**Clinical significance**
This report describes a new form of Suginaka Riegel® denture. It provides latch effect-derived retention through preparation of the rest seat and guide plane alignment in the abutment (clasped) tooth, eliminating the need for a retentive projection or elastic clasps.

**Abstract**

**Purpose:** The riegel and swing-lock® attachments are excellent retainers in terms of secure retention, but the former requires a great volume of abutment tooth reduction and the latter has problems with aesthetics and abrasion. In contrast, the RPI and RPA clasps have been highly appreciated as excellent retainers for abutment tooth protection, but any retentive forces are needed. Thus, the purpose of the study is to design a retainer that made the use of these merits.

**Methods:** The form of the retainer (named Suginaka Riegel® lock retainer) for this purpose is based on the RPPA, for which a lingual arm is provided. In applying this technique, the buccal arm corresponding to the Akers-type buccal arm in the RPPA utilizes the undercut area below the survey line, ranging from the distal to the mesial corner. This buccal arm extends from the metal tooth that turns the hinge placed in the buccal denture border. The Suginaka Riegel® device placed in the denture base locks the metal tooth in place.

**Results:** Utilizing the deeper undercut below the survey line provides secure retention while eliminating the risk of adverse forces being exerted on the abutment tooth during denture function or insertion and removal.

**Conclusion:** This new, additional form of the Suginaka Riegel® lock denture allows the abutment tooth to provide latch effect-derived retention solely by preparation of the rest seat and guide plane. This allows use on a healthy tooth and on a tooth for which prosthetic treatment has already been completed.

**Key words:** Riegel attachment, RPA, RPPA, Swing-Lock® attachment

**Introduction**
The retainers in partial dentures have a significant effect on the abutment tooth according to the retentive mechanism.

For the riegel precision attachments¹ that use the latch principle without the use of retentive forces, a great volume of abutment tooth reduction is required and commonly the abutment tooth is essentially a pulpless tooth. Even with the Suginaka Riegel® attachment² that simplified the dental prosthetic laboratory procedure of conventional riegel attachments, the restoration must be established on the abutment tooth. And, at least, a Class II inlay is required³ to fabricate the restoration with minimal tooth reduction.

The alternative that uses the latch principle of locking without the use of retentive forces includes Swing-Lock® attachments.⁴ Swing-Lock® dentures have a major advantage of allowing use of the residual teeth “as is” without a need to prepare the abutment tooth except for the rest seat. However, they present the aesthetic disadvantages of labially showing many minor connections and also present a problem of labial and buccal tooth wear due to the minor connection.

In contrast, the RPI clasp designed by Krol⁵ and Kratovil et al.⁶ has been recognized to be rationally designed, and highly appreciated clinically with the RPA clasp.⁷ It has been suggested that the modified techniques of the RPPI and RPPA clasps⁸ that enhanced the connecting rigidity⁹,¹⁰ between the abutment tooth and the denture better control denture mobility. However, even if these are used to reduce retention, any retentive forces are needed.

Thus, the purpose of the study was to design a denture with the retainer that allows use of the residual teeth “as is,” obtainingment of denture retention through the latch effect without need for a
Methods

The denture that has both mechanisms of RPPA and swing-lock® dentures serves this purpose. This denture could be designed through the use of the Suginaka Riegel® attachment and was named the Suginaka Riegel® lock denture (Fig. 1).

The Sugiaka Riegel® lock retainer that made the use of both merits of the RPPA clasp and the swing-lock® attachment is morphologically based on the RPPA (Fig. 2). However, although wide mesial and distal guide planes are prepared in the RPPA, the tooth substance cannot be reduced as much as needed for RPPA when the abutment tooth is sound. Consequently, in the Suginaka Riegel® lock retainer, the guide planes are prepared as much as possible and the lingual arm is used to increase the bracing area. When both guide planes can be sufficiently prepared, no lingual arm is needed.

When the premolar is used as an abutment tooth, a rest is prepared at the mesial marginal ridge. The minor connector linked to this rest is aligned to make contact with the guide plane prepared on the mesial surface of the abutment tooth.

The lingual arm is placed from this minor connector to the lingual distal proximal corner. When unilateral free-end missing teeth are unilaterally restored, this lingual arm is placed in the undercut area below the survey line. However, for bilateral free-end dentures, the lingual arm is placed on the survey line because the undercut area below the survey line cannot be used. The guide plane is also prepared on the distal surface in parallel with the mesial guide plane (Fig. 3).

The buccal arm in the RPPA is placed so that its clasp arm runs on the survey line from its origin and the clasp tip runs within the undercut area below the survey line and is primarily assembled with wire clasps. For the Suginaka Riegel® lock retainer, the buccal arm is placed both on the survey line and in the undercut area below that, and can be assembled with both wire and cast clasps. The buccal arm passes through the intersection of the facial contour ridge (FCR) and the survey line. The mesial and distal halves of the arm are placed in the undercut area below the survey line. Naturally, the arm must not contact the gingiva or tooth root due to the use of deeper undercuts (Fig. 4).

When the unilateral free-end missing tooth is unilaterally restored, the lingual arm is placed below the survey line. However, for a cross-arch splint in unilateral free-end dentures or bilateral free-end dentures, the lingual arm cannot be placed below the survey line, so it is placed on the survey line.
Of course, dentures that utilize a deep undercut can neither be easily inserted nor easily removed. To resolve this, the buccal arm may be placed from the lateral direction. A hinge is placed in the denture border that corresponds to the placement position of the metal tooth. The buccal arm is joined to the metal tooth that turns around the hinge. Then, to fix the buccal arm and the metal tooth in place, a slot that can contain the retentive section of the Suginaka Riegel® attachment is placed into the internal surface of the metal tooth. Thus, the metal tooth that turns around the hinge is locked by the Suginaka Riegel® mechanism placed in the denture plate (Fig. 5).

Due to differences in the residual ridge form, as the position of the hinge to be placed at the mucobuccal fold gets close to being below the position of the Suginaka Riegel® mechanism to be placed, the tangent to the turning direction of the metal tooth gets closer to the direction of the Suginaka Riegel® device to be placed. This could cause the metal tooth to turn, detaching from the retentive area of the Suginaka Riegel® device, even with the hook closed. To avoid this, the Suginaka Riegel® device should be placed so that the occlusal direction with the hook’s angulation is inclined between 5 and 10 degrees of being parallel to the occlusal surface (Fig. 6).

The denture can be removed through opening the hook of the Suginaka Riegel® attachment and turning the metal tooth to separate the buccal arm from the tooth surface. The denture can be inserted through the following procedures: First, the hook of the Suginaka Riegel® device is opened to turn the metal tooth buccally approximately 90 degrees. Second, the denture is inserted through fitting the minor connector, the lingual arm, and the proximal plate along the abutment tooth. While the denture is in position, the metal tooth is turned to be in a corresponding position allowing alignment of the hook. Then, the hook is closed to lock the metal tooth to prevent it from opening.

When the canine is used as an abutment tooth, it is frequently difficult to prepare the mesial guide plane depending upon the condition of its eruption, so the rest seat is prepared using the special form. For the canine, it is common not to use a lingual arm; however, use of a lingual arm to enhance the bracing effect is an option. The guide plane on the distal proximal surface is prepared lingual to the center of the proximal surface (Fig. 7).

The mesial surface of the canine may become a horizontal undercut for the buccal arm. In such a case, a wire clasp is used rather than a cast clasp.

**Comparison with the conventional method**

Because these precision retainers, either riegel attachments or Suginaka Riegel® attachments, require a retentive projection, some restoration is needed on the abutment tooth. The Suginaka Riegel® lock retainer can achieve its aim through preparing a rest seat and guide plane only, with-
out needing such a restoration. In the field of adhesive dentistry, the concept of Minimal Intervention (MI)¹ aims at restoration while as much as possible avoiding reduction of the healthy tooth. For various prostheses in accordance with the MI concept, clasp dentures are the most reasonable and least likely to be defective, except for implants. The RPI is a reasonable choice under the concept of minimal coverage¹² without covering the crown and gingiva so much as to significantly increase the risk of caries and periodontal diseases. However, in the Suginaka Riegel® lock retainer, when the abutment tooth is sound, because the proximal guide plane required for the RPPA clasp cannot be prepared, the lingual arm is needed to obtain the bracing effect.

Since the retention of clasps commonly utilizes the undercut area below the survey line with its own elasticity, the undercut amount is defined. Consequently, the precise undercut amount must be determined. The Suginaka Riegel® lock retainer does not have to consider the elasticity of clasps and the undercut amount because it instead uses the latch principle of locking. Though Swing-Lock® attachments also adopt this technique, they present the aesthetic disadvantages of showing many minor connectors and also present a problem of tooth wear due to the minor connectors. In terms of aesthetics, when the minor connector is replaced with the veneer-type connector, the neck of the abutment teeth (clasped teeth) and the gingival margin are covered, increasing the likelihood those tooth necks will develop problems because of being prone to become unclear. For Swing-Lock® attachments, while ready-made hinges and latches would be primarily used, the hinge used in the Suginaka Riegel® lock retainer can be made by hand without special machinery and appliances.

Effect
For clasps, the available undercut amount below the survey line is limited. However, the Suginaka Riegel® lock retainer can utilize the deeper undercut, so the same latch effect achieved by riegel attachments using a retentive projection can be exerted to obtain secure retention. The buccal arm holds the abutment tooth cervically, so that the Suginaka Riegel® lock retainer can control rotating and rocking of the denture. This allows the use of riegel attachments in cases of bilateral free-end missing teeth as well as unilateral restoration of unilateral free-end missing teeth.

In insertion of the denture, it seems very difficult to insert the unilateral free-end denture restored unilaterally through holding the lingual arm only by hand. Consequently, the patient should be provided with guidance on how to insert the denture using the model. To facilitate holding the denture, the resin plate is mesially extended from the minor connector during practice insertion of the denture. After the patient becomes accustomed to insertion of the denture, the extended plate can be removed. Because the buccal arm runs close to the gingival margin, the patient should be instructed to carefully clean this area.

Conclusion
The Suginaka Riegel® lock retainer described in this paper utilizes a deeper undercut below the survey line without a retentive projection. It can be applied in both healthy teeth and already re-
stored teeth with minimal abutment tooth reduction. With the Suginaka Riegel® lock retainer, secure retention can be obtained through the latch effect with the same stability of locking as the riegel attachment that uses a retentive projection.

References