Chapter 5- The standard indications for the application of one-piece, T-type and two-piece types

Director of Kuroyama Oral and Maxillofacial Surgery Clinic
Yushiro Kuroyama

I. The difference between one-stage and two-stage types

The numbers of stages indicate the number of surgical steps involved. The installation of one-stage type is complete with one surgical intervention, whereas two stages, for first the burial of the fixture, and second the fenestration surgery are required for the two-stage type.

Generally, the values of each method have been concluded that the treatment period can be reduced with the one-stage type, while the two-stage type has been noted of its high success rate. Along with the others, their pros and cons are listed in Table 2-5-1. The notably high success rate of two-stage type is largely be owing to the burial of the fixture under the mucoperiosteum for several months without any exertion of pressure, enabling firm integration with the bone. Due to the higher risk of infection with the one-stage type than with the two-stage type, its application has been limited in cases where the bone is insufficient in terms of its width and height, and where bone augmentation procedure is necessary.

Nevertheless, concomitant installation of one-piece type with GBR membrane to conduct immediate loading has always been a success from my experience (Fig.2-5-2). From such observations, I have come to question the conditions indicated for the two-stage and one-stage types, as they have not always been appropriate.

In the past, besides the disadvantages of the two-stage type such as the added complications in the procedure such as the increased number of surgical steps, lengthened treatment period, the cost compared to the one-stage type, as well as loosening of the screws or fracture problems had been identified and reported. In the development of the AQB two-stage type, these issues were solved by renovating the screw systems.

One-stage type

Advantage: - Can complete the procedure in one go.

Disadvantage: - Occlusal force, labial force and buccal force can all be exerted from the early stages

Two-stage type

Advantage: - Easier to obtain primary stability with this method

Disadvantage: - Fenestration procedure is required

- **The gap in between the fixture and abutment**
- **Loosening of the screws and fracture**
- **Loosening of the abutment**

Fig. 2-5-1 Properties of one-stage and two-stage types

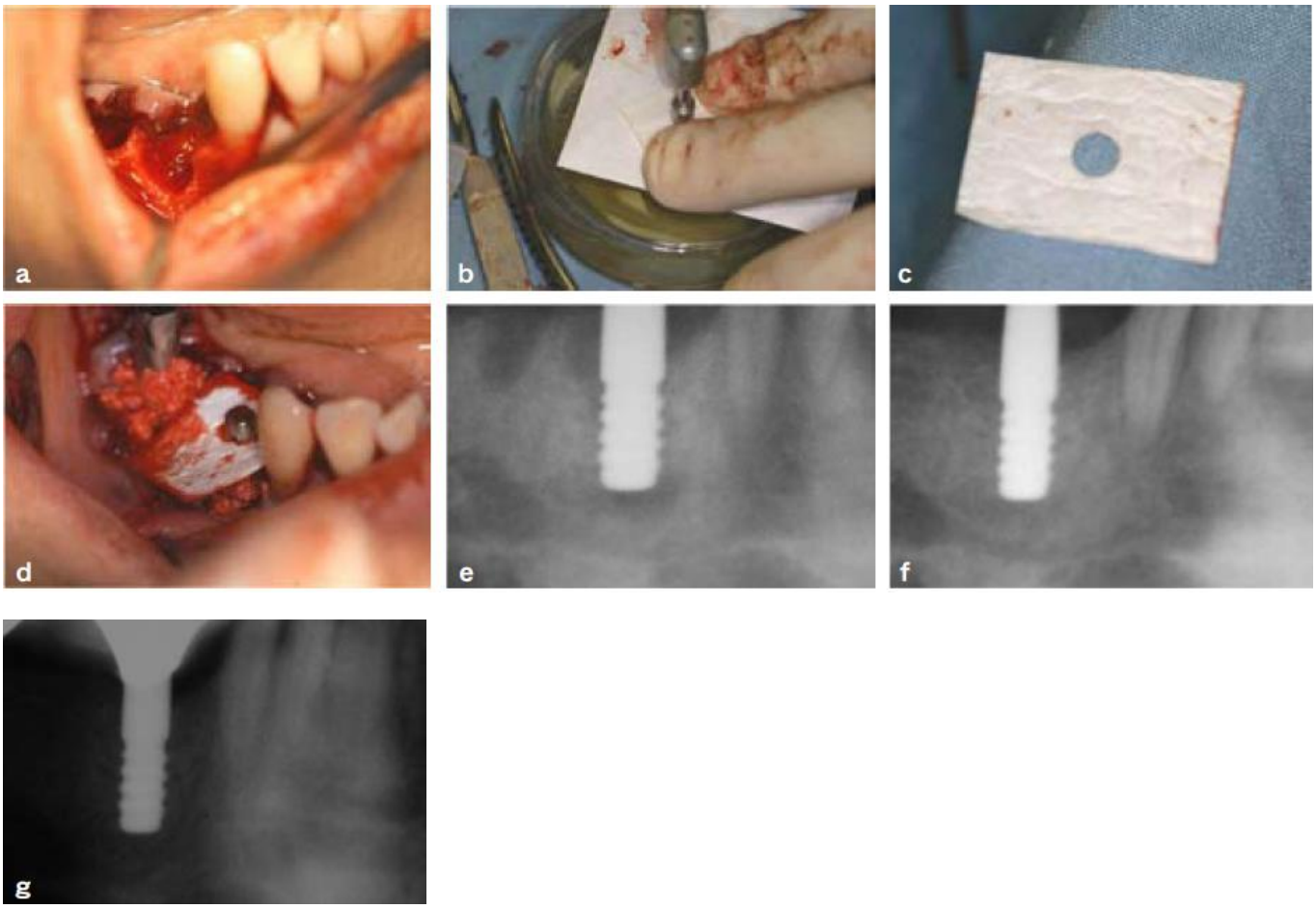


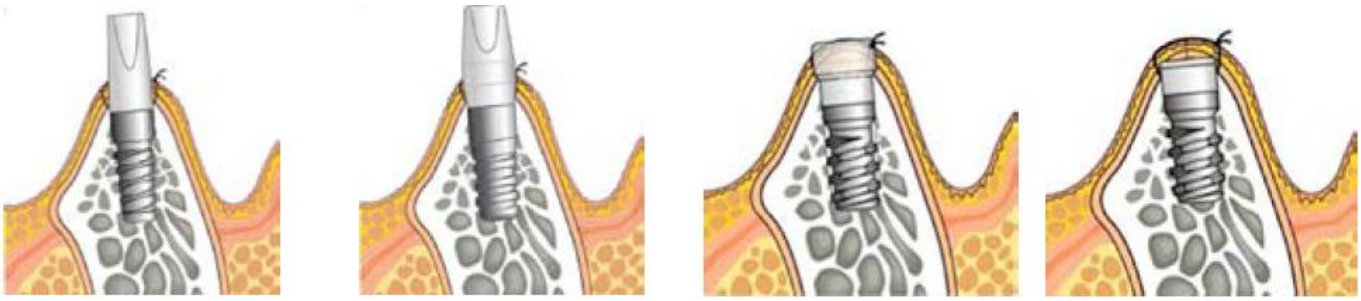
Fig. 2-5-2 a to g An example of immediate loading with the one-piece type implant

Under the standard implant treatment, roughly 4 months is required to allow the healing process of the extraction cavity before the installation of implants. The bone healing on the buccal side was thought to occur in its resorbed state, therefore was treated as stated below:

a. Bone defect was observed in the buccal side of No.21, where immediate loading was conducted.
b. , c. Hole punching in the absorbable membrane with a circular knife, and the hole that matches the diameter of the implant.
d. Filling with PRP and β-TCP.
e. Radiograph taken directly after the surgery.
f. Radiograph after 4 months after the surgery.
g. Radiograph after 3 years and ten months from the surgery.

II. Properties of AQB implant system

The one-piece, one-piece one-stage T-type, two-piece one-stage and two-piece two-stage are included in the product lineup of the AQB implant system (Fig.2-5-3) and are all possible to be applied. When the AQB implant was first placed on the market, only one-piece type was present. The effectiveness of one-stage method and HA coating had both been rejected by the world, and thus had to face severe views in the sales. But 15 years since the start of its sales, with the technique in which to convert the α-TCP coating[2] into recrystallized HA with hydrothermal treatment, [3),4)] one-piece one-stage has proved its efficacy with the clinical trial results, and good longevity.



a. One-piece type (one stage)　b. One piece T-type　c. Two-piece one stage　d. Two-piece two stage

Fig. 2-5-3 Basics of AQB implant system

Recently, various studies on examining the safety of implants were conducted, and the general understanding of the one-stage type became one that said, provided that a suitable treatment is conducted with the one-stage type, there are no significant differences in the infection risk with the two-stage type. For example, in a study that observed the one-stage and two-stage type titanium implant 5 years from the implantation with X-ray radiography, there was no difference in the survival rate between the two.[5] In addition, from the animal studies I conducted in Tokyo Medical and Dental University, as shown in Fig 2-5-4, 2-5-5, the comparison of bone resorption between the two types with the X-ray radiography (at initial stage, a month, 3 months and 5 months after the implantation), showed no significant difference.

Of course if there are concerns as to the efficacy and the clinical results of one-stage type, two-stage type can be applied to all of the cases. The survey to the AQB users (n=228) conducted in 2001 by ADVANCE Co., Ltd. indicated 83% of the users to demand inclusion of two-piece type in the AQB Implant system (Fig.2-5-6-a). The reasons for this were for cases where angled orientation was required, for esthetic outcome, for edentulous jaw, application as a support for the denture, and to apply immediate loading (Fig.2-5-6-b).

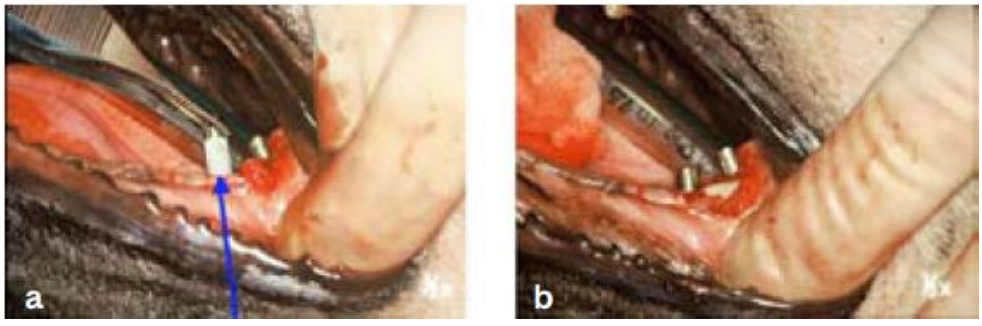
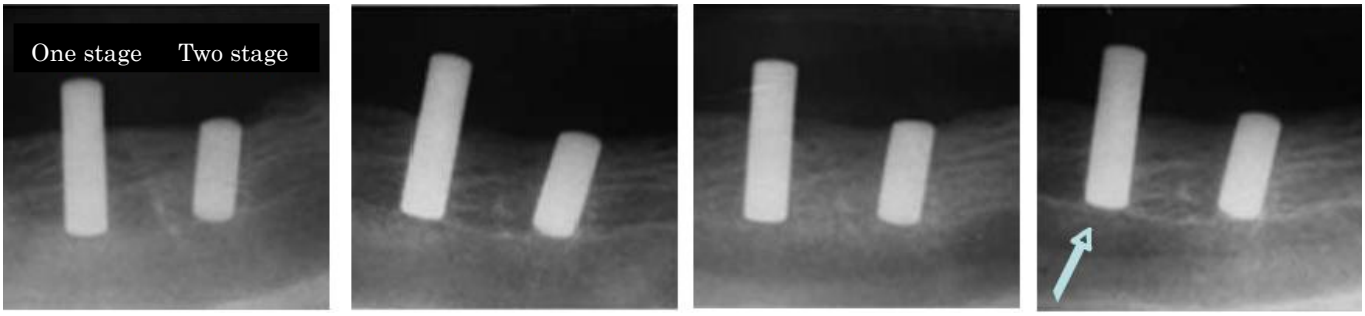


Fig. 2-5-4-a,b Experiment on German Shepherd. Recrystallized HA coated (50 μm) implant sample was installed 3 months after the tooth extraction.



a. Right after the implantation b. One month later c. Three months later d. Five months later

Fig. 2-5-5 Radiograph images of one-stage and two-stage implants installed (Experiments were performed in Tokyo Medical and Dental University). No significant bone resorption could be observed with one-stage type even after 5 months from its implantation.

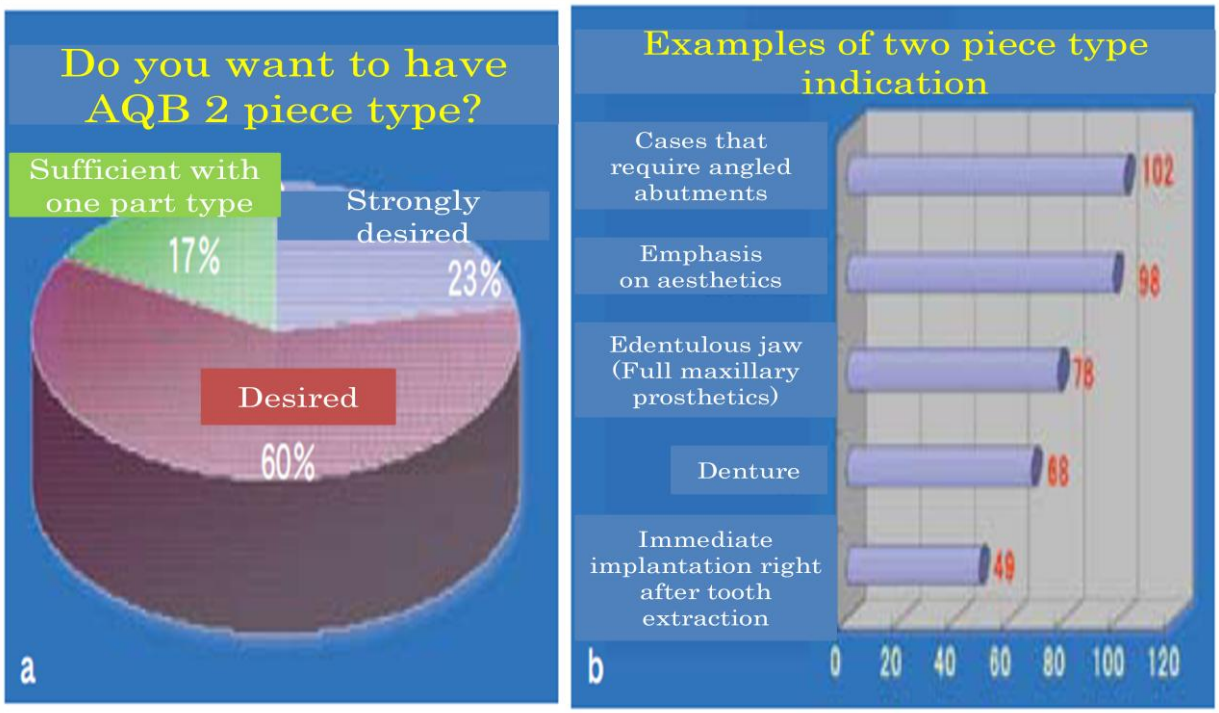


Fig. 2-5-6 A survey conducted to find out the need for two-piece type implant (ADVANCE Co., Ltd., 2001, n = 228).

In the development of the two-piece type, AQB team investigated the means to improve the accuracy of interdigitation in order to overcome the issues faced with the two-piece type that were circulating at the time such as the loosening of the screws and fracture. The result of this research led to the idea of internal joint to connect the fixture and the abutment (Fig. 2-5-7) with titanium alloy (Ti-6Al-4V) screw. The interlocking part of the fixture and the abutment takes a SOL (smooth octagonal lock) interdigitation system that disperses the stress applied (Fig.2-5-8). The interdigitation has been structured with precision machining technology and its high precision is evident from the SEM image (Fig.2-5-9).

The thorough investigation resulted in the release of AQB two-piece type implant that incorporated the advantages of one-piece type, to widen the cases that the AQB implants can be applied to. A clear standard for selecting the one-piece or two-piece types does not exist, but for many of the users of AQB implant system, the first-line choice is the one-piece one-stage type as is the main product of this system, can be applicable to most of the cases; and two-piece for the more complex cases.[6] The operation of the

two-piece type can be conducted with the addition of SOL driver bit, a Hex driver bit and a torque control (Fig. 2-5-10) to the conventional tools for one-piece type.

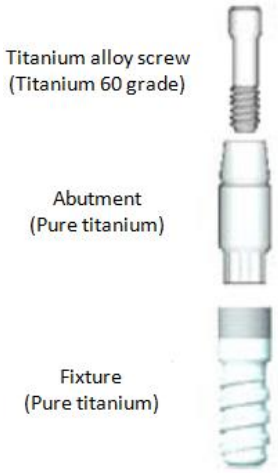


Fig. 2-5-7 AQB two-piece system

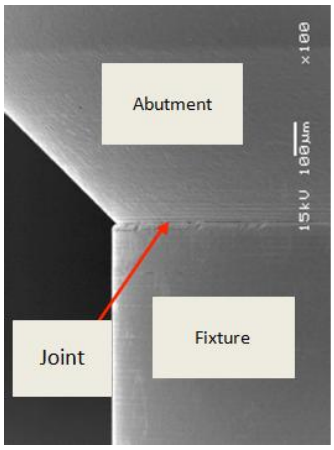


Fig. 2-5-9 SEM image of the interdigitation of the two-piece type

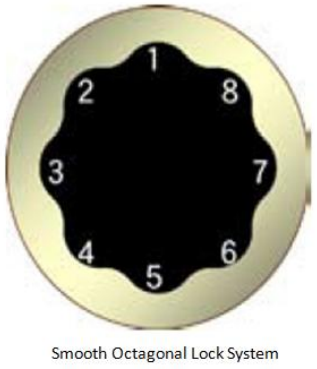


Fig. 2-5-8 SOL system (smooth octagonal lock system)

- The octagonal interdigitation without the acute corners can evenly disperse the stress exerted.
- Eight different interdigitations can be selected.

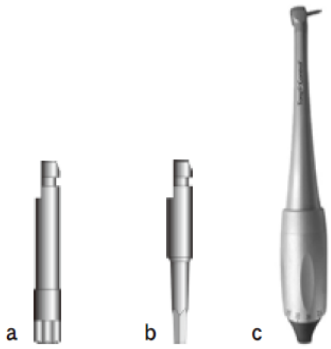


Fig. 2-5-10

a) SOL driver bit
b) HEX driver bit
c) Torque control

In 2007, AQB one-piece T-type that has been added with a 6° inclination angle to the abutment was also introduced into the system (Fig. 2-5-11-a). The tapered structure was suited to prevent the subsidence and aberration of the implant structure into the maxillary sinus after socket-lift or sinus-lift procedures. Its abutment diameter is 0.4 mm thicker than that of the one-piece type therefore the tooth cervix of the superstructure was able to be designed to be thicker. The only time a tool specific for T-type is required is for its implantation with a fixer (Fig. 2-5-11-b).

To investigate the strength of the implant neck of AQB one-piece, two-piece and T-type, a bending strength test was conducted with stroke speed 0.5 mm/s applied with weight (N) (Fig. 2-5-12). The bending strength was the in the order: one-piece < two-piece < T-type (Fig. 2-4-13, y-axis show the relative bending strength to the strength of the one-piece 3 mm diameter implant to be set as 1).

The result that the bending strength of the one-piece type to be weaker than that of two-piece type was unexpected, but the reason for this can be largely owed to the titanium alloy (Ti-6Al-4V) screw and to the SOL interdigitation system (Fig. 2-5-8). The increase in the abutment diameter with T-type was due to

the shift in the positioning of the screw, this can be said to be the reason for the higher relative strength of the T-type to the one-piece type (Fig. 2-5-14,15).[7)]

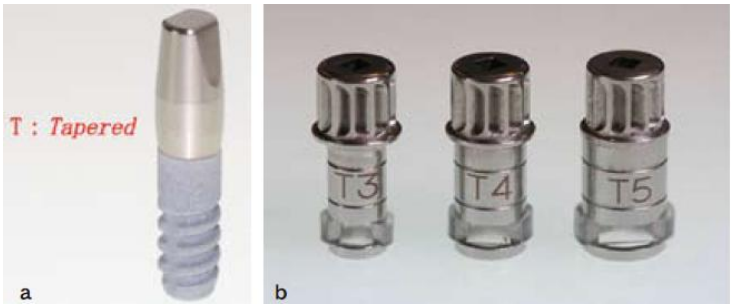


Fig. 2-5-11-a,b One piece T type (a) and a specific fixer for T type (b)

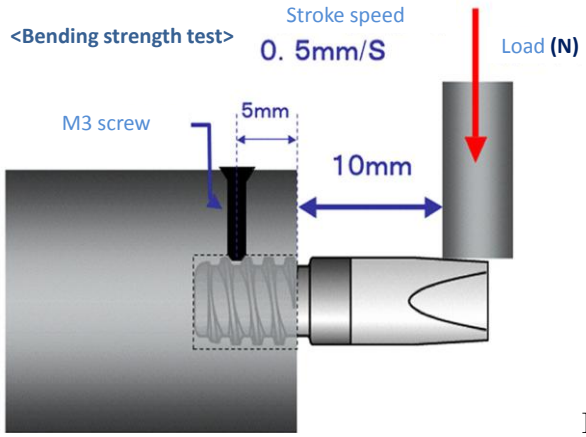


Fig. 2-5-12 Strength comparison of implant neck

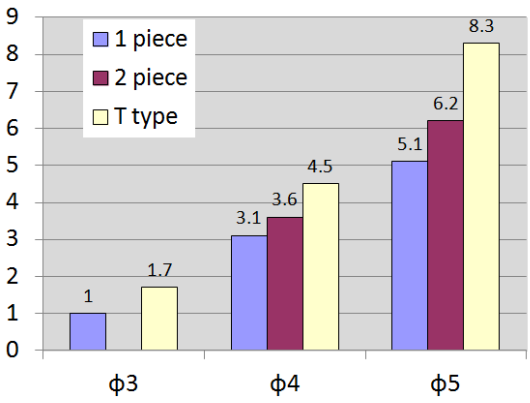


Fig. 2-5-13 The result of the bending strength test

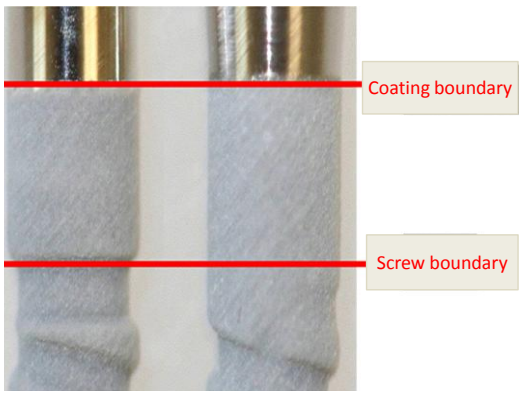


Fig. 2-5-14 Comparison of the screw sections of one-piece type and one-piece T-type

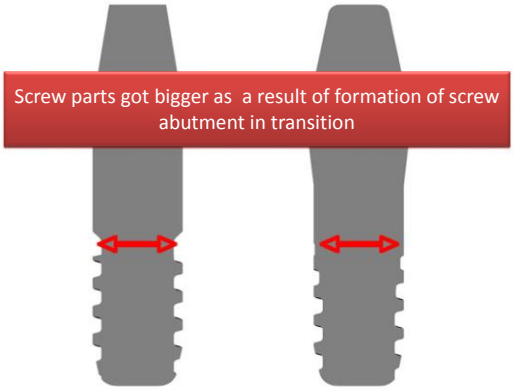


Fig. 2-5-15
The reason for the increase in the strength of the one-piece T-type is that the increased strength is due to the repositioning of the portion of the screw.

III. Selection criteria for maximizing the properties of one-piece, two-piece and T-types

A. One-stage (one-piece, two-piece)

The simple structure of the one-piece one-stage type can be applied to most of the cases. The use of two-piece one-stage type to particular cases in which the inclined angle, parallel nature are required and be completed at once (Fig. 2-5-16). Alternatively, there are cases where two-stage method initially intended to become treated as for a one-stage method due to the exposure of the healing abutment (Fig. 2-5-17) during the consolidation stages. This is not considered as an issue provided that bone integration can be established.

B. Two-stage (two-piece)

Two-stage two-pieces are often applied in situations where achieving bone integration is considered to be of prime importance, and where infection and loading need to be avoided. It is also effective where inclined angle on the abutment of to adjust the parallel nature of the multiple installed implants are required (Fig. 2-5-18 to 20).

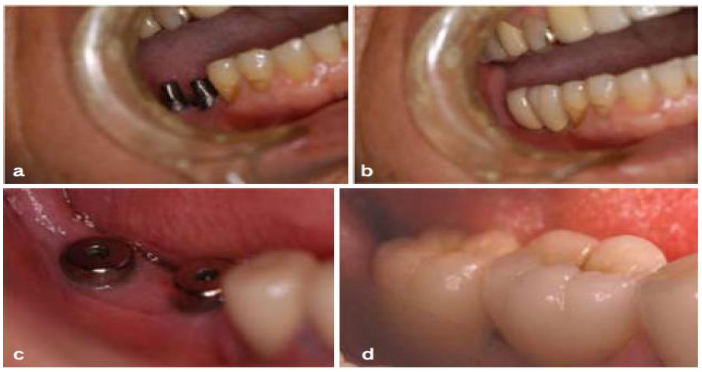


Fig. 2-5-16 Case examples of one-stage: one-piece and two-piece types
a. One-piece type: preparation of abutment teeth
b. One-piece type: superstructure placement
c. Two-piece type: postoperative placement of healing abutment to await its consolidation
d. Two-piece type: superstructure placement

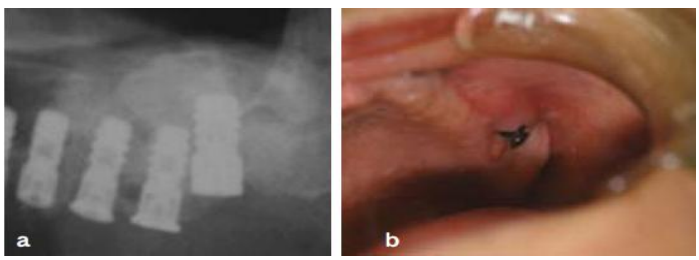


Fig. 2-5-17 Healing cap becoming exposed. Sinus-lift procedure was conducted simultaneously with the implantation to the left maxillary molars. The healing abutment of the No. 2 position became uncovered.
a. Radiograph with the exposure of healing abutment
b. Image of the oral cavity

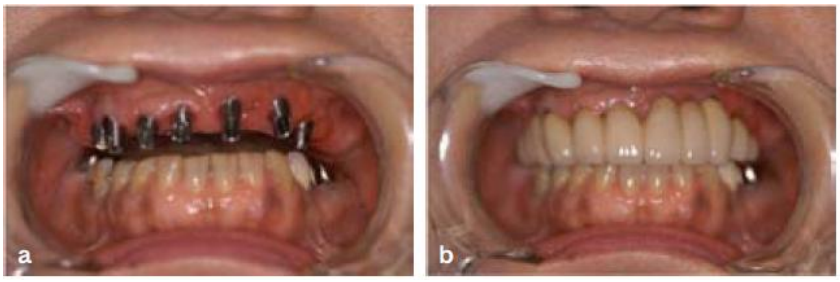


Fig. 2-5-18 A case of multiple implantation with two-piece two-stage type
a. Abutment placement
b. Superstructure placement

Fig. 2-5-19 A case in which an inclined angle and parallel nature of the abutment was modified with two-piece two-stage type
a. Panoramic radiograph with the multi-abutment placement
b. Placing the abutment that have been adjusted to be in parallel with the adjacent structures
c. Placement of superstructure

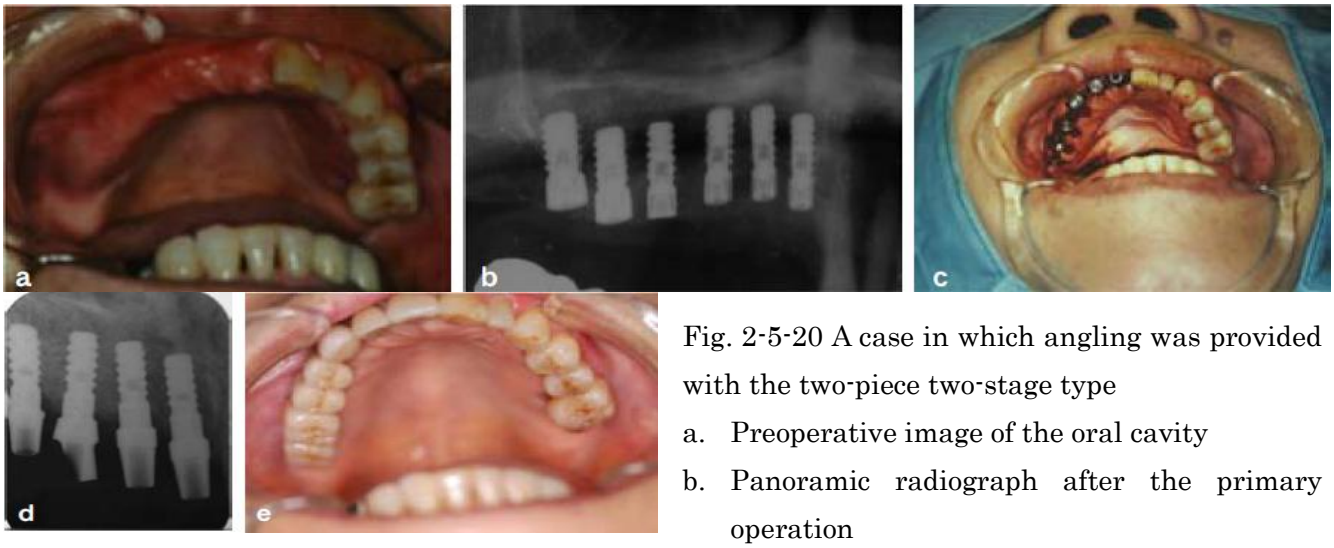


Fig. 2-5-20 A case in which angling was provided with the two-piece two-stage type
a. Preoperative image of the oral cavity
b. Panoramic radiograph after the primary operation
c. Fenestration procedure
d. Dental radiograph after the placement of abutment (the degree of angle adjustment at No. 11 position was more than what was expected)

C. T-type

T-type is suited to prevent the subsidence and aberration of the implant structure into the maxillary sinus after socket-lift (Fig. 2-5-21) or sinus-lift procedures, as well as for immediate loading following tooth extraction (Fig.2-5-22). Previously, one-piece type was the main type installed when associated with socket-lift or nasal sinus floor elevation (Fig. 2-5-23). Recently, however, to such examples with low bone density, and narrow bone, it has become more common for the two-stage type or T-type to be applied (as shown in the example featured in Fig. 2-5-17-a, the implant subsiding into the maxillary sinus interior

has been prevented with the use of diameter 4 mm fixture and 5 mm diameter healing abutment SS to the positions No. 3 and 4).

Each one-piece, two-piece and T-types in conjunction with sinus-lift (simultaneously) have been shown in Fig. 2-5-24. All of the examples show favorable outcome, but T-type seems to show convenience in terms of preventing implant body from subsiding. The advantage of T-type is in its ability to stop sliding into the maxillary sinus especially where the cancellous bone is particularly soft. Implantation is conducted by observing the coating layer therefore the implants can be inserted further than was initially planned especially with the soft bone.

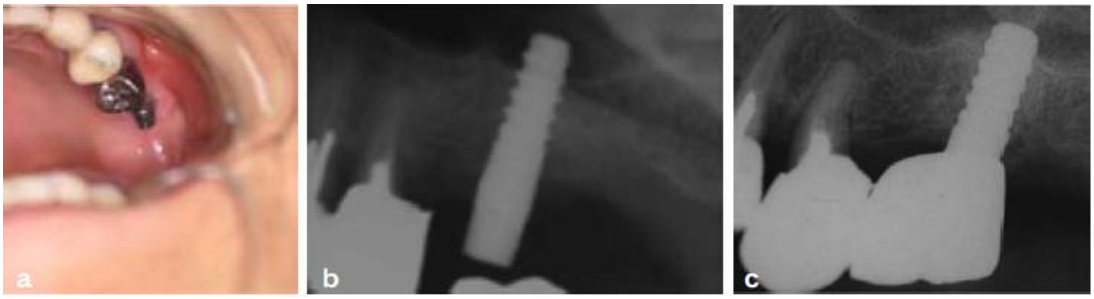


Fig. 2-5-21 A case of T-type socket-lift

a. Intra-oral image (2 months postoperatively)
b. Dental radiograph straight after the operation (no bone filling agents are used)
c. Dental X-ray 4 months after the operation (osteogenesis of the maxilla can be seen, by the osteoconductive property of HA.

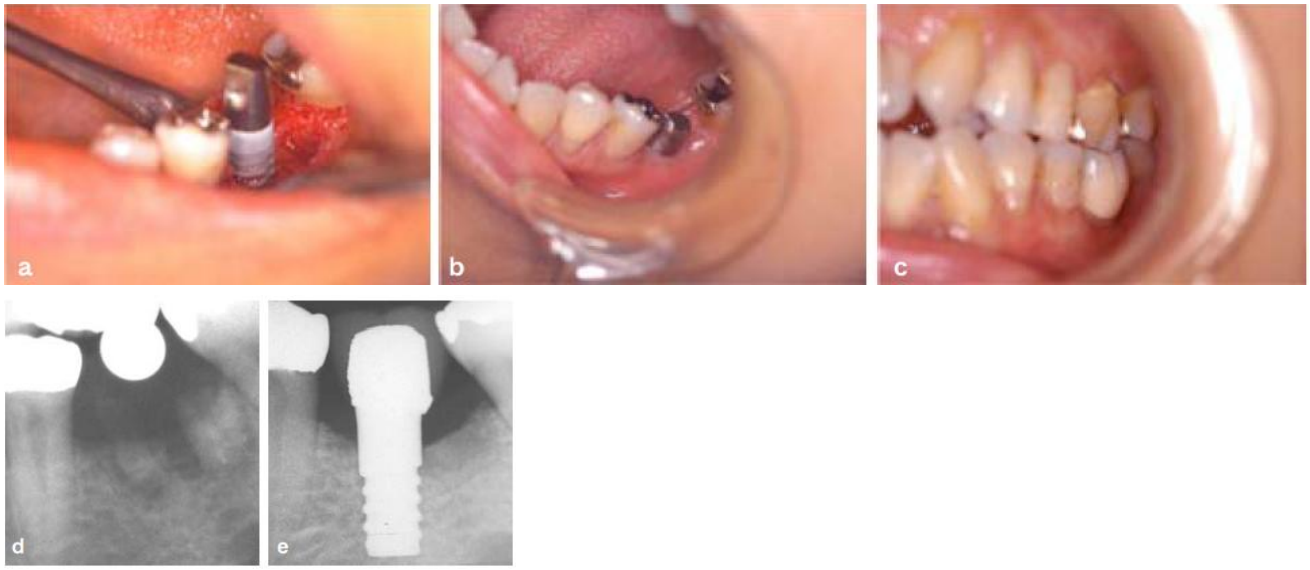


Fig. 2-5-22 A case of T-type immediate loading after tooth extraction. The distance to the mandibular canal is relatively short, therefore applied T-type to prevent the subsiding of the implant and for a better fit at the cervix to the funnel-shaped extraction socket

a. The remaining root was extracted to be replaced with T-type implant (5 mm diameter, 10 mm in length of the HA coated section).
b. The image of the oral cavity a month after operation
c. The image of the oral cavity two months after operation
d. Preoperative radiograph to No. 30
e. Postoperative radiograph 2 months and 2 weeks later (2 weeks after the superstructure placement).

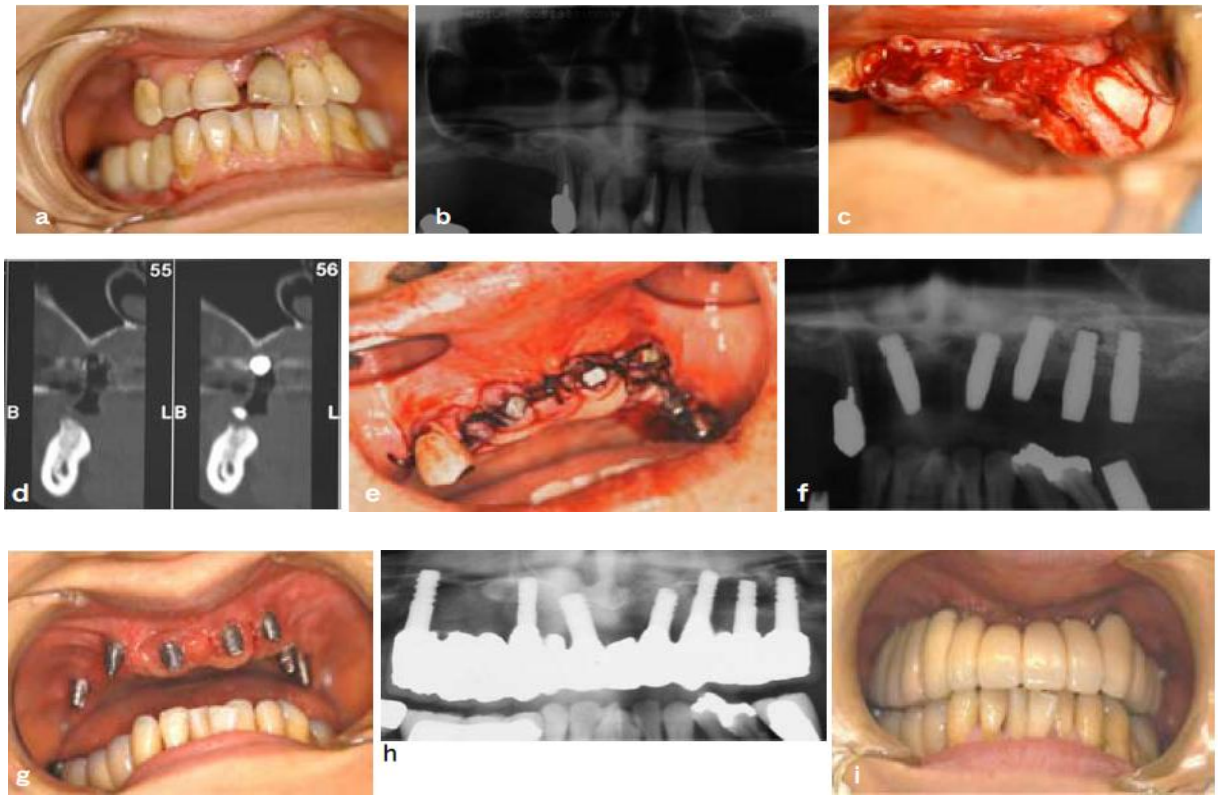


Fig. 2-5-23 A case of sinus-lift with T-type implant, immediately after the tooth extraction, with elevation of the floor of nasal sinus. The sinus-lift was conducted with β-TCP and PRP.

a. Preoperative image of the oral cavity
b. Preoperative panoramic radiograph
c. Perioperative image during the extraction of the anterior tooth and sinus-lift procedure to the left
d. CT image of the region to which sinus-lift was conducted (thickness of the cortical bone: approx 2 mm).
e. Image of the oral cavity after the implantation
f. Postoperative panoramic radiograph
g. Image of the oral cavity after sinus-lift procedure to the right, and during extraction of right maxillary canine
h. Panoramic radiograph featuring the dental arch, 1 1/2 years after the placement of the superstructure. No problems have been encountered thus far.
i. Image of the dental arch, 1 1/2 years after the placement of the superstructure. No problems have been encountered thus far.

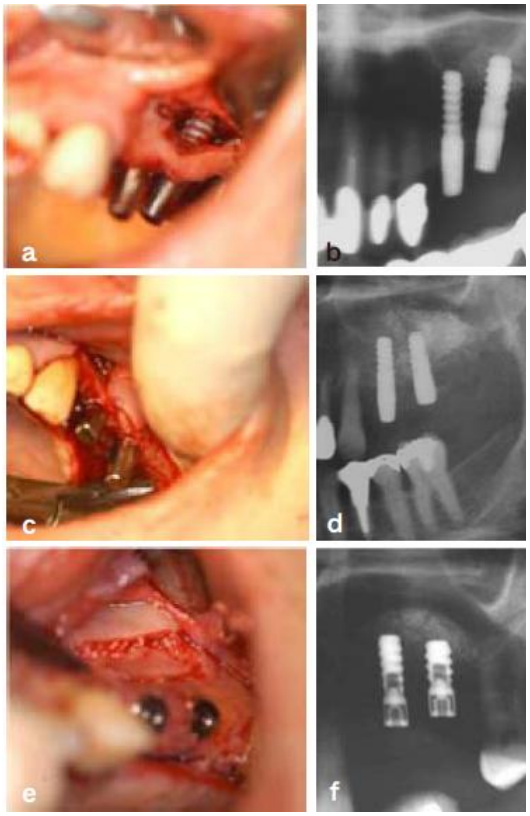


Fig. 2-5-24 Sinus-lift conducted in conjunction with each type of AQB implants. One-piece type implants were inserted to the No. 2, 4, 5 positions (No. 2 is not included in the image). Judging from the buccal bone quantity directly from the lateral window, the cortical bone of the maxillary sinus floor appears relatively thick. However, it was confirmed to be thin as 1.5 mm with the CT scan, therefore the implant body could not be stabilized with the bone if inserted in parallel. In order to prevent the subsidence into the maxillary sinus, implant body had to be stabilized so that it was in a slanted position.

a., b. Image and radiograph of the oral cavity post-operation with one-piece type

c., d. Image and radiograph of the oral cavity post-operation with T-type

e., f. Image and radiograph of the oral cavity post-operation with two-piece type

D. Comparison of the types in designing their margins

The main factor of concern in terms of the esthetics of one-stage and two-stage types is their emergence profile. As shown in Fig. 2-5-25, the edge of the superstructure of one-piece one-stage type is often placed close to or on top of the gingival margin therefore giving a base of the superstructure that spreads to the sides. On the contrary, the superstructure margin can be placed beneath the gingival margin with the two-piece type thus providing a natural emergence profile.

This is still possible with the one-piece type, but as it requires a number of tedious steps such as incising into the gingival structures surrounding the abutment, pressurize the area with provisional crown and wait for it heal, the application of two-stage type is recommended from the beginning.

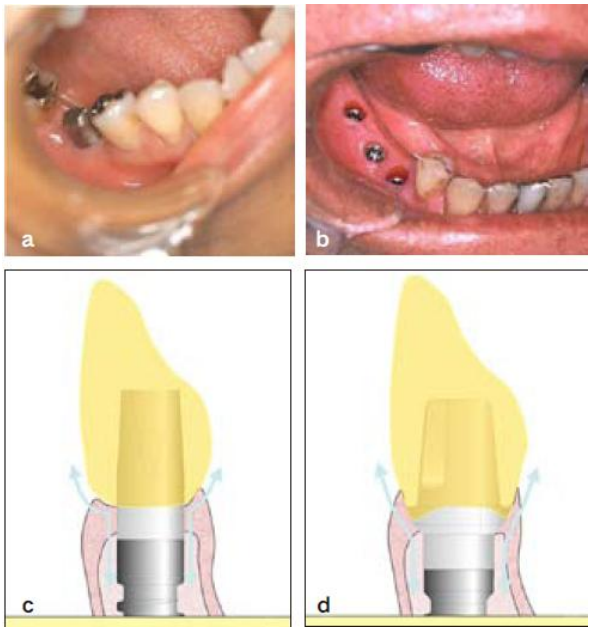


Fig. 2-5-25 The gingival margin and the positioning of the superstructures of one-piece and two-piece types

a. Gingival margin of one-piece type
b. Gingival margin of two-piece type
c. Superstructure positioning with one-piece type
d. Superstructure positioning with two-piece type

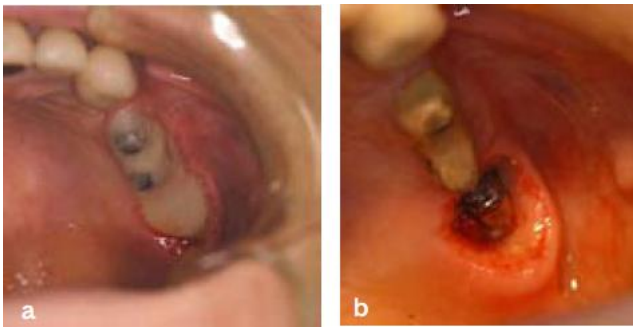


Fig. 2-5-26 Incision into the gingiva for one-stage type

a. After the incision of the gingiva surrounding the implant
b. Healing of the gingiva surrounding implant (2 weeks later)

Examples using each of the different types were presented in this chapter, but the first-line choice, personally, is with the one-piece one-stage type, and apply the T-type and two-stage types accordingly to the conditions presented (Table 2-5-1, 2) although, it is indeed possible to select and apply T-type or two-piece type only to all of the cases presented.

1. Elevation surgery (Socket lift, maxillary sinus floor augmentation procedure, and nasal cavity elevation etc)
2. Immediate implant insertion right after tooth extraction
3. Case of attach greater importance to strength

Table 2-5-1 Cases where use of T-type is recommended

1. Case which angulation is necessary
① Depend on bone conditions of front tooth maxilla and implant part
② Occlusal condition such as shift between opposing teeth space and interalveolar crest line
③Necessity of parallelism for multiple teeth
2. Case of postoperative early infection and wants to avoid early overload
3. Case of low bone density
4. Case which attaches put greater importance on esthetics (Emergence profile)
5. Case of edentulous jaw (Full maxillary prosthetics)

Table 2-5-2 Cases where use of two-piece two-stage type is recommended

1. Angling is required
    ① In the anterior region or due to the bone structure of the implanting region
    ② For correcting occlusion- to fit the opposing teeth, or shift relative to the interalveolar crest line
    ③ Implantation in parallel to the adjacent structures is required with cases of multiple implant installation.
2. Infection, or loading directly after the operation needs to be prevented
3. Low bone density
4. Esthetics (a good emergence profile) is required
5. Edentulous jaw
6. Recovery from the perioperative loosening with one-stage type implant

References

1) Morooka M, Ishikawa T, Ito T, Fukuchi A. Frequent fracture of titanium root-formed implant and structure and measures –Case report–. Quintessence DENTAL Implantology 2008; Vol.15,No.3: 329-344. (in Japanese)

2) Kuroyama Y. Characterization of α–TCP coated titanium materials and bone tissue reaction. Dent Mater J. 1993; 12-6: 773-789. (in Japanese)

3) Kuroyama Y. Present condition of HA coating. Dental Diamond 1996; 21: 58-63. (in Japanese)

4) Michi K, Kamoi K. Biointegrated implant 1 Introduction for beginners. Tokyo. Nagasue Shoten, Ltd. 1997; 2-11.(in Japanese)

5) Ericsson I, Randow K,Nilner K,Peterson A: Some clinical and radiographical features of submerged and non-submerged titanium implants.A 5-year follow-up study. Clin Oral Implants Res oct8 1997; 5: 422-6.

6) Takarada H, Kuroyama Y, Hayashi M, Tanaka T. Proper use of AQB one stage and two stage implant. Abstract for the 7th Academic Meeting of Innovational Advanced Implant Assosiation. Tokyo. Innovational Advanced Implant Assosiation, 2004; 6-12. (in Japanese)

7) Kuroyama Y. Information of new AQB one piece T type implant. Abstract for the 10th anniversary Academic Meeting of Innovational Advanced Implant Assosiation. Tokyo. Innovational Advanced Implant Assosiation, 2007; 50-53. (in Japanese)