

Removable appliances

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Objectives

- Understand the various types available of removable appliances which are available
- Explain how a removable appliance applies force to the teeth
- Understand how to design a removable appliance

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History

- Removable appliances began to be used routinely in the 19th century.
- Modern removable appliances generally use acrylic baseplates and stainless steel wires.
- With the development by Adams of the modified arrowhead clasp (1950) the scope and efficiency of these appliances was greatly increased.
- Unfortunately, they often represented the only available method of treatment and, as a result, were commonly used to treat a wide range of malocclusions for which they were inadequate and unsuited.

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- In some areas of clinical activity, removable appliances have significant advantages over fixed appliances.
- A well-constructed maxillary removable appliance can be highly conservative of anchorage.
- Intraoral anchorage is not only provided by the teeth themselves but also supplemented by the contact of the acrylic baseplate with the palatal vault.
- This is particularly useful where it is necessary to achieve occlusal movement of misplaced or impacted teeth, for example in the correction of unerupted incisors and canines.

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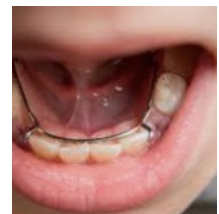
Action of removable appliances

- Spontaneous movement
- Where extractions are carried out as part of treatment, the relief of crowding may, on its own, allow neighbouring teeth to upright towards the extraction sites.
- Removable appliances can enhance such tooth movement and treatment depends principally upon the ability of the active components of the appliance to tip teeth.
- In many cases, spontaneous tooth movement can be relied upon to assist alignment and this may be particularly important in the lower arch, where removable appliances are bulky and are less efficient.

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Eruption guidance

- In the late mixed dentition stage, appropriate extractions allow an enhanced path of eruption for crowded or misplaced teeth.
- Removable appliances have an important role to play as space maintainers, following relief of crowding.



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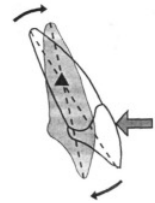
Uprighting

- When crowding is relieved a tooth may upright by movement of the crown towards an adjacent extraction space.
- This is commonly associated with crowding of canines and works most effectively when inclined because uprighting can take place towards the first premolar extraction sites.
- In the lower arch this can be particularly beneficial.

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Active movements

- Tipping
- Removable appliances act by applying controlled forces to the crowns of the teeth. Because only single-point contact is possible, tooth movement occurs solely by tipping.
- The fulcrum will usually be about 40% down the length of the root from the apex.
- By applying forces of 25-50 g, tipping can be achieved with the crown moving by about 1 mm per month.
- Active removable appliances should be used only where the teeth can be tipped into their correct positions. Tipping can either be in a mesio-distal direction (in the line of the arch) or in a buccopalatal direction.



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Mesio-distal tipping

- Teeth can be tipped towards a space, usually one which has been created by extraction to relieve crowding.
- Where a tooth is mesially inclined it can be readily tipped and uprighted.
- The commonest example of such tooth movement is provided by the retraction of canines.
- Upright or distally inclined canines will become more distally inclined as the result of tipping with a removable appliance.

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Bucco-lingual tipping

- Bucco-lingual movement of incisors can be carried out readily, but in the lower arch, the labio-lingual position of the incisors is normally accepted.
- Movement should only be sufficient to compensate for crowding of the lower incisors and deliberate proclination of the lower labial segment is highly likely to relapse.
- In the upper arch, tipping of the upper incisors can readily be accomplished with a removable appliance.
- The essential criterion must be the position of the apices of the incisors, which will only alter slightly when tipping takes place

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Components of removable appliances

- A – anchorage
- R – retention
- A – active
- B – baseplate
- The removable appliance needs to have:
 - retention (to make sure the appliance is held in place), e.g. clasps/cribs
 - parts to move the teeth, e.g. springs or screws
 - a baseplate that fits around the teeth securely and carries all the metal components and also provides anchorage

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Mechanics of springs

- Most orthodontic springs are variants of the simple cantilever.
- For a round wire, the force generated by a small deflection within its elastic limit depends on the deflection, the cross sectional area of the wire and the length: $F = d^3c/l$
- The cross-sectional area of the wire is especially significant.
- Doubling the wire diameter increases the force 16 times and even using a wire of 0.7 mm rather than 0.5 mm diameter doubles the force for a given deflection.

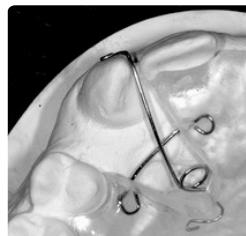
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Force

- For a single-rooted tooth, a spring should deliver a force in the range of 25-40 g (the lower forces being indicated for teeth with short roots, such as lateral incisors).
- Very light forces may lie below the threshold for a reasonable rate of tooth movement.
- Excessive forces delay tooth movement, overload anchorage and may cause discomfort to the patient.

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Palatal finger springs



- Palatal finger springs are constructed in 0.5- or 0.6-mm stainless steel wire and used to move teeth mesially or distally along the dental arch.
- The incorporation of a helix increases the length of the wire and allows the delivery of lighter forces whilst a guard wire will protect the spring from distortion.

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Single cantilever spring (finger spring)

- This spring may be used to move teeth labially or in the line of the arch. It is normally constructed from 0.5 mm hard stainless steel wire.
- Some operators prefer to use 0.6 mm wire and activate the spring by a smaller amount (50% of the deflection will give about the same force).
- A coil is incorporated into the spring close to its emergence from the baseplate. This increases the length of wire and thus the flexibility of the spring.

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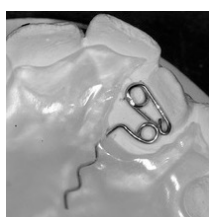
Adjustment

- A palatal spring is simple to adjust.
- Use a dental mirror with the appliance in place to check that the spring contacts the tooth correctly and lies close to the gingival margin.
- At the time of fitting slight activation of no more than 1-2 mm is advisable, but at subsequent visits an adjustment of 3 mm is appropriate.
- The spring should not be bent where it emerges from the baseplate - this is a site of stress concentration and if the wire is further work-hardened by bending then fracture may occur.
- The correct site of adjustment is in the free arm of the spring as close to the coil as possible. In cases where the direction of the spring has to be corrected to achieve the intended direction of movement adjustment may be carried out further from the coil.

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Double cantilever spring ('Z' spring)

- In some situations, particularly where an incisor is to be proclined, space for a single cantilever spring is limited.
- In these circumstances, a double cantilever, or 'Z' spring (0.5 mm wire) can be used.
- It is important that the limbs are as long as possible, otherwise these springs can be rather stiff. If the limbs of the spring are short, the range of adjustment is limited and the patient may find the appliance difficult to insert.
- The spring should be perpendicular to the palatal surface of the tooth; otherwise it will tend to slide incisally and to intrude the tooth.
- If a lateral incisor is to be proclined and space is very short it may be permissible to construct a 'Z' spring in 0.35 mm wire.



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Adjustment

- Adjustment can be carried out to the palatal limb first - close to the coil at the fixed end of the spring to establish the degree of activation - then at the other end of the limb to keep the free limb perpendicular to the intended direction of movement of the tooth.
- It is often possible to activate the spring in a single movement by grasping its outer arm in the beaks of the pliers and pulling it gently forward and away from the acrylic baseplate.

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'T' spring

- Where a premolar, or sometimes a canine, is to be moved buccally, the patient may find insertion of the appliance very difficult if a single or double cantilever spring is used.
- A 'T' spring made from 0.5 mm wire, can cantilever spring but, as both ends of the spring are incorporated into the acrylic, the flexibility is correspondingly reduced.
- Fortunately, a large deflection is not indicated in this situation, otherwise the patient may have problems in inserting even this type of spring.
- It must be recognized that the force applied by the spring has a vertical, as well as a horizontal component much simpler to manage.



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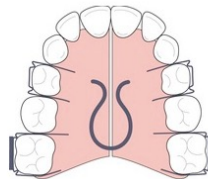
Adjustment

- The spring is adjusted by pulling it away from the baseplate.
- Provided that it is only adjusted by a small amount it should seat itself correctly when the patient inserts the appliance.
- Once the tooth has moved some distance, it may be necessary to elongate the spring at the adjustment loops.

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Coffin spring

- This is a strong spring made of a thick gauge wire (1.25 mm) and is used for transverse arch expansion, for example to treat a unilateral crossbite with lateral mandibular displacement.
- It has the advantage over a screw that differential expansion can be obtained in the premolar and molar regions, but the appliance tends to be unstable unless it is expertly made and adjusted.



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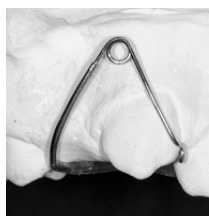
Buccal springs

- These springs can be used for mesio-distal tooth movements, palatal tooth movement and, in conjunction with some form of bonded attachment to a tooth, occlusal movement, rotation or buccal movement.
- Care needs to be taken during construction so that they do not intrude too deeply into the buccal sulcus.
- Instructing the patient on how to remove the appliance should specifically address the ease with which the buccal springs may be distorted.

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Buccal canine retractor

- A buccal spring is used where a buccally placed canine has to be moved palatally as well as distally - an operation for which a palatal spring is not satisfactory.
- Buccal springs are liable to be uncomfortable (which can make them unpopular with patients).
- They are relatively unstable in the vertical dimension which can make them difficult to adjust, because if the spring acts on a sloping surface, it will tend to slide along the incline.
- An unsupported buccal spring has to be constructed from 0.7 mm wire to provide stability and will be much less flexible than a palatal spring, so that a small deflection generates a large force.



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Adjustment

- The spring should be activated by only 1 mm, otherwise the force will be excessive. Provided that it has been constructed to contact the tooth correctly, adjustment is simple.
- Distal activation is effected at the coil by bending the anterior limb over the round beak of a pair of spring-forming pliers.
- Palatal activation is undertaken in the anterior limb after it emerges from the coil.
- When the appliance is inserted, the spring may catch on the cuspal incline of the canine and the patient should be instructed to check and correct this if necessary.

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Bows

- Bows may be active or passive and will usually span a number of teeth. Both ends of the bow are incorporated in the acrylic.
- Active bows are used for incisor retraction.
- The bow selected will depend partly on the preference of the operator and partly on the amount of retraction required.
- Flexible bows, such as the Roberts' retractor, are most suitable where a large overjet has to be reduced.
- When the amount of retraction is small but minor irregularities need to be corrected (and perhaps over-corrected) a less flexible bow may be preferred because it is more precise in its action and needs only a small amount of activation.



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Roberts' retractor

- This is a flexible bow that is constructed from 0.5 mm diameter wire inserted into stainless steel tubing to give support at either end of the bow.
- A coil is placed at the point of emergence of the wire from the tubing. The tubing emerges from the baseplate distal to the canines.
- The horizontal section of the bow is bent into the smooth curve to which the incisors should conform.
- The flexibility of this bow lies in the vertical limbs and coils that should be of adequate size (at least 3 mm in internal diameter).



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Adjustment

- This bow is light and flexible.
- An adjustment of about 3 mm is suitable but the site is very important because if the wire is bent where it emerges from the supporting tube (a site of stress concentration) it will often fracture.
- The bow is adjusted by bending it in the vertical limb below the coil. Provided that the spring has been carefully made and adjusted correctly, fracture is rare.
- As the incisors move palatally, the bow will drop anteriorly and the level of the horizontal part will have to be adjusted.

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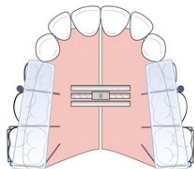
Appliance retention

- Appliance retention is provided by wires, in the form of clasps and bows.
- Good retention is essential if treatment is to proceed efficiently and needs to be planned carefully.

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Screws

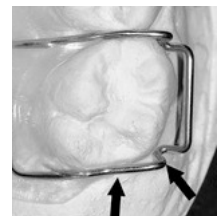
- Screws can be embedded into the baseplate of an appliance and activated by the patient progressively turning a key.
- Screws can be effective for expansion to correct a posterior dental crossbite, or for distal movement of the buccal segments, often supported by headgear.
- Each quarter turn of the screw activates it by approximately 0.25mm.



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The Adams' clasp

- This clasp, like most others, is made from 0.7 mm stainless steel wire.
- It engages the mesiobuccal and disto-buccal undercuts that can be found on the crown of almost every tooth.
- A depth of undercut of about 0.25 mm is ideal.
- The model must be carefully trimmed to reproduce the anatomical contour of the crown so that when the appliance is constructed, the clasps engage the undercuts snugly.



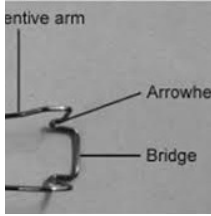
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Adams clasp is made up of 3 parts:

- Two arrowheads
- Bridge
- Two retentive arms

The arrow heads engage undercuts at the mesial and distal corners of the buccal tooth surface and can easily be adjusted chairside to increase retention

The bridge can be used by the patient to remove the appliance from the mouth



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Advantages of the Adams' clasp

- Its bridge provides a site to which the patient can apply pressure with the fingertips during removal of the appliance
- Auxiliary springs can be soldered to the bridge of the clasp
- Hooks can be soldered to the clasp or bent in during its construction to accept intermaxillary traction
- Tubes can be soldered to the bridge of the clasp to accommodate a facebow for extraoral traction

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Adjustment of the Adams' clasp

- When the appliance is seated a clasp should be nearly passive.
- Active clasps can exert a palatal force on the teeth, so that if the appliance does not seat fully they will tend to be tipped under the depth of the undercut.
- Further tightening, in an attempt to improve retention, produces further tooth movement, which makes the situation worse. It is even possible to create a crossbite, which can only be corrected by the use of an additional appliance.
- Such problems are liable to occur where retention was initially poor due to faulty appliance design and construction, sometimes compounded by an awkward crown form.
- It can be avoided only by careful scrutiny and trimming of the model, thoughtful clasp placement and careful routine adjustment.

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The ball-ended clasp

- This uses the undercut provided by the embrasure and provides effective retention.
- The use of the embrasure is not generally desirable because of the danger of gingival damage and tooth separation, but the clasp may occasionally be of use when deciduous teeth must be used for retention.



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The Southend clasp

- The Southend clasp is easy to construct, unobtrusive and well tolerated.
- The wire passes round the gingival margin of the central incisors and engages undercut between the incisors.
- It is the preferred anterior clasp, particularly if the incisors are proclined and can be modified to fit between a central and lateral incisor. Breakage is relatively uncommon.



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Plint clasp

- Plint clasps are useful when using a removable appliance in combination with a fixed appliance.
- These clasps are constructed in 0.7-mm stainless steel and engage the undercuts on a maxillary molar band.



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The baseplate

- The acrylic baseplate constitutes the body of the removable appliance.
- It has three functions: it provides a foundation, which supports other components such as springs and clasps;
- it contributes to anchorage through its contact with the palatal vault and teeth that are not being moved; and
- it may be built up into bite planes to disengage the occlusion or produce overbite reduction.

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- Acrylic Orthodontic appliance baseplates are generally manufactured from cold-cured acrylic.
- It is economical in terms of laboratory-time and warpage is less than with heat-cured acrylic.
- It does, however, have more free monomer present after curing and the appliance is less strong.
- The extra expense of a heat-cured appliance may be justified where breakage is liable to be a problem.
- Examples might be the presence of a deep overbite and very heavy occlusal forces, the need for shallow but strong posterior bite planes and the situation in which a prosthetic tooth must be added to an orthodontic appliance.

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Anchorage considerations

- In order to obtain maximum anchorage the acrylic should cover most of the palatal mucosa, finishing distal to the first molars, although it may include the second molars if they have erupted fully.
- The acrylic should contact all the teeth in the arch with the exception of those that will be moved.
- Where screws are to be used, consideration must be given to the position of the split of the appliance and its influence on the number of teeth to be moved.

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Bite planes

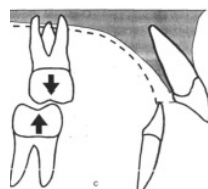
- The acrylic of the baseplate may be thickened anteriorly to provide an anterior bite plane or extended to cover the posterior teeth to form a posterior bite plane.
- Careful thought about the design and construction of a bite plane can save considerable chairside time later.



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Anterior bite plane

- The principal use of anterior bite planes is in the reduction of overbite.
- This occurs primarily by alteration in the rate of eruption of the posterior teeth relative to the eruption of the lower incisors that are in contact with the bite plane.
- Overbite reduction by this method is most successful in an actively growing patient.
- In an adult, overbite reduction can sometimes be successfully achieved using a biteplate, but the amount of overbite reduction that can be obtained is less than that for a child patient, takes time to achieve and may not remain stable.



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Initial fitting of the appliance

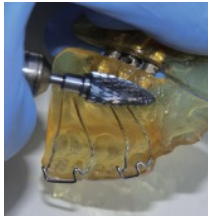
- Removable appliances should ideally be fitted within 2 weeks of the impressions being taken.
- Provided that no tooth movement has occurred in the meantime, the baseplate should fit without adjustment.
- If this is not the case any trimming should be done with care and should be carried out from the fitting surface, because small gaps between the baseplate and the teeth encourage food packing.
- If there is any difficulty in seating the appliance it may be best to bend the clasps gently away from the teeth to check whether the resistance is from the baseplate or from the wires.
- If there are undercuts, the acrylic should be carefully trimmed from them without touching the edge of the polished surface of the appliance so that this still contacts the teeth.
- Once the appliance can be fitted, it should be examined in the mouth to ensure that the acrylic is clear of the teeth that are to be moved.
- The appliance should be removed and retried if necessary to ensure that there is no interference with the intended movement and that gingival hyperplasia will not be encouraged.

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- As with all laboratory-produced work, the following should be checked:
- That you have the correct appliance for that particular patient
- That the appliance has been made accurately to the prescription
- That there are no sharp spicules of acrylic on the fit surface or polished surfaces
- That the tag ends of the various wire components do not come through the acrylic on the fit surface
- That the active components, screws and springs move freely, and there are no spicules of acrylic preventing movement.

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- Spicules of acrylic or sharp wires can be trimmed using a straight handpiece with an acrylic-trimming bur



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- The appliance should be rotated into the patient's mouth, with the patient in the supine position.
- The appliance should be placed in position, then firmly seated with the tip of the finger against the palatal acrylic.
- A well-fitting appliance should elicit a click as it is seated in position and should not 'rock' when finger pressure is applied to each side of the baseplate.
- The retention of the appliance should be checked by trying to remove the appliance with downward pressure on the most posterior retentive components, usually Adams' clasps on the first permanent molars.
- A retentive device is one that requires firm finger pressure on the clasps to dislodge it. The patient should not be able to dislodge it with their tongue.

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- All retentive components should be checked to ensure that they are positioned so that they engage the undercuts supra-gingivally and do not impinge on the gingivae.
- This is especially the case for the arrowheads of the Adams' clasps.
- The baseplate should be checked for closeness of fit with the palate.
- The baseplate should also be checked to ensure that no acrylic will prevent the planned movement of teeth

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- If an anterior biteplane has been added to the appliance in order to reduce the overbite, then it is imperative that its height is sufficient to disengage the posterior occlusion by at least 2 mm.
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- It is also necessary to ensure that there is even contact between the lower incisor and canine teeth with the biteplane as, if only one or two teeth are in contact, the full occlusal force will be transmitted through these teeth.

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What if appliance doesn't fit

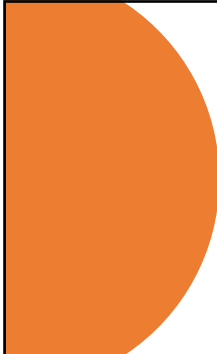
- Teeth have moved or erupted more since the impression was taken. This is more likely if there is a significant delay in fitting the appliance.
- The impression was distorted due to poor impression technique or being left too long under inappropriate conditions before being cast up.
- The appliance has been poorly made

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- In many cases where the appliance does not fit straight away, it is possible to adjust the appliance so that it fits or the fit becomes more acceptable.
- There are a series of steps that should be followed in order to determine the cause of the inadequate fit and how this can be rectified

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- 1. The active components should not be touched until the clinician has ensured that the appliance is a good fit. All removable appliances will be sent from the laboratory with the active components as yet unactivated.
- 2. The retentive components should be slackened so that there can be no hindrance to the fitting of the appliance by retentive components that are too tight.
- 3. If the appliance is still not seating adequately, then the cause is certain to be some aspect of the acrylic baseplate:

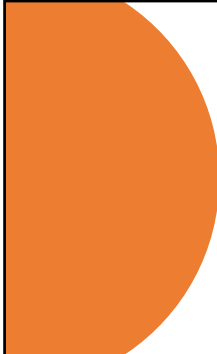
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Correct positioning of Adams clasp



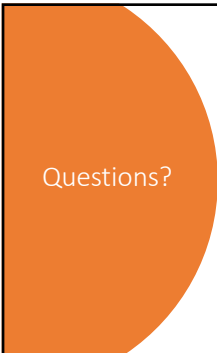
- The fly-overs should be as close to the contact points of the teeth as possible as they crossover from the palatal acrylic to the buccal aspect of the tooth.
- The bridge should lie approximately two-thirds of the distance from the gingival margin to the cusp tips, and there should be a gap of no more than 1.5 mm between the bridge and the buccal surface of the tooth.
- The arrowheads should be positioned in the undercuts just above the gingival margins on the mesio-buccal and disto-buccal aspects of the crown.

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- Once the position of all parts of the Adams' clasp has been checked, then the retention of the appliance should be re-checked.
- In theory, the correct positioning of the parts should ensure that the appliance has enough retention, but patient factors and the accuracy of the impression material need to be taken into account.

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Questions?

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