Chapter 4 - Superstructure of AQB implant system

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I. Selecting the connection form of crown bridge

In cases of partial loss of teeth, there are two main concepts regarding the designs of implant superstructure. The first is to connect the implant bodies and then place the superstructure, and second, to not connect the implants as much as possible to fabricate prosthesis. The idea behind connecting the superstructure is to disperse the rotational force that is applied on the cylindrical implant, and avoid it become loose. On the contrary, the technology to link the implants with the superstructure is more complex therefore reducing the accuracy of the fit.

A. The natural teeth and implant movement during their function

1. The movement of natural teeth and the strain on the alveolar bone

The natural tooth is supported by the elastic periodontal membrane in the jaw bone (Fig. 4-4-1). The functional force that is exerted on teeth and the jaw bone during mastication is relieved by the teeth sinking into the alveolar bone and shifting to the distal direction of the tooth root on the palatal side with the maxillary molars (Fig. 4-4-2); or to the lingual side with respect to the mandibular molars (Fig. 4-4-3). At rest, the positions of the teeth are restored from their displaced positions by pulsating in antagonistic direction from the functional position aided by the blood flow in the periodontal membrane. Since the interdental contact forces are not acting in between the adjacent teeth, the teeth are able to receive any kind of functional forces without it becoming an overload. Furthermore, during its functions such as chewing, teeth are pressed into the alveolar bone, and shifting to narrow the width of dental arch. By becoming in close contact with the adjacent teeth, the interdental spaces become saturated, protecting the space from becoming filled by food pieces.
A three-dimensional dislocation is observed during its functions, but the extent and the direction of this shift are different between the upper and lower mandible.

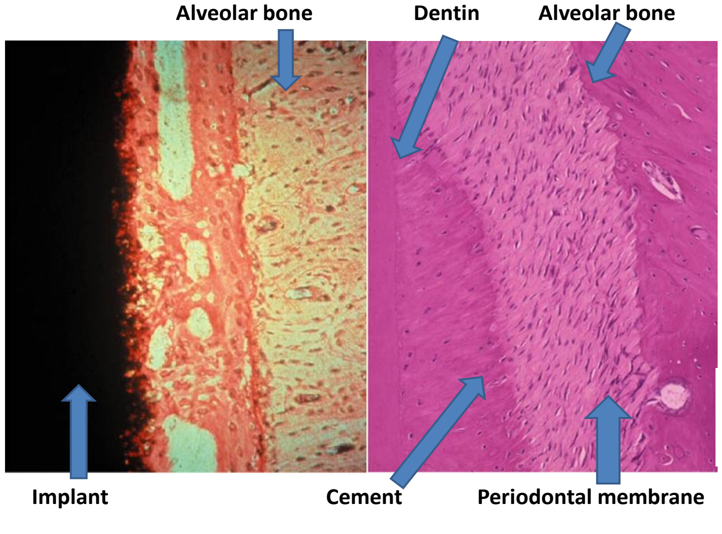


Fig.4-4-1 Tissue structures of implant (left) and natural teeth (right)

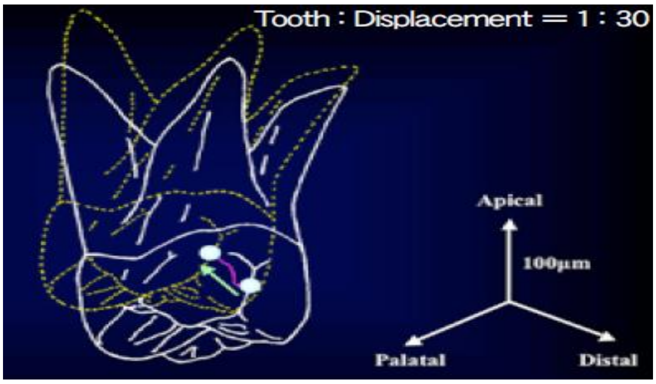


Fig.4-4-2 Tooth displacement of the maxillary first molar (Intercuspal position)[4)]

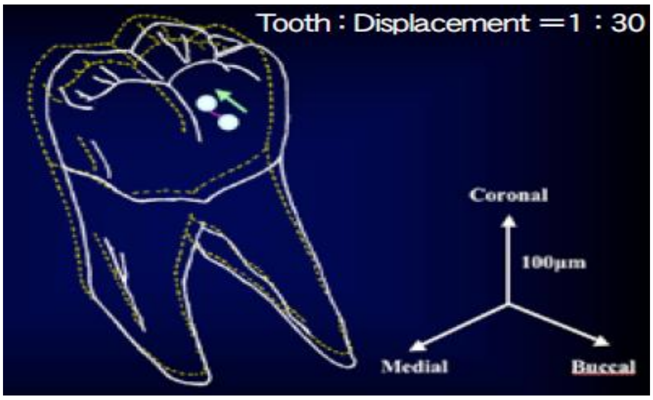


Fig.4-4-3 Tooth displacement of the mandibular left first molar (Intercuspal position)[4)]

For the maxillary primary molar, clenching at the intercuspal position within the frontal plane, results in shift of the buccal cusp by 74 to 128 μm to either the palatal apical side or towards the tooth root; and 66 to 123 μm with the buccal cervix. With the mandibular first molar, the clenching at the intercuspal position within the frontal plane, the displacement of the central position on the buccal side was by 40 to 66 μm to the lingual coronal side or to the lingual side. The degree of displacement of mandibular first molar is much less than that of the maxillary first molar. This is thought to be due to the differences in the structures of the jaw and the periodontal tissues.

The degree of shift of the maxillary first molar at the time of chewing Pretz was found to be 131 to 163 μ min in lingual apical direction in the frontal plane. During chewing, the mandibular first molar showed displacement of 40 μm to the apical and lingual direction and 20 μm to the apical buccal direction in the frontal plane, (Fig. 4-4-4). Teeth become displaced to the lingual apical direction by the primary stroke of chewing movement exerted towards the tooth root to break the Pretz, but with the strokes that follow, the shift is made to the buccal apical direction with the first phase, and to the lingual apical direction with the second phase. During mastication, the mandibular teeth not only experience the rotational force acting on the labial side, but also receive counteracting force in the buccal direction resulting in a rational mechanism. The differences in the degree of displacement become further distinguishable between the upper and lower mandibles during mastication than in clenching. Shift of roughly 150 μm and 40 μm, were found with the maxillary and mandibular first molars respectively.

2. Alveolar bone distortion

The degree of shift of the abutment teeth were investigated by creating a state whereby gaps between the opposing and adjacent teeth were formed (Fig.4-4-5) with the abutment preparation, then achieving occlusion at the intercuspal position. The results are shown in Fig. 4-4-6. The difference in the degree of shift is only slight with the first molar in which gaps with the opposing and adjacent teeth are present, however, with regards to the second premolars and second molars with occlusal contact, the shifts in the same direction were observed. This is thought to demonstrate the reaction of the alveolar bone to the occlusal force acting on the teeth, indicating that the alveolar bone to distort with the tooth in the direction of physiological displacement of the natural teeth.

3. Implant movement

Contrarily to the natural teeth, since the implant is not supported by the periodontal membrane (Fig. 4-4-1), the displacement pathway was thought to vary. To investigate this, the displacement of implant prosthesis installed to the right mandibular primary molar was analyzed during chewing Pretz. The implant was found to shift in the mesiobuccal direction by 50 μm, but did not show any movement in the apical direction unlike the natural teeth. The reason is thought to be due to the absence of periodontal membrane in the implant surroundings.

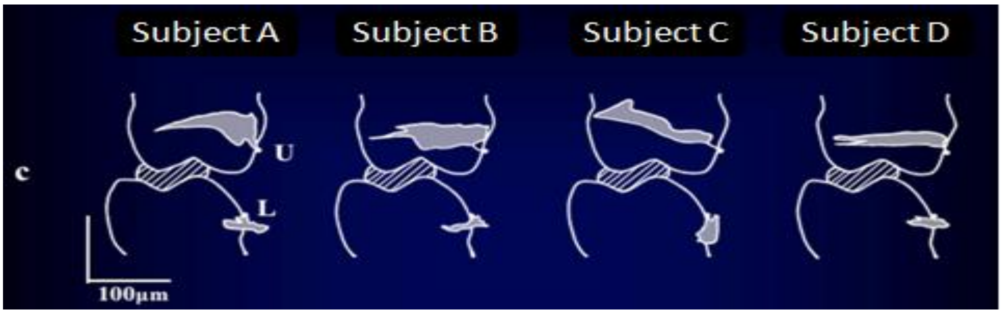
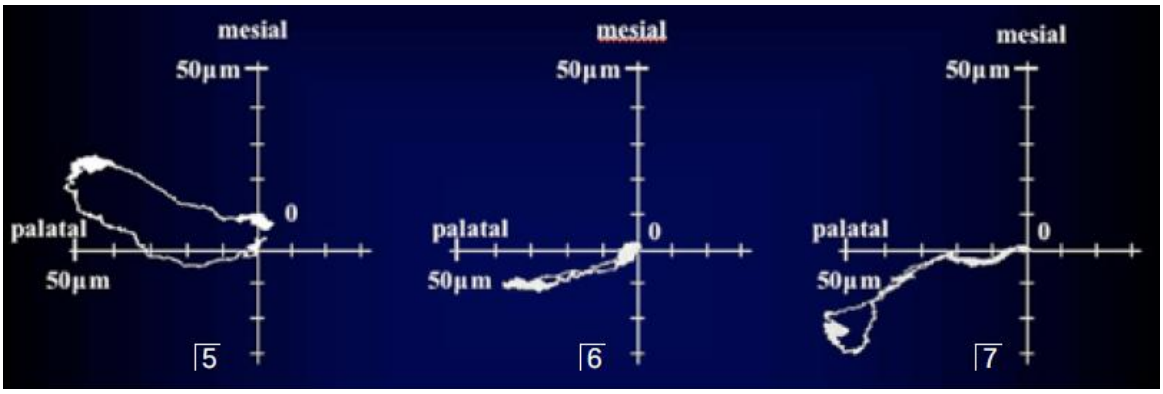


Fig.4-4-4 The displaced state of upper and lower mandibular first molars during Pretz chewing (Frontal plane)

Fig. 4-4-5 The abutment in the maxillary first molar after its preparation



· Fig. 4-4-6 The dislocation pathway of the abutment tooth (maxillary first molar) and the two adjacent teeth at the intercuspal positions at the time of clenching (horizontal plane). The distortion of the periodontal tissues with occlusal force (horizontal plane)

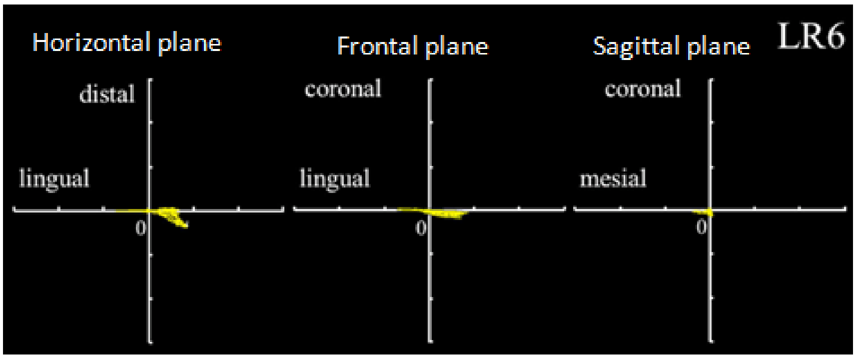


Fig. 4-4-7 The displaced state of the implant prosthesis to the mandibular first molar at the time of chewing Pretz. The displacement pathway of implant with chewing Pretz (50 μm per meniscus)

B. Effect of connective support

The effect of connecting the superstructures in the form of a bridge to the degree in the displacement of the tooth during its function is a factor worth investigating in the clinical setting for the success of the bridge prosthesis. The degree of displacement when three maxillary teeth, the second premolar, the first and the second molars were connected together is shown in Fig. 4-4-8. The connections were made to the buccal and lingual plates with gold-platinum alloy in such a way that it would not affect the occlusal relationship or the relationship with the adjacent teeth, and attached with cement.

In comparing the physiological displacement pathway of natural teeth and the pathway after the connection had been made, most shifts were made within that of the physiological distribution, with the maximum difference of 20 μm before and after the linkage. In combining this finding with the movement threshold of periodontal membrane or with the level of accuracy required for occlusion in the stomatognathic system, the maximum difference of 20 μm was within the acceptable range of the periodontal tissue movement. This suggested that the structure of periodontal tissues is not affected to a significant extent when connecting abutment teeth that display a similar displacement pathway, such as with the molars or the frontal teeth with structures such as bridge prosthetics.

However, both functional displacement pathways and the degree of displacement of implant and natural teeth vary. Thus, as mentioned previously, these two should not be connected together. Having said that, the rapid bonding of the AQB implants with the recrystallized HA coating enables firm stability to be established, therefore considering the technical operation and the accuracy of the fit, the linkage of the implants with the superstructures for AQB implants are not necessarily required.

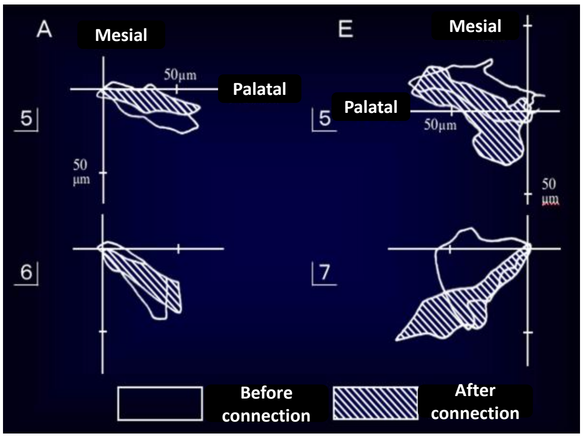


Fig. 4-4-8 The displacement pathway before and after connecting the superstructure in comparison to the physiological displacement range [5]

II. Maintenance of implant superstructure and fixation method

The maintenance and fixation methods for superstructure can be divided into the cement bonding and screw fixing. Each has their pros and cons, and therefore the final superstructure design should be decided having considered the following factors: intraoral state, esthetics, mechanical stability, degree of freedom in the design, and effects to and the maintenance of the soft tissues.

A. Pros and cons to cement bonding

The bonding method for the superstructure (crown, bridge) attachment to the implant body should be conducted in accordance with the usual method. The significant advantage of this method is that there is no need for an access hole to be created to enable loosening or tightening of the screws, therefore the esthetics similar to that with the natural teeth can be achieved and with more freedom in the design of the final structure. Additionally, the technical operation is simple as with the natural teeth; reduction in the cost; and the strength of the porcelain facing portion can be retained because of the absence of the access hole.

This method has often been employed by the main implant types. AQB implant also employs this method for the maintenance of the superstructure and for fixture.

Problems arise if the cement is left in the subgingival margin or the fit is inaccurate, by causing periodontal tissues inflammation.

B. Pros and cons to screw fixing

An alternative method is with fixing the superstructure to the implant body with a screw, and is further divided into a type that screws from the occlusal plane to the longitudinal plane of the implant (occlusal screw) and one in which the screw is applied to the lateral side of the abutment (mainly to the lingual side) (Horizon screw).

The maintenance strength of the horizontal screw is relatively weak as it is not screwed onto the longitudinal plane of the implant body. Although the technical operation is relatively complicated, the absence of the access hole of the screw on the occlusal plane means that the esthetics can be retained therefore it has often been applied in the frontal to premolar regions of the teeth.

The major advantage of the screw type is that the superstructure can easily be removed by the surgeon at any time, if necessary. By adopting the coping technique to achieve high accuracy in the fit, the edge of the superstructure can be placed into the subgingival margin without causing any complications on the periodontal tissues.

The disadvantages are that the esthetics cannot always be achieved with the presence of the access hole at some of the locations. Others include a slight displacement in the fit or overload can easily result in the loosening of the screw or fracture. There is also an increased risk of fracture if an access hole is located in the porcelain facing region.

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