior cusp angle and so the degree of freedom may be limited.

As for occlusal plane, basis should be parallel to Camper's plane, but it should be more advantageous for bilateral balanced occlusion by tilting them as anteriorly as possible. Author's experience indicates to the degree of freedom within 2~3° in clinical cases ¹¹⁾, and it should not be large enough of freedom.

Since Spee's curve is to some extent limited depending on 4 other factors above, it cannot be considered to give excessively strong curve. Rather, curve strength will be better based on common practice following an average way of teeth arrangement and a ready made template.

In this way of clinical practice, even 4 other factors other than sagittal condylar guidance inclination are quite limited to permit clinician's judgment, and so requisites of Hanau Quint will be met duly only if artificial teeth choice and arrangement follow

almost basic standards of them (5-10).



5-10 If artificial teeth are arranged along with the set up template, compensating curve can be provided automatically and bilateral balanced occlusion can be attained.

Q: What are proper denture shape and size?

A: Proper things will be decided by a suction effective denture. The suction effective denture is not singularly advantageous to denture retention. The oral conditions while in function are continuously changing and dentures can be unstable easily with too long or short denture border. Suction effective denture borders should be necessarily sufficient and yet will need to be compact enough without any interference in function.

Attainment of suction = Proper denture shape and size

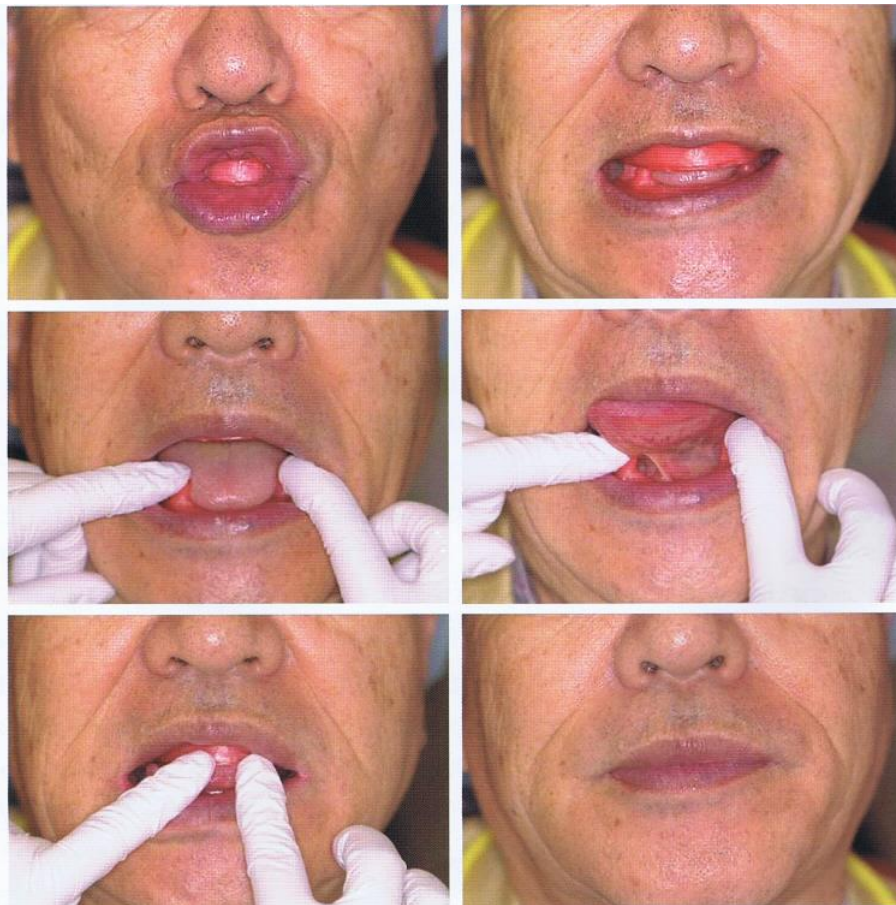
Complete dentures should have proper shape and size depending on patients. Denture shape and size are, in other words, denture border shape to be established and no dentures are comfortable if they are too large or small in every part.

Oral mucosa while in function is continuously movable applying destabilizing forces to dentures. If the borders are too long to make the mucosa contracted, the denture will be lifted and unstable. For this prevention, the border shapes should be compact. By contrast, if the borders are too short, any occlusal loading support for crushing food is not good, and so the denture base surface area should be sufficient.

Suction effective shape is to meet both of these conflicting requisites all at the same time. Suction dentures are themselves effective for maintaining them in a given

position, and moreover they are compact enough to prevent from dislodging against moving mucosa, and necessarily sufficient surface area is equipped.

Impression taking for suction effective denture is processed with the closed mouth way of functional impression taking. Assuming mucosal surface shape changes while in function, five different functional movements are employed. The border shapes taken from the closed mouth functional impression are specific for each patient, and so they are the shapes that are likely to be finally immobile resistant to mucosal surface shape changes under functional pressure. In other words, denture border shapes are determined by patients themselves, and so it can be said that they are generated more functionally (6-1).



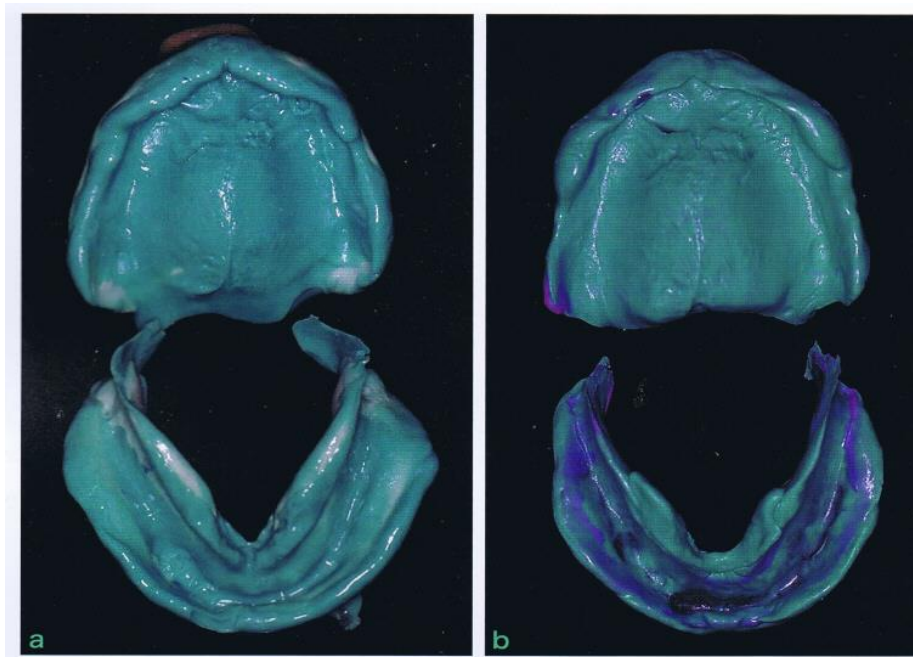
6-1 Patient driven type impression taking for attaining suction

Functional border movement shapes are taken with specific oral exercises: sounding of “oooh”, “eeeh”, (Ah), lip licking and lapping, “goooh” sounding and gulping. As preparatory steps of licking the upper lip with the tongue, push the lower with fingers

in order not to lift it up at the mouth opening.

In order to take an operator driven impression taking like conventional method of border molding method, impression should be taken necessarily assuming shape changes of these mucosal surface shape changes. Unless an operator is equipped with experience and skills, comfortable border shapes cannot be taken properly. In case of patient driven impression taking method, the support surface area is taken more importantly and it tends to be larger (6-2).

In this way, a suction effective denture is a denture that has well-balanced coordination of the followings: the direct retention effect of suction, the bracing effect of immobility resistant to mucosal surface shape changes and the necessarily sufficient support capacity for chewing forces. Author believes, therefore, that above should be one of an ideal condition of complete dentures.



6-2 Operator driven type impression on the same patient (a) and patient driven type impression

Suction denture border shapes are determined by patients themselves

According to popular apprehension, a denture is said to be made up in common shape and bilaterally symmetric to any patient.

Conversely when details are studied carefully, residual ridge appearances and mucosal surface shapes while in function are different from individual patients, and so, as a matter of fact, there is absolutely nothing same in denture shapes, and even within the same patient there is nothing symmetrical.

In order to make up the shapes of suction denture border, the peripheral border seal must be made to apply proper pressures to the mucosa throughout the denture margin entirely, and so it is necessary to judge the location and shape of where to accommodate the denture border correctly. This kind of difficult subject should not be mastered by limited resources of clinician's experience and skills, but this difficulty can be solved automatically by taking a snap impression of the closed mouth method using the Frame Cut Back Tray initially, and by being followed with the patient driven type impression taking method. Thinking of asking patient so that the denture border can be determined by patient's own in this way, any clinician can attain a suction effective denture in almost all cases.

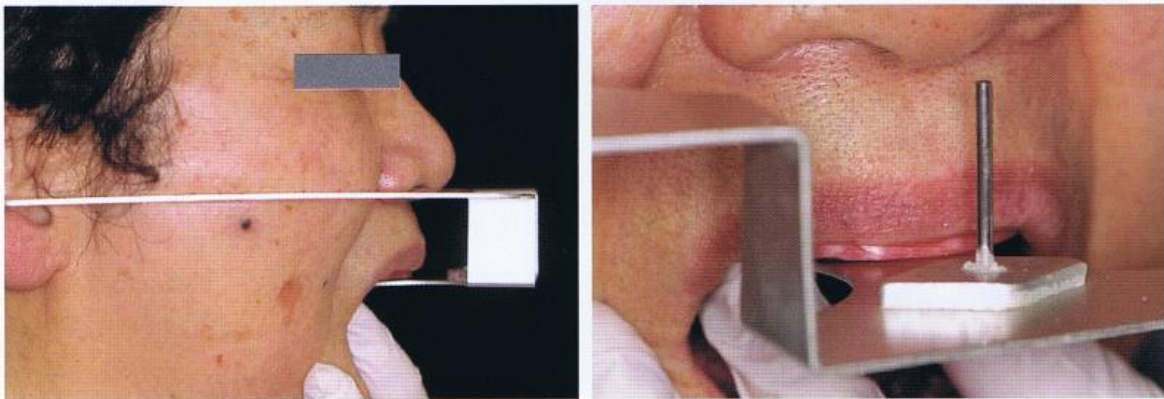
Q: What is the reason for making the bite taking of complete denture patient difficult?

A: Bite taking of complete denture patient is determined by patient's own occlusal plane, occlusal vertical dimension, and horizontal mandibular jaw position. Reasons for what makes difficult are because it needs to take this method by putting together both factors of patient's own shapes and of functions. So this method cannot be taken from every patient in full confidence yet in good advance, but it is developed through gradual steps from obscurity. Upper and lower residual ridges cannot determine upper and lower dentures easily in three dimensional positions, even though they are connected with TMJ and other oral tissues. In order to take bite taking successfully, one should try carefully to set up basic standard, to evaluate functions, and to accommodate within the area of patient's own 'strike zone'.

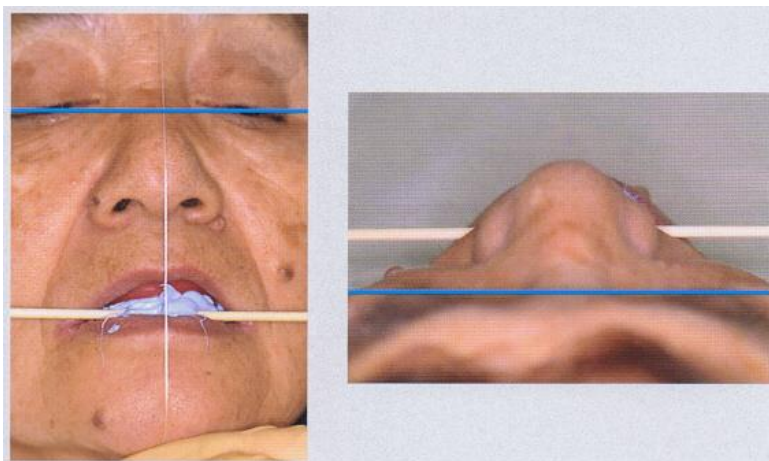
Anterior incisal positions and Camper's plane

Occlusal plane is based on Camper's plane (7-1). And as an important factor of anterior esthetics, anterior teeth frontal plane and horizontal plane are judged from the pupillary line (7-2). The occlusal plane is established almost parallel to Camper's plane, and this anterior reference point is the anterior incisal edge. Since most prosthetic therapy, orthodontic therapy or crown restoration therapy cannot be accomplished without paying attention to esthetics of maxillary anterior teeth, bilateral positions and angles in the central incisors are always first in priority while taking careful consideration to the relationship with upper lip ¹²⁾. In case of dentures, another factor of selecting artificial teeth shapes and sizes will be additionally needed.

As for complete dentures, with the two factors of anterior incisal edge positions and Camper's plane, approximate occlusal plane will be determined.



7-1 As long as the anterior incisal edge is fixed in position, occlusal plane is determined almost in parallel to Camper's plane.



7-2 At the incisal edge, position a piece of straight bamboo stick in parallel to the pupillary line, and the

frontal plane can be recorded as in the right photo. Maxillary anterior teeth can be arranged by coordinating the labial surfaces to patient's facial front.

Reasons for why bite taking is not done well in an edentulous jaw

If there is any discrepancy between bite taking records, touch them with finger surface while having patient close upper and lower artificial teeth. With this, you can feel the discrepancy as displacement of dentures from the touching senses (7-3). Like in this case, are the errors of bite taking records that prevent smooth intercuspation responsible for clinician's reading mistakes at the stage of trial insertion or finishing?

Errors of bite taking records are caused by method failure of constructing a biteplate, its poor handling, or incorrect situation of reproducibility of occlusion to a given position. These causes are categorized on problems of clinicians or patients.

As for errors involved with clinicians, causes behind cannot be detected incidentally. They are causes of ill fitting of biteplates being difficult to keep a given position and of interfering of upper and lower wax rims or biteplates somewhere in the way of guiding mandibular positions.

As for errors of patients side, when the patient driven type is taken on the upper and lower wax rims asking "close them, please" or "bite them, please", then, inability of controlling mandibular jaw positions from central nerve system problems may cause accidental discrepancy in the anterior or lateral directions. Especially in case of any involuntary motion like tongue habit, there may be a cause of unstable mandibular jaw position (7-4). Also, in case when a bite is taken on the operator driven type of impression taking, issues will include how comfortably patient is relaxed in advance or how much clinician is equipped with guiding skills. The biggest problem is, however, concerned with disorders with TMJ as in the followings.



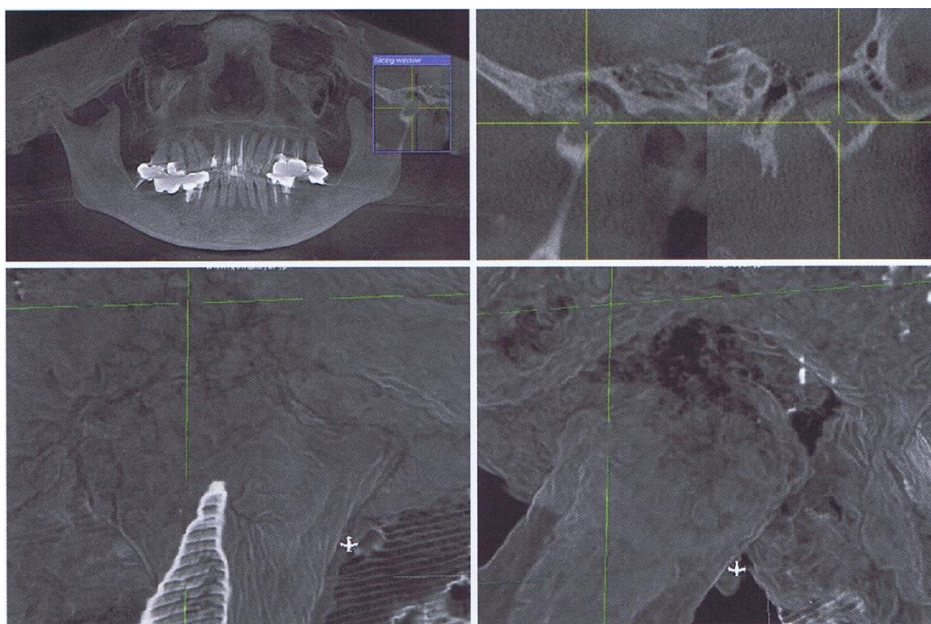
7-3 Detect discrepancies at the intercuspal position



7-4 As for aged patients developing with involuntary movement like a tongue playing habit, they have no stable mandibular movements or no stable tapping points.

TMJ and tapping points

Reasons for making the bite taking difficult are responsible for TMJ structural problems. When the condyle of a dentate patient is pushed in the direction of articular fossa, caused by posterior tooth loss or by strong bruxism, there causes any mouth opening disorder. If any pressure like this is prolonged for a long term, not only functional disturbances but also organic changes like condylar malpositioning, deformity, or surface erosion are involved (7-5). According to Murakami's report, 75.6% of TMJ is involved with functional disorders ¹³⁾, and Tanaka reports on 68.6% of TMJ internal derangement ¹⁴⁾, and so, it concerns well that many patients have been suffered from any kind of modification within TMJ already early in the process of tooth loss.

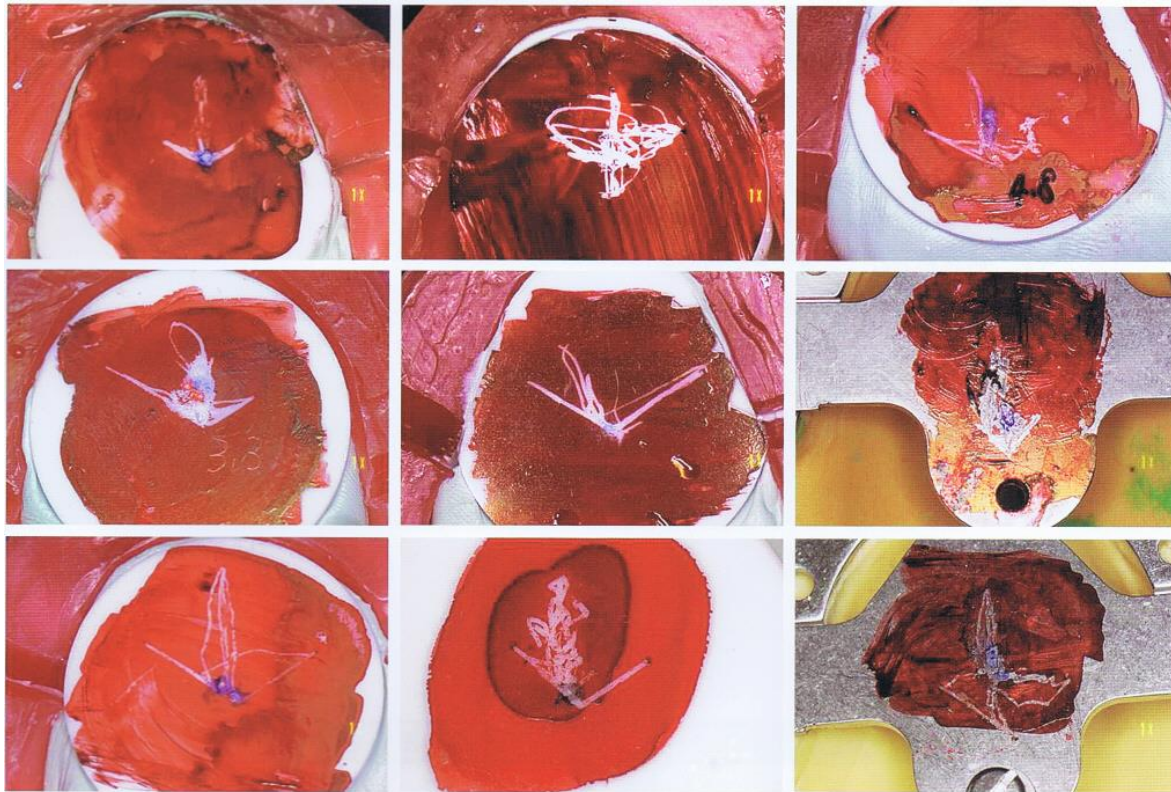


7-5 TMJ of female patient at age 47, who had a visit with complaints of mouth opening disorders. Mouth opening was measured in 21mm. The mandibular condyle was pressurized to the articular fossa, and the articular cavity was narrowed with detected condylar deformity, And some part of bone radiolucency was confirmed progressive.

Furthermore, TMJ changes are known deformed more readily after edentulous status ⁶⁾, and so variety of modifications can be extensively involved in addition to aging process changes. TMJ's, in themselves, have to cope with various loads while reserving some permissible capacity from life-maintaining needs even under demanding circumstances. TMJ does not work like a door hinge that works in fixed position but functions well in good freedom with to and fro, up and down motions ¹⁵⁾.

Like in this way TMJ keeps changing and especially for edentulous patients there is no way to handle with textbook knowledge of TMJ normal structures and functions. Researches on Gothic arch tracing studies conclude that only about 10 ~ 13% of edentulous patients can trace normally ^{16), 17)}. For this reason, the author thinks that edentulous bite taking procedure is to record patient's specific maxillomandibular relations under reasonable current situation.

Bite taking in clinical practice is in reality to judge the reproducible tapping points based on the functional examination of Gothic arch tracings after removing engram, and to determine the mandibular jaw position as best compromised points ¹⁶⁾ (7-6).



7-6 With the Gothic arch tracings, tapping points are verified for proper judgment. Tapping points taken with reproducibility and stability should be employed.

3 Essences and 4 Steps in denture construction

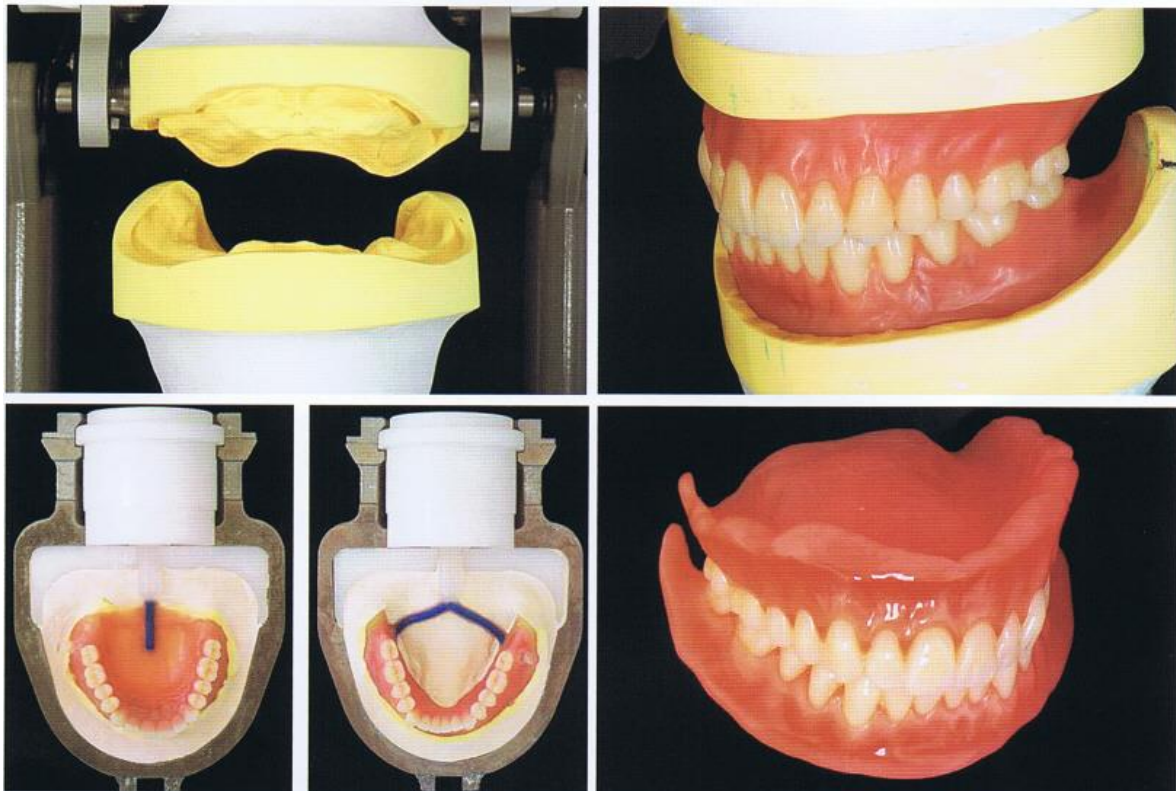
Complete denture construction can be consolidated into 3 essences: denture base shape, bite taking and finalization of denture with artificial teeth arrangement.

“Denture base shape” means “impression taking” in other words, and “bite taking” is “vertical and horizontal mandibular jaw position”. And, “denture finalization with artificial teeth arrangement” means equally to “a laboratory bench work to integrate those two above to realize esthetics and functionality and to finish them through polymerization”. Complete dentures are perfected by consolidating these 3 essences into one unit of structures (7-7).

By contrast, at dentists chair side, complete denture construction includes major 4

steps: impression taking, bite taking, insertion trial and finishing. Even if a treatment denture is employed, time will be taken similarly for taking impressions and bites, and so 3 essences above are eventually proceeding with these 4 steps.

Good quality denture for individual patient is the one that dentist judges about 3 essences with discretion based on basic and standard, and that dental technician proceeds with error-free laboratory work while adding best values to finishing dentures (7-7).



7-7 Impressions are taken by dentist, stone casts are made to develop denture border shapes, and bite taking determines maxillomandibular relation record for mounting them on an articulator. Dental technician arranges artificial teeth in order to have both ways of function and esthetics. Through polymerization, precise dentures are finished. (Dental laboratory work: Mr.Tetsuya Sudo, Defy Lab)

At the conclusion

Do you think that denture suction is not only added value for patients but also success criterion for dentists now? In other words, it is one of indications to evaluate

the degree of success of complete dentures, and as described so far, as long as suction is effective, the entire peripheral seal is confirmed by variously different oral conditions depending on individual patient, and they are evidences that retention, bracing and support are all well harmonized. Even if suction is not effective, as long as this denture is finished through a series of established procedures for attaining suction, such a denture should be accepted for a patient with favorable results. If one of functions, that is, “denture suction” is enhanced, denture performances in total will be improved eventually.

How many dentists and dental technicians in the world are supplying their own made dentures with confidence? We, as goodwill suppliers of dentures in daily practice, are continuously addressing questions, “what denture is an ideal complete denture?” and we should never cease asking it.

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【End】