

## Chapter 4 - Treatment planning

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### I. Introduction (Aim of this chapter)

The previous chapters have mentioned the examination and diagnosis (Chapter 2) and indications and contraindications (Chapter 3) therefore, I have decided to discuss under the title of “Treatment planning” the practical applications of AQB implants to various cases of tooth loss and occlusal state at each stages of the installation (bury) and placement of prosthodontic appliances (fabrication of superstructure). But first I would like to clarify that the following chapter will be discussing the application of one-piece type in general, and the terms used will be installation and prosthodontic appliance placement, in contrary to burying with two-piece two-stage type, and superstructure in two-piece types.

In the past, only a handful of texts on implants that have touched on the subject of treatment planning after discussions of examination and diagnosis; indication and contra-indication, and are usually directly followed by the installation (burying) methods.

Amongst those that had been recorded, the oldest manuscript that have mentioned the treatment planning for the use of titanium two-piece type implant, four and a half centuries ago 1). More precisely, it describes the means to design the treatment planning for different classes according to Kenney's classification (1923) of partially edentulous arches; and also with respect to the application of bone-anchored bridge, and overdenture.

The treatment planning<sup>2)</sup> that have been mentioned in the recent texts are also not very current, and have not been updated. In addition, there are no specific instructions for the different implant types therefore there are not much information that can be directly applied to the treatment procedure with the one-piece type implant with HA-coating. The same is true in “the basic manual for AQB Implant system” where there are no detailed discussions on treatment planning<sup>3), 4)</sup>.

The recent manuscripts are written with regards to the titanium two-piece implant, therefore the treatment planning in that respect recommends the the use of CT scanning to aid the diagnosis; to plan the installation procedure with the use of top-down treatment; and application of surgical stent to determine the location and orientation of the implant installation<sup>5)</sup>. For a treatment with two-piece implant, as these can be buried facilitated with the application of GBR to aid bone augmentation, the treatment planning is usually based on CT scan, since the bone augmentation cannot be applicable with one-piece type, a careful planning, with consideration to the property of the bone, that does not involve any risks have to be conducted.

The vast majority of the AQB implant patients have been treated with one-piece type therefore the treatment planning mentioned in this book should be clearly differentiated from those for the titanium two-piece type.

The medical practitioners in the past diagnosed the patients with careful visual observation, the pulse, ad senses of touch and sound, but it has been noted with the advances in the analysis techniques, it has led to the practitioners to derive diagnosis by investigating the analysis data and not the actual patient. This trend can also be observed with the diagnosis of two-piece type implants where it heavily relies on the 3D

structure of the jaw bone derived from CT scan. With its ability to visualize in the cross-sectional slices of the structure of the jaw, it can be said to be a superior technique in comparison to others such as dental radiograph and panoramic radiograph, but it should not be the sole source of information. On contrary, for the installation with one-piece type, careful observation of the jaw structure and of the occlusal state with the opening of the flap are required prior to derive final diagnosis and treatment plan, therefore this can be said to be a treatment that lies closely to the basics of medical practice (Fig. 2-4-1).

## **II. Factors to be considered in diagnosis and treatment planning**

In general, if the tooth loss is left without any treatment, it can have consequent effect on the occlusal relationships with the elongation of the opposing teeth. In such cases, the occlusal plane should be corrected to achieve a leveled plane by either grinding the elongated section, or where the opposing tooth is a prosthetic, a replacement with a crown more suitable, should be conducted prior to installation. Then, with consideration to the financial ability of the patient, the number of implants, and the location of these implants should be discussed with the patient, as it might not be necessary to insert an implant to each of the extracted sockets. Here, the priority should lie in the establishment of occlusion in the molar region. Further, the practitioner should take a more flexible approach, such that in cases where the implant installation is not required to all of the planned locations, decisions as to the actual number and the locations should be drawn that is in accordance with the suitability of the implant prosthesis to the location with consideration to the life span of the adjacent remaining teeth. In other words, the stance should be that the practitioner will have a life-long relationship with that particular patient.

The treatment should be planned with the following factors in mind: diagnosis made with examinations of visual and sense of touch, radiographic examination (including CT scan); the period, section, location, size and orientation of installation derived from the state of tooth loss and occlusal state; the order of implant installation in cases of multiple tooth loss; the types and forms of superstructures to be placed after the establishment of osseointegration (single or connected crown). Furthermore, in instances of replacing the plate denture to composite resin with the installation of AQB one-piece type implant, a detailed planning of the order in which to install the implants are required. Where a significant indentation is present, and in situations where aesthetic recovery could be difficult, bone augmentation procedures (staged approach) may be required to facilitate the implant installation, which can be an essential deciding factor in the order of installation.

Not all of the alveolar bones for implant installations are those that have been given time after the tooth extraction. In a case of multiple implant installation to a partially edentulous jaw, the treatment can be conducted in several stages, where the first batch of installation to a more stabilized edentulous region can be done, while waiting for the jaw bones in the extraction sockets to be healed (period of 4 to 5 months) before installing, or delayed installation to this section. In the placement of implants to a region of the jaw with two or more teeth loss, where an implant installation to one of the sections can be thought to take more than a month, first, install to the more stable section in order to establish osseointegration. This can subsequently act as the stabilizing factor for the rest of the implants if the primary stability cannot be achieved with the second batch of implants. The application of self-curing resin for a temporary fixture, to facilitate osseointegration, which is also referred to as time-lagged implantation is also used as an alternative method.

In the clinical settings, the cases are not always straightforward and under unfavorable conditions, methods such as those mentioned above could become an effective means to overcome the complications (Table 2-3-1).

Other factors that require mentioning include the resistance to periodontal disease, in those cases where the installation is conducted to a partially edentulous patient with a chronic case of periodontal disease; or the applicability of immediate-loading after tooth extraction, and whether two-piece, two-stage type or two-piece, one-stage type is more suitable, therefore there are a significant amount of factors that require consideration (listed in Table 2-4-2).

The treatment planning in this chapter will mainly be dealing with the one-piece one-stage type implant that was the original AQB Implant type introduced into the market, and one that has been applied to the majority of AQB implant users. Therefore the two-piece type will be mentioned in a contrasting manner to the one-piece type in the latter part of the chapter.

Delayed implantation	This is a method to first implanting to the area close to the extraction cavity, where the condition of the bone is fairly stable, then to place implant to the area with which the tooth has been extracted after waiting for 4, 5 months for it to heal.
Lagged implantation	This is a method to accelerate the bone fusion for when inserting more than two implants to an area where a part of the area of deficiency is not suitable for implantation by implanting first to the more stable area. Once achieving some integration with the bone, implant to the more unsuitable area. Connect the implants together with self-curing resin, using the primarily inserted implant as the point of stabilization, then wait for the bone integration to be achieved.

Table 2-4-1 Delayed loading and lagged loading (These are not general terms but are used in our clinic to refer to the methods).

①	Correction of the occlusal plane with elongated teeth that occlude with the area of tooth loss
②	Considering the financial aspects, option of partial implantation – in discussion with the patient
③	Visual and sensory observation, and X-ray (including CT scan) analysis.
④	Analysis of the dental form of the lost tooth and the state of occlusion
⑤	Determining the timing, region, location, size and orientation of the implant placement
⑥	The order of implantation, in case of multiple implantation
⑦	Preparation of temporary resin crown when implanting to an area where estheticism is required.
⑧	Selecting the size and form (single or connected, metal bonded or gold alloy crown) of the superstructure
⑨	Selecting carefully the order of implant placement when shifting from floor denture to AQB one-piece type with crown or bridge placement
⑩	Deciding whether bone augmentation procedure is required to facilitate the implant placement to a case where esthetic recovery would be difficult due to the presence of significant indentation.
⑪	Deciding whether to use effective methods for complicated examples such as delayed or lagged approach
⑫	How to treat patients with chronic case of periodontal disease

⑬ Suitability of implantation immediately after tooth extraction

⑭ Consider two-piece two-stage, or two-piece one-stage type implant

Table 2-4-2 Factors that needs to be considered during diagnosis and in treatment planning

### III. Factors to be considered in diagnosis and treatment planning

The author has applied AQB one-piece type implants and prosthesis to various cases with trial and error method to derive a suitable solution to different situations, but the fundamental factors in the implant treatment planning has been discovered to lie in the careful observation of the state of the tooth loss and occlusal state. With these two factors, a treatment plan can be formed that can achieve an ideal occlusion that is specific for each patient.

When referring to different partial edentulous types, Eichner's index comes to mind. This classification was introduced 30 years before Kennedy's classification (1950s) and the different forms were largely grouped based on the existence of occlusal contact of the premolars and molars called supporting zones. Maximum of four supporting zones can exist, by which the sub-division is made. It can be perceived as a rough method for classification, but it has been noted as an useful method to grasp the disease condition (Table 2-4-3) 6).

No complexity lies in the treatment planning to those with one or few tooth loss that have maintained normal, ideal occlusion. In such cases (i.e. with respect to those classed as A-2, A-3, B-1) where all or three out of the four support zones in the molar or premolar region are present, the implant prosthesis should simply be applied to retain the occlusal harmony of the remaining dental arch. With respect to cases classed as B-2, B-3, where there are only 2 or 1 out of the support zones are in contact with the antagonists, generally have a low level occlusion and need to incorporate a plan to rise the occlusal height, but the ability of occlusal support achieved by the implant prosthesis can solve the issue of occlusal elevation that was complicated with the past methods, therefore it can be considered troublesome.

In contrast, in those patients with partial or full edentulous jaw resulting in the collapse of occlusion, the solution is not a straightforward scenario. Numerous cases, that are grouped under B-4, where no support zone is present except a slight contact in the frontal region, have been noted with a low level of occlusion and a concomitant presentation of flare-out in the frontal region. Those cases under the C-1 classification, "teeth on the maxilla or mandible may be present without any occlusal contact" also are generally low level occlusion. The most reliable method for B-4 and C-1 case treatments is to undergo primary treatment to recover a favorable occlusal relationship by adjusting it to a suitable occlusal height and the dental arch with a floor denture; followed by a subsequent secondary treatment for a gradual step-by-step replacement with the AQB implants with composite resin bridge with application of masticatory movement. For the classes C-2 and C-3 where the presence of one edentulous jaw, or both, after re-fabricating a floor denture with the intension of regaining a favorable occlusal relationship by correcting the occlusal height and the dental arch, and then construct the treatment plan in a similar manner to that of the classes B-4 and C-1 (Table 2-4-4).

A-1 A dental arch with 4 support zones without any lacking teeth
A-2 A dental arch with 4 support zones with tooth loss on one side of the jaw
A-3 A dental arch with 4 support zones with tooth loss on both the lower and upper mandibles
B-1 A denture with 3 support zones
B-2 A denture with 2 support zones
B-3 A denture with 1 support zones
B-4 A denture without any support zone and with contact occlusion only at the anterior teeth
C-1 A denture without any support zones with teeth remaining on the lower and upper mandible
C-2 A denture without any support zone with one edentulous jaw
C-3 Both jaws are edentulous

Table 2-4-3 Eichner Index

The area of occlusal support have been divided into four regions, the premolars and molars on the right and left, where A has contacts on all of the support zones, B does not have contact on all of the support zones, where as C has no contact on any of the support zones.

1) Small number of tooth loss in a patient with favorable state of occlusion where the majority of teeth have remained. ‘Out of the 4 support zones, presence of all or at least 3 contacts’ – A-2, A-3 or B-1 in accordance with Eichner’s index. →Place implant and prosthesis in accordance with the occlusion of the teeth remaining.
2) A deficient state with median number of teeth remaining, with tendency for tooth elongation and infraocclusion. In cases where there are ‘only 1 or 2 contacts in the support zones’ such as B-2, B-3 in Eichner’s index →Need a treatment plan to raise the height of the level of occlusion
3) Cases of infraocclusion associated with flare out in the anterior region caused by loss of occlusion due to multiple teeth loss. ‘There is only a contact only on the anterior teeth (not a support zone)’ – B-4 in Eichner’s index ‘Remaining teeth exists, but the occlusal form is a cross bite’ – C-1 in Eichner’s index →As a primary step, recover occlusion by correcting the occlusal height and dental arch with the use of floor denture →As the secondary step, replace with one-piece AQB implant fitted with crown/ bridge in batches to be used in normal occlusion
4) C-2 ‘edentulous on one jaw’, C-3 ‘edentulous on both jaws’ according to Eichner’s index → Reconstruction of floor denture to correct the height of occlusion and the dental arch, if necessary → Conduct the same treatment procedures as to B-4 and C-1 to area that requires it.

Table 2-4-4 Treatment plan that has been designed with considerations to the form of teeth loss, and state of occlusion

#### IV. Examples of treatment plans for different types of tooth loss.

##### A. Treatment to the lack of few teeth

The implant treatment to the patients in the levels, A-2, A-3 or B-1 in the Eichner's classifications, where the majority of the denture is remaining, should not require much contemplation. Implants should be simply be installed and prosthetics placed in accordance with the natural occlusion of those teeth remaining. Having said this, there are factors (as mentioned in Table 2-4-2) that can be picked up when implanting to the selected positions:

- ① Correcting the occlusal plane by modifying the opposing elongated tooth
- ⑤ Orientation of the installation of implants
- ⑥ Order of installation
- ⑦ The temporary crown resin
- ⑧ Choice of prosthesis and its form
- ⑩ Bone augmentation procedure before the installation
- ⑪ Delayed installation, installation with a time-lag

The above can be included as the factors that may require consideration. Therefore, these factors have been deliberated upon in the following section. With regards to the 12<sup>th</sup> factor, the issue of immediate loading is not much of a concern with the cases of few lost teeth, but will be discussed in the later chapters.

#### **B. Factors to be considered when treating these types of cases**

The first, correction of the occlusal plane, is so obvious that may not even require mentioning, but it is indeed desirable to achieve a continuous and smooth occlusal plane that does not exert excessive pressure during the masticatory movement, since the implant treatment is conducted.

For a one-piece implant, the orientation of installation (⑤) factor is as important as the position of installation, and the installation size. By installation in a suitable orientation, a slight glitch in the installation can be modified and corrected at the time of abutment preparation therefore allowing the application of one-piece to various cases. This factor is also important in order to establish a favorable occlusal contact between the superstructure and its opposing teeth, and to achieve a contour that is suitable for the maintenance of oral hygiene. In addition, it is made more simple to match the orientation as much as possible when planning to place a connective crown structure.

The order of installation (⑥) in a case where multiple teeth are lost, are generally installed from the molar region, to prioritize the establishment of occlusal support in the molars. If the molar region is already stable, the installation should be done to the anterior or premolar regions where aestheticity is particularly demanded, or to the jaw position where the extraction wound healing has been sufficient.

The best method for the temporary crown is to take impression with alginate material soon after the installation, and place the fabricated material with the temporary cement, on the following day, after a disinfectant clean. If the orientation of the abutment has to be modified or need to match the orientations for the placement with connected temporary resin crown, the abutment form should be mimicked on the working model for the fabrication of the temporary crown, and then prepare the AQB abutment in the same manner before the placement of the temporary crown.

The usual choices of superstructures or their forms (⑧) are largely dependent on their locations. Metal-bonded crowns are placed to the anterior or premolar regions where the aestheticity is important,

but gold-alloy crown are chosen for the large molar region where aestheticity is less of an issue, but there are always exceptions to the rule. Modifications are required for installation to positions where periodontal membrane is absent, as relatively fragile metal-bonded crown cannot be used. In the molar region, crowns can be custom-built to a form whereby the metal is exposed at the occlusal plane, or the gold-plated alloy to be coated with hard resin material on the buccal surface in its placement to the molar region. Another alternative is the application of hybrid resin crown. For a multiple installation of 3 mm diameter AQB implant, except to the anterior section of the mandible, it is fundamentally placed with connected crown structure. With the 4 mm implant to the premolar region where, in terms of aesthetics and oral hygiene, the use of single crown is desired, but in situations where the ratio of the crown to the dental root is unsuitable; a cantilever bridge pontic is placed; Or in the large molar region, the connected superstructure should be more suitable. If a slight gap was formed between the implant and the natural tooth, it should be fixed with the application of cantilever bridge rather than forming a bulge to form an unnatural overcontour to overcome the problem, as the former method has been proven to be superior both in terms of aestheticity and oral hygiene.

Bone augmentation procedures to facilitate the implant installation (⑩) should be conducted to the maxillary anterior and premolar regions where the jaw bones show severe indentation, and where the implant installation to the position would be insufficient in terms of aesthetic outcome. In such cases, it is desirable to extract bone fragments at the time of surgical intervention or implant installation with the use of bone chisel or trephine bur, to aid the bone augmentation procedure by the application of these extracted fragments to the indented position by conducting onlay graft procedure (Staged approach). Since contrarily to mandible, maxilla is fundamentally made up of cancellous bone, the onlay graft has been said to bond well and provide stability to the installed implants. On the contrary on the mandible, in which the main composition is cortical bone, an onlay graft can easily result in bone resorption within a short period of time. The vertical reconstruction of the mandible is a complicated procedure in itself, therefore the bone augmentation method that applies allograft bone and GBR technique at the time of two-piece type installation (simultaneous approach) is the most favorable, with the highest success rate, even though it is highly invasive. However, the high risk of bone resorption to the augmented bone should be noted.

A preferred method for widening the width of the mandible is a “split crest” technique where the surgical invasion is relatively low, with a low risk of bone resorption. There is also a possibility of using 3 mm AQB implant to such cases where the width is relatively narrow. As long as it is wide enough for installation of the 3 mm diameter implant and the connective crown can be applied, it has been clinically proven that the occlusal support can be achieved. If such style of installation is possible, the surgical intervention like split crest is not necessary, and providing with an effective means to enable installation to the existing bone.

The underlined concept of AQB implant places its emphasis on the existing bone. Provided that the HA coated layer of the implants have been inserted within the bone, and that excessive amounts of lateral force is not exerted, it has become clear from clinical observations that major complications are rare in AQB implants that can easily gain occlusal support.

With respect to the delayed installation, and lagged installation (⑪), refer to Table 2-4-1 or Chapter 6. The issue of whether immediate loading is an effective method, a subject matter that is of interest to me as a clinician and one that is highly debatable, will be discussed in the later sections.

### **C. Treatment to the multiple teeth loss (median to many)**

Even though the cases presented with the level of B-2, B-3, B-4, C-1 in the Eichner's classification shows a widely varied structures, the fundamental of the implant treatment to such cases is the correction of overclosure, therefore may require establishment of occlusion with the aid of plate dentures to facilitate the implant installation. The factors for consideration that is of particular relevance is the ② considerations for the financial aspects and ⑨ Laying out a detailed treatment plan for the replacement of the floor denture with a composite resin structure on one-piece AQB implant. The other factors are also included in the A. of this section for few lost teeth, but the factors that are also of relevance will also be mentioned here. With regards to the points, ⑫ implant treatment strategy to a chronic periodontal patients lacking teeth or ⑭ choice of two-piece two-stage type or two-piece one-stage type, are also should be reflected upon for this case but the details will be discussed in the later sections.

### **D. Factors to be considered when treating these types of cases**

The financial aspect (②) included in the factors that require consideration in a multiple tooth loss is one of the most important. For cases of multiple tooth loss, the number of implants can result a costly burden on the patient, therefore in considering the patient's financial abilities, instead of placing the implants to every extracted cavity, use of partial plate dentures with the plantation of the least number of implants should also be taken into account. For example, AQB implants were installed and prosthesis in the positions No. 18 and 31 to act as an anchor for the placement of partial dentures to a case where the patient had been placed with a denture to the distal position with a strong sense of discomfort and a low ability of occlusal support. The replacement resulted in a vast improvement in the sense of comfort, as well as their masticatory functions (Fig. 2-4-2). Its durability as an anchor for the prosthesis structures and the ability to support high occlusal stress are remarkable advantages of AQB implants. In comparison to the two-piece type, the one-piece type is less costly, and enables the implant treatment to be conducted with at a lower price setting. For a patient with a financial limitation, the possibility of installation of more number of implants with one-piece type is an added advantage.

With regards to the size and orientation in which it is installed (⑤), for the elevation of the level of occlusion, the thicker the diameter and the longer the root (HA coated) the better. The direction of the installation should be decided with the opposing functional cusp in order to avoid the external occlusal forces. By slightly inclining the planting cavity in the direction of opposing teeth, it can reduce the lateral forces that are exerted on the implant.

The choice of the prosthetic appliances and its form is dependent on their ability to maintain the elevated occlusion in the median to many losses of teeth that are deficient particularly in the molar regions. The single crown can be applied where the implant with a 5 mm diameter can be used in the molar regions, but connected crowns or bridges should be used if only 4 mm diameter could be inserted, and in the case of 3 mm implants, these should be inserted closely to each other with no gaps (3 implants in place of loss of 2 molars, or 4 implants to loss of 3 teeth), and subsequently mount with a connected prosthetic appliances. In the case of classes B-2, B-3 where one or two out of the four support zones have been retained therefore occlusal elevation is not thought necessary, implants should be installed in a way to lighten the pressure exerted on the support zone of the natural teeth, and mount the prosthetic appliance to a slightly elevated implant. A slight elevation in the molar region may lead to a weakening of the



occlusal contact on the anterior teeth right after the procedure, but it is an overjet that flared-out due to the loss in the molar region, as long as the mouth can be closed at the resting phase, it is usual to find that the anterior axis to have naturally recovered to the upright position and form a contact with the opposing incisors within a short amount of time.

With regards to the factor ⑨ A careful consideration to the order of installation in the case of replacing the plate denture to a composite resin bridge with one-piece implant, should be conducted in a step-wise manner. The occlusal height can be corrected by applying the newly fabricated or the restored plate denture to the usual masticatory movement, in preparation for the installation of the implants to region at a time. The treatment plan at each stage to the various regions should be applied according to each of their requirements.

In most of the class B-4 case where the loss of occlusal support in the molar region with the occlusal contact to be only on the frontal teeth, have resulted in low level occlusion with a flare-out. If there is no flare-out, even though the occlusal contact is only at the anterior teeth, it can be treated as with the B-2, B-3 cases. Otherwise, for the cases with flare-out, floor denture should be fabricated for the molar region in order to stabilize occlusion.

C-1 cases are characterized with low level occlusion therefore the fabrication of the denture with a suitable occlusal height should be the prime importance. In patients with unpreservable teeth, considering convenience of the patient, it would be ideal to apply immediate dentures straight after the tooth extractions. The elevation should be conducted in a gradual manner even in a case where the height of occlusion is incredibly low, as a sudden loss of occlusal contact at the frontal teeth cannot be tolerated by some patients. The installation of AQB implants only becomes possible once mastication in stabilized occlusal state is established facilitated by the application of dentures. Implant installation should not be rushed before the normal mastication has been achieved with the denture.

Upon installation of implants, the floor of the denture is calved in a U-shape to accommodate for the extrusion of the implant structure. Although this can result in destabilization of the denture, provided that it can remain adequate stability to prevent any external damages to facilitate the main objective of the osseointegration of the implant body, this has been the most effective means. The fabrication of accurate denture is vital, also from this respect.

For the stability of the AQB installed region, the installation should be conducted in sections. For example, in installation to the left, this region should be protected by the masticatory pressure to be received by the right side of the jaw. with consideration to the clasp location of the plate denture, the implant installation should be conducted in the order (⑥) of the region where the stability of the denture can be maintained. Where distal-end denture is attached, implant first to the distal-end, where a denture for intermediary tooth loss is attached, implant first to the side that is not required for the maintenance of the denture, and place the denture by cutting off the clasp and carving out the floor.

The final prosthesis placement without the correction of the occlusal height should be conducted in the order of the AQB that has established osseointegration and where necessary with an application of wire-clasp for an added stability and progress to the next block of installation. Gradually changing to a denture of smaller size, and eventually becoming replaced with the AQB implant with composite resin.

Where the occlusal height should be set above the denture with the placement of the final superstructure, to one of the sides first, the occlusal height can be elevated by the mounting of the superstructure to the side that has achieved osseointegration, then accommodate for this rise with the application of resin-up to

the artificial teeth of the denture. When conducting the elevation with the mounting to both sides simultaneously, a temporary crown (resin crown) should be placed on top of the implant that was able to establish osseointegration first, and then completed with the placement of the composite resin bridge to both sides simultaneously.



Fig.2-4-2-a,b,c An example of implantation with minimizing the prosthesis to the least. Install AQB implant to No. 18 and 31 (a, b) to support the partial denture (c), to cover the vacancies. It has been 8 years since replacement of the cantilever bridge to the partial dentures, the 6 remaining natural teeth have been healthy owing to occlusal support formed by the No. 18 and 31 teeth.

#### **E. Treatment to an edentulous jaw, or edentulous jaws**

In C-2 state, “no occlusal support with one edentulous jaw”, or in C-3 state, “edentulous jaw on both above and below” according to the Eichners’s classification, if a suitable denture is already present, this can be utilized to progress onto the implant treatment. However, if the occlusal relationship or the denture is deemed unsuitable, a complete denture should be re-fabricated in order to achieve occlusal recovery, fitted with favorable occlusal height and dental arch, then install implants in batches as a secondary measure. The most reliable means for the installation of implants should be conducted gradually with retaining the masticatory function facilitated by the use of dentures to the regions that are most suitable, as described for classes B-4, C-1, to replace the complete denture to the implant prosthesis with composite resin bridge.

A significant majority of C-2 cases present with the complete denture to the maxilla, and if there are deficiencies in the mandibular molar region, by installing the implants to the mandibular pre-molars then the molars unilaterally and placed with superstructure, the maxillary full denture can be stabilized, therefore there have been numerous cases where the replacement of the full denture on the maxilla has not been required.

The maxillary dentures of the C-3 cases have often been retained, and it is the mandibles that are more complicated. These cases are treated usually with the placement of implants to either the No. 22, 27 canine positions on both sides or the No. 21, 22 and 27, 28, the first premolars on both sides of the jaw to be placed with a crown or a bridge. Where there is a possibility of implantation to positions distal to the secondary premolars and can be installed with some distance away from the mandibular canal, this could be a preferred treatment procedure.

The factors that are required for consideration in such cases would be the region of installation, and the size of the implant (⑤), or ⑨, a careful consideration to the order of installation in the case of replacing the plate denture to a composite resin bridge with one-piece implant. However, with edentulous jaws the jaw bone lacking dentures are usually significantly affected with bone resorption and therefore there are a limited number of cases where the implants can be installed to all of the positions with deficiencies.

Therefore in my experience these cases have been treated with the concomitant placement of floor dentures with the implants inserted to act as the anchoring teeth with the composite resin superstructure, with a particular considerations to the financial aspects (②) as the number of the implants required would amount to a costly procedure.

The replacements of the complete dentures in the maxilla have been conducted in the past, but only to replace the tooth loss in those of conus telescopic or magnetic dentures. It is not usually the case where a normal complete denture on the maxilla. The most important factor in the success of one-piece implant is whether the primary stability can be achieved. Osseointegration of an implant to the jaw bone of the mandibular canines is relatively undemanding as the primary stability in this area of the jaw bone is easily gained. The maxillary bones mostly consist of cancellous bone, which is less able to establish the primary stability in comparison to the cortical bones that constitute the mandible structure.

If the replacement of the maxillary denture is required, even a slight facilitation with a stable partial denture would be effective in gaining the primary stability, but in situations where an loosely fitted denture is present, the initial settlement becomes more complicated, and result in issues such as loose motions of the implant at the initial stages. If such situations can be foreseen, the option of two-piece, two-stage type or two-piece, one-stage type (⑭) should also be considered. Yet, issues such as bone quantity remains, as the implant installation would be less suitable and hazardous to a location where it has been severely affected by bone resorption, and where the clearance between the jaws.

#### **F. Factors to be considered when treating edentulous maxilla**

There are three types for an edentulous jaw. C-2 can either be the edentulous jaw of the maxilla or the mandible, with the opposing jaw still with remaining teeth, or in C-3 where both the jaws are edentulous. In insertion of AQB implants, the most challenging is the maxillary edentulous jaw. In actual fact, the application of two-piece type is much more suitable for the maxillary jaw implant treatment. Due to the exposure of the abutment of the implant body out of the periosteum, the presence of destabilized complete denture, or the anchoring teeth placed for multiple deficiencies, it is more prone to influences of the external pressure from the denture. This tendency is albeit achieving primary stability, therefore cannot gain osseointegration. Cancellous bone that is the main constituent of the maxilla is less resistant to external pressure. As a solution to overcome this issue, fabricate a denture that is well adsorbed onto the jaw surface, and wear it to become familiarized with the maxilla. Then install few implants to the canine and molar regions (⑤) that are most likely to have retained sufficient bone quantity, and the size (⑤) to be 4M type or 4L to a canine region if possible. The size should be determined with the intension to gain bicortical anchorage that requires the position of the tip of the implant to be interacting with the floor of the nasal cavity or the cortical bone of the maxillary sinus floor. When restoring the complete denture back onto the maxilla with the U-shape calved out, the stability of the denture will have been affected, therefore some modifications are required in order to accommodate this change, and to prevent any external forces from being exerted.

It could be an effective measure to connect the implant structures with the placement of connected resin crown to a case of simultaneous implantation to a jaw with multiple deficiencies. For example 5 to 6 implants to canine and premolar regions bilaterally, and connect this with the resin crown in order to reduce the pressure exerted on each of the implants. In the success of the installation to the canine and premolar regions, and apply the clasp after the placement of connective superstructure as an anchor tooth,

this can result in an example with a stabilized partial floor denture for a case of multiple deficiency. Where there is other deficiencies in the other regions, further implantation could be possible, with the ⑨ factor: a careful consideration to the order of installation in the case of replacing the plate denture to a composite resin bridge with one-piece implant.

Alternatively, as a more aggressive means, in instances where a sufficient bone quantity is present for installation of implants with diameter 4 to 5 mm, implant 8 to 9 implants simultaneously, rapidly fabricate composite resin bridge for the whole of the jaw, and place it, in accordance with the immediate loading method.

#### **G. Factors to be considered when treating edentulous mandible**

Contrary to the maxilla, hard cortical bone is the main constituent of the mandible and lines the mandibular alveolar crest thickly. The cancellous bone in the dental pulp is also harder when compared to those of the maxilla, therefore a firmer primary stability is possible. For this reason, even with a slight disturbance with the external forces, it can still achieve osseointegration. The need to fabricate a denture that adsorbs well to the mandible, and familiarize this to the mandibular structure also applies to this case. With regards to the position of the installation (⑤), should also be conducted to the canine or premolar region where it is most likely to have retained a sufficient quantity of bone for an insertion of implant. One to two implants that are either 4M or if possible, 4L is desirable for the size (⑤) of the implant. The carving out the U-shape and modifications in order to accommodate the alteration in the stability of the denture should be conducted in a similar manner as the above.

Another point worth noting is that the loose motions of the mandible is generally much larger than the maxilla, therefore should avoid simultaneous installation of implants. Following the success of implants to the canines and pre-molar regions, and utilize this as the anchor teeth after the superstructure placement, it can result as a case of multiple deficiency that has been placed with stable partial plate denture, and installation to other regions can be conducted in a similar aforementioned manner.

The bone resorption in the molar region of an edentulous mandible results in the reduction in the distance to the mandibular canal, thus making the implantation to this area difficult. It is also possible for a placement of a bridge with the use of bilateral anchoring abutment teeth. In order to fabricate this, install implants to the canine or premolar region to stabilize the denture by acting as an anchor after the placement of resin crown, and then install to the opposite side of the jaw.

In the treatment of advanced case of bone resorption, the method of burying two-piece type fixture to the positions No. 22 and 27 and complete with the magnetic denture could also be an effective method.

#### **H. Factors to be considered when treating edentulous jaws**

In considering the factor ⑥, the order of installation, for a case of fully edentulous jaws, its should be conducted first to the mandible that has higher success rate, then continue on to the installation to the maxilla once the stability has been gained in the mandible. The maxillary denture is said to be more comfortable than those on the mandible, therefore it is not always necessary to replace it with implant prosthesis. Hence, under some circumstances whereby the substantial loss of bone quantity with bone resorption is present, with a large clearance between the jaws should be left with the complete denture, and should not be tampered with (Fig. 2-4-3). The two-piece type has lowered risk of external forces acting on it at the initial stages after the surgery, therefore the success rate with this should be higher in

the edentulous cases.

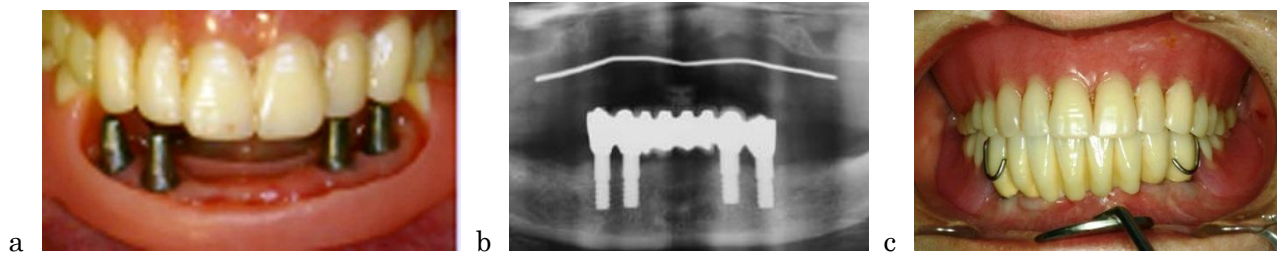


Fig. 2-4-3-a,b,c A case in which implants were installed to the mandibles where both upper and lower mandibles were edentulous. The metal bonded bridge was fitted with the implants installed to No. 21, 22 and No. 27, 28 as the anchors (a, b), and partial dentures were placed onto both sides, No. 18-20 and No. 29-31 (c).

#### **I. Cases where two piece-type implants should be applied to replace badly fitted full dentures to both jaws**

The two-piece, two-stage type should be selected for the cases where highly secure osseointegration (with titanium implant) or biointegration (with HA coated implants, AQB) is necessary, and where bone augmentation procedure is required. It is a particularly viable system for the simultaneous installation to cases of multiple tooth loss or edentulous jaws. The fixture of the two-piece type can be inserted at the same time as conducting the bone augmentation procedure, then during the consolidation period, it can be protected from external pressure with the placement of temporary over-denture type superstructure. The two-piece, one-stage type has been developed for a jaw that does not require augmentation procedure, thus after its installation it can be treated in the same manner as the one-piece type, but the over-denture can be placed even with the of the healing abutment exposed from the mucosa, therefore, from this perspective, it is similar to the two-stage type. The most effective means for the application of two-piece, one-stage type is to install the fixture to the sections of the jaw that does not require augmentation, and place the superstructure at a later date having contemplated in detail the timing of the superstructure placement.

#### **V. A treatment plan for a lack of dentures resulting from a severe case of chronic peri-implantitis**

The number one cause of tooth loss is owing to the chronic periodontal disease. There is an extreme case of periodontal disease that presents due to a particularly low resistance of the periodontal tissues; and concomitant bone resorption coupled to periodontitis that result even with a regular oral cleaning. The suitability of implant treatment to such patients has not yet been determined.

A wide variation in the resistant ability of the periodontal tissues have been noted, where in one individual with plaque accumulation does not lead onto periodontitis, and conversely, in those individuals who undergo a regular oral cleaning progress onto periodontitis. In extremely prone individuals with substantially low resistance, with a progressive case of bone resorption resulting in worsening of periodontitis are referred to as severe or malignant periodontitis patient, and are generally perceived that the prognosis of implant treatment is not favorable due to the progressive bone resorption in these type of patients. These types of cases will eventually accumulated in the near future to be able to derive

at a conclusion, but in my opinion, to a patient with a good oral hygiene can receive substantial gains from an implant treatment.

The plane of the natural tooth root that has been affected by a chronic inflammation in the deep periodontal pocket, contains protein that can subsequently convert the natural teeth into necrotic cementum or denatured dentin. Alongside the reduction in the resistance of the periodontal tissues, a progressive inflammation and bone resorption can consequently result in the destruction of the periodontal tissues. However I would like to point out that the implants consist of titanium metal or titanium oxide that has a stable surface, therefore does not contain any protein components as in the natural dentition, thus the problems that were associated with the natural dentition, necrotic cementum, or denaturation of dentin structure that lead to reduction in the periodontal tissue resistance are not applicable here. Additionally, even to replace the tooth loss in a malignant periodontitis patient, provided that the oral hygiene can be maintained, the probability of the chronic peri-implantitis can be decreased. Treatments are conducted with discussions with the patient but the maintenance of oral hygiene on the patient's part inarguably the most important. There have also been cases that have presented with a general progress of chronic periodontitis, in cases where the number of lost teeth were not significant, but the remaining teeth had inclined mesially, leading to lowered occlusal level, and the frontal teeth of both maxilla and mandible had inclined to the anterior direction, even in the patients without severe chronic periodontal disease. Such environments where even the natural teeth are inclining forwards, a vast improvement in the tooth brushing, and periodontitis treatment are essential criteria that have to be met before an implant treatment can be started.

The occlusal plane modification with implant treatment has often been conducted with the installing in the direction that the occlusal force is acting, therefore in the case of where the implant is inserted to a distal position to the natural teeth that have been incline mesially, the direction of the installation has to be carefully examined. The treatments in the past have often required the installation to a position that is some distance from the natural teeth, in an upright orientation, and with a subsequent placement of a mesial pontic attached superstructure.

## **VI. Treatment planning for the bone augmentation to facilitate the implant installation**

The importance of the one-piece type implant lies in the presence of sufficient bone quantity, therefore the presence of innate bone that enables the installation is essential. A sufficient quantity of the bone in the anterior region is particularly necessary in order to achieve aesthetic recovery. The fundamentals of aesthetic outcome is the morphological property of the bone, where the indentation is only small, the recovery can be achieved without any treatment, but there is significant deficiency, bone augmentation procedure may be necessary to facilitate the installation. Bone augmentation to the maxilla can be conducted with onlay graft in both, horizontal and vertical orientation.

Alternatively, the two-piece, two-stage implant type is one that can be adapted to the application of simultaneous approach of the augmentation procedure. This can be said to be the major advantage of using this type of implant. This simultaneous approach can also be applied with the one-piece type by using the GBR membrane, but this method is generally associated with complications, therefore the staged-approach with one-piece implant is preferred. With this method, the one-piece type is installed into the indentation on the buccal side, and if the aesthetic recovery is necessary, extract the bone

fragments with the trephine bur after the installation of the implants to other regions to conduct onlay graft method to build the base before the installation. The onlay graft to the mandible typically results in rapid bone resorption and it is thought that it does not undergo distraction osteogenesis, therefore the split crest method is deemed more suitable. The author has developed a method to utilize the 3 mm diameter implant, only produced with one-piece type, in order to leave the original bone structure as much as possible (Refer to Part 6 – ‘A case of safe insertion and prosthesis of 3 mm diameter AQB implant into regions other than the anterior teeth of lower mandible’ for further details). There have not been any problems with this method, since 3 mm diameter implant has been applied by implementing the advantages, its weakness, and the solutions for this (Table 2-4-5,6), to conduct a safe implantation and prosthesis. The accumulation of these treatment cases will eventually give rise to a conclusion.

- ① Implant is possible to a narrow jaw bone
- ② Less likely for the bone fission to occur
- ③ The extent surgical invasion is less than those with larger diameters
- ④ Less problems to arise during the postoperative treatment course
- ⑤ Even in cases where the alveolar mucosa is thin, the suturing up is simple, without the use of circular knife.
- ⑥ Ease in maintenance of oral hygiene since the buccal, (labial), and lingual width are all small, the interdental spaces can be sufficiently reached with the brush.

Table 2-4-5

The advantages of 3 mm diameter AQB implant

- ① Due to its narrow body, it is easy to be fractured with excess occlusal force, particularly with lateral forces.
  - Install several implants without any spacing in between, and prosthesis should be connected. Set in such a way as to endure less occlusal force than with 4 mm diameter implant.
- ② There is a risk of dislocation in the maxillary molars where there is low bone density
  - Avoid implant to the maxillary molar region
- ③ Is limited with orientation at the abutment preparation stage due to its narrow body
  - Install in parallel to the adjacent structures
- ④ The plaster cast of even extreme strength is prone to fracturing
  - The model should be constructed with epoxy resin in the majority of cases. A point that is also applicable for implant prosthesis in general, but the importance lies in selecting a workshop that has been able to come to a mutual understanding, and where a high level of prosthesis fabrication is possible
- ⑤ Low level of aesthetic recovery in the areas except for the anterior mandible region, due to its narrow body.
  - In order to improve its aesthetics, enable the emergence profile to be as natural as possible by fabricating the superstructure to the subgingival level, and let the superstructure to erupt directly from the margin.

Table 2-4-6 Issues faced with 3 mm AQB implant and its solutions

## VII. Treatment plan for immediate loading

The immediate installation method is preferred by a number of practitioners by the fact that the surgery can be completed at once, and it is an area that is of interest to many, but is also one where the views are divided amongst the clinicians. There should be no problems in adopting this method to regions where a large extraction cavity are not formed, such as in the anterior or premolar regions where the roots are short; or after the extraction of milk tooth of congenital absence of permanent tooth. But the exposure of one-piece type abutment into the oral cavity after the surgery increases the risks of infection and bleeding. Even in the installation of implant that can result in the cervical section of the implant can be placed directly next to the bone, the fact that implant cavity has been formed can often see a conical type of bone-resorption extending to the implant cervical section within two to three months. This has been reported to occur even without infection.

The reality is that the bone resorption can result from a temporary exposure of the bone plane due to the inadequate attachment of the alveolar mucosa surrounding the implant. If this is left untreated for more than few days, unforeseen bone losses due to sequestrum formation have been reported to occur. The spacing in between the extraction cavity and the implant body makes the establishment of primary stability difficult even with the ease of HA coating to achieve primary interaction with the bone. Due to this space between the implant body and the bone, even with the primary stability to have been gained, fissure in the surrounding structure of implants can result. The gap can be filled with the bone fragments and be covered with the absorbable GBR membrane, however a risk lies in becoming dependent upon this as there is no guarantee that the bone augmentation process will be carried out (Table 2-4-7).

The implantation with two-piece two stage type for a subsequent placement of overdenture, or a temporary bridge with the remaining teeth on both sides, has its advantages in reducing the risk of infection, but the significance in the reduction in the number of surgical steps are lessened as secondary fenestration of the gingivae is required. With the two-piece, one-stage type the need for the fenestration step is removed but the risk of infection with this is placed between the one-piece type and the two-piece two-stage type.

Advantage	<ul style="list-style-type: none"> <li>- Only one surgery required</li> <li>- Limit the alveolar bone resorption after the tooth extraction to a minimum</li> <li>- No need for temporal prosthesis (attached resin, one artificial tooth) after the tooth extraction</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>- Establishing primary stability can be difficult</li> <li>- Risk of infection if the blood circulation is insufficient</li> <li>- Insufficient curettage for the removal of periapical lesion can result in residual cyst formation</li> <li>- Temporary crown is prone to hazards (regrettable in the regions where the aesthetic outcome is expected).</li> </ul>

Table 2-4-7: Advantages and disadvantages of immediate loading

## VIII. Treatment plans for two-piece one-stage type, and two-piece, two-stage type



The treatment plans for HA coated AQB one-piece type implants that were discussed in the previous sections are utterly distinguishable from the plans for the titanium two-piece type. In this chapter, I will summarize the treatment plan for the AQB two-piece type. It has been reported that roughly 10 to 15% of the AQB users either only apply two-piece type or in accordance to the symptoms presented. The treatment plan in this chapter previously mentioned those for the one-piece type and as well as discussing situations where the use of two-piece type would be more appropriate. Therefore I would like to summarize these latter points in this section.

As I mentioned before, the concept of using one-piece and two-piece one-stage type is in maximizing the use of remaining bone, therefore the use of transparent resin or surgical stent in order to determine the orientation of the implant would neglect its purpose. It is a system to implant into the existing bone in the best orientation possible within the available space. If the bone quantity is insufficient when using the one-piece type, the abutment can be prepared to an extent to achieve the desired orientation; or when using two-piece one-stage type, an angled abutment can be selected. Where bone augmentation is needed, onlay graft should be incorporated as a step-wise manner.

The basic concept of two-piece two-stage type on the other hand, is one where the final structure of the prosthesis is initially proposed, which in turn determines the orientation of the implant hole to support the superstructure with the surgical stent, and drilling the hole for the insertion of the fixture. Where the bone width is deemed insufficient at this stage, GBR membrane can be applied with the autogenous bone or bone filling materials for bone augmentation in a simultaneous manner. This system can be best described with the term, top-to-bottom treatment. The orientation of the abutment can be determined with the selection of suitable angled abutment. The augmented bones in the maxilla have shown relative stability, but those to the mandibles have generally resulted in bone resorption with time. As alternative methods, split crest or use of 4 mm fixture for positions with insufficient jaw bone width can be adopted. I have summarized the treatment plans for one-piece, two-piece one-stage and two-piece two stage types for comparison (Table 2-4-8)

	One-piece	Two-piece one-stage	Two-piece two-stage
<b>Basic concept and bone augmentation technique</b>	Use of remaining bone. Conduct staged approach, e.g. onlay graft before implantation.	Use of remaining bone. Conduct staged approach, e.g. onlay graft or split crest before implantation	Top-down treatment and simultaneous approach. In conjunction with GBR membrane and autogenous bone/ bone filling agent.
	Multiple installation of 3 mm diameter implants is possible without the need for bone augmentation	A system whereby implant is inserted to a position wherever possible to the jaw bone that does not need bone augmentation. The superstructure is decided at a later date with consideration to various factors.	- Split crest Relatively high success rate can be achieved even in implanting to insufficient bone quantity with the application of bone augmentation procedure with fixture insertion.

Number of implants at one time	A few (2 to 3) to avoid external injury	3 to 4 implants are possible, since it is less likely to be injured	4 to 5 implants since it is least likely to be injured.
Preventative measures to avoid postoperative external injury due to occlusion and temporary prosthesis	At least 1 mm clearance is required, after implantation  Do not allow occlusal contact to be established with temporary crown.	Overdenture with tissue conditioner Pontic bridge prosthesis	
Measures for multiple teeth loss	In using stable prosthodontics (inclu. cornus, magnet denture), implantation with cutting or removal of the floor denture is possible.  The facilitated implant even with relatively unstable prosthodontics is possible.	Bonding with the bone is possible with the use of overdenture with tissue conditioner	More reliable bonding with the bone is possible with the use of overdenture with tissue conditioner
Measures for edentulous cases	If the floor denture is stable, implantation is possible with cutting or partially removing the denture facilitated by the use of denture stabilizing agent.  The floor denture needs to be relatively stable for this method to be applied to the maxilla, as osteointegration is complicated with the external injury.	Bonding with the bone is possible with the use of overdenture with tissue conditioner	More reliable bonding with the bone is possible with the use of overdenture with tissue conditioner  Its application to jaws with significant bone resorption and with a large clearance to the opposing bone has its risks. Implanting to such conditions should be reconsidered.
Determination of dental axis and application of apical attachment	Implant in the desired orientation as much as possible. It can be adjusted at the preparation stages of the abutment tooth, therefore it can be applicable to a variety of cases.	Selecting angled abutment  There is a choice of OD abutment base or apical attachment for application to the mandibular with progressed bone resorption.	

Table 2-4-8 Chart comparing the treatment procedures for one-piece, two-piece one-stage and two-piece two-stage types

### **A. Factors that should be considered with two-piece one-stage type**

After the implantation of the fixture and placement of the healing abutment, similarly to the one-piece type, the healing abutment is exposed from the mucosa into the oral cavity. For this reason, the simultaneous approach to apply GBR membrane, autogenous bone or bone filling agents in the same operation with the two-piece one-stage type are associated with risks, although not to the same extent as the one-piece type, thus sufficient amount of remaining bone is required. On the contrary, as with one-piece type, onlay graft for maxilla, or split crest to the mandible, a staged bone augmentation approach can be taken to increase bone quantity for safety purposes. In comparison to concomitant application of split crest with the one-piece type, in which primary stability is difficult to be gained, since the abutment is not exposed with the two-piece one-stage type, its success rate is an improvement of the one-piece type.

It is less likely for the occlusal injury to affect the two-piece one-stage type than with the one piece type, therefore a light increase in the number, 3 to 4 implants can be installed at one time, compared to 2 to 3 with one-piece type. If the temporary bridge cannot be used due to multiple implantation, the preferred means to avoid the external injuries to result from occlusion, temporary prosthesis with overdenture can be used with tissue conditioning agent. This overdenture should be milled so that the mucosal plane does not become in contact with the healing abutment. The use of overdenture with this type of implant can be applied to those cases in which one-piece type is difficult to be applied, such as the jaw with multiple tooth loss or to the edentulous jaw, and generate osseointegration. The angled abutment can be used if the abutment is placed after achieving osseointegration. If applying apical attachment, OD abutment and apical attachment should be applied as a pair.

### **B. Factors that should be considered with two-piece two-stage type**

The fundamental concept of two-piece two-stage type is by top-to-bottom treatment whereby the superstructure is first decided then the direction of insert guided by the surgical stent, and to drill in the determined direction for the insertion of the fixture. In situations where there is a lack of bone quantity, conduct bone augmentation simultaneously with the implantation, using GBR with autogenous bone or bone filling material. Generally, the treatment plan for this type is as thus: Conduct split crest, if the bone is narrow, to insert the fixture, place GBR membrane to close with the mucoperiosteal flap on top with suture. Since the treated area is completely closed off, bone augmentation with this type has higher success rate than with the two-piece one-stage type. It is also thought that an increased number of implants, 4 to 5, can be inserted at once due to the least likelihood of receiving external injury. The temporary prosthesis with this type is the same for the two-piece one stage type, in that, if the temporary bridge cannot be used with the large number of inserted implants, overdenture that has been prepared to avoid becoming in contact with the healing abutment can be used with concomitant application of tissue conditioning agent. The use of overdenture with this type of implant can be applied to those cases in which one-piece type is difficult to be applied, such as the jaw with multiple tooth loss or to the edentulous jaw, and generate osseointegration. As to the application of abutments after bone integration and the use of apical attachment are the same with the two-piece one-stage type.

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