SOLDERS AND CONNECTORS IN FIXED PARTIAL DENTURES

INTRODUCTION:

Joining or fusion of metal or an alloy is required for assembling bridges in prosthodontics, for establishing esthetics and for uniting clasp to cast metal framework in removable prosthodontics.This is done using procedures like soldering,welding,brazing.

CONNECTORS:

Connectors are those parts of a fixed partial denture or splint that join the individual retainers and pontics together.Rigid connections in metal can be made by casting,soldering, or welding.Cast connectors are shaped in wax as part of a multiunit wax pattern.

Advantage:

Cast connectors are convenient and minimize the number of steps involved in the laboratory fabrication

Disadvantage:

Fit of the individual retainers may be affected.

SOLDER & CONNECTORS :

Solder is a fusible metal alloy used to unite the edges or surface of two pieces of metals

Soldered connectors involve the use of an intermediate metal alloy whose melting temperature is lower than that of the parent metal . The parts being joined are not melted during soldering but must be thoroughly wetted.In soldering metal parts are joined together by melting a filler particle between them at a temperature below the solidus temperature of metal being joined and below 450 degree

Welding: The connection is created by melting adjacent surfaces with heat or pressure. A filler metal whose melting temperature is about the same as that of the parent metal can be used during welding.

FACTORS TO BE CONSIDERED IN SOLDERING :

1.Type of soldering

2.Composition of solder

3.Composition of parent metal to be soldered

4.Flow temperature of filler metal or alloy

5.Ability of filler metal to wet the parent alloy

6.Adequate fluidity at the temperature of soldering

7.Gap distance between the metal or alloys to be united

8. Heat source used to obtain required temperature

9.Time

COMPONENTS OF SOLDER JOINT

1.Parent metal

2.Solder /filler metal

3.Fluxes & antifluxes

PARENT METAL:

The parent metal is the metal or alloy to be joined.This is also known as a substrate metal or base metal..The composition of parent metal determines-

1.Melting range

2.Oxide that forms on the surface during heating

3.Wettability of the substrate by the molten solder.

4.Soldering should take place below the solids temperature of the parent metal.

SOLDERING FLUX :

In Latin flux means “to flow”.Purpose of flux is to remove any oxide coating on the substrate metal surface when the filler metal is fluid and ready to flow into place.They protect the alloy surface from oxidation during soldering and dissolve metallic oxides as they are formed.The resulting solution of oxides or other matter in flux constitutes “slag”.

CLASSIFICATION OF FLUX

1.According to their primary purpose / activity

Surface protection type: - This type of flux covers the metal surface and prevents access to oxygen, so that no oxides can form.

Reducing agent type: - This type reduces any oxides present and exposes clean metal.

Solvent type: - This type dissolves any oxides and drives them away.

2.According to their composition

Borax fluxes

Fluoride fluxes

3.According to the pH of the flux

Acidic fluxes – SiO_2

Basic fluxes – CaO, lime $CaCO_3$ LIMESTONE

Neutral – Fluorspar ($Ca.F_2$),Borax ($Na_2B_4O_2$)

Fluxes are available in powder ,liquid and paste forms.Flux formula is ,

Borax glass(55 parts)

Basic acid(35 parts)

Silica(10 parts)

Fluroide flux:(dissolves stable oxides of Co,Cr,Ni)

Potassium fluoride:50%-60%

Boric acid:25%-35%

Borax glass:6%-8%

Potassium carbonate:8%-10%

*Soldering Antiflux :*Antiflux is used to limit the spreading of solder. It is placed on a casting before the flux application to limit the flow of molten solder.

Graphite

Iron oxide in chloroform

IDEAL QUALITIES OF SOLDER :

1. Corrosion resistant-It should have high fineness to resist corrosion

2. Lower fusing

3.Non pitting which can be obtained by increasing base metal in the solder and when solder is over heated

4.Strong –the hardness of solder decreases as the fineness increases(615 or 580 fineness is probably the lower limit of clinical acceptability.)

5.Free flowing-solder that melt at higher temperature have low surface tension and flow easily

6.Same color

7.Solders harden during cooling because of the "order disorder"transformation and the formation of other intermetallic phases, which occur at grain boundaries.Adhesion generated by the penetrations of solder into surface irregularities of the parent metal tends to hold the soldered interface

CLASSIFICATION OF SOLDERS :

I.According to the hardness:

1.Soft solders:Lead tin alloys with a low melting point

They have low fusion range of about 260°C or less. Soft solders lack corrosion resistance, so they are impractical for dental use

2.Hard solders:Dental gold solders,silver solders

II.According to the technique:

1.Free hand soldering-used in orthodontics

2.Investment soldering-used in bridges and restorations

GOLD SOLDERS : Has good tarnish and corrosion resistance.Extensively used for crown and bridge applications.

Composition:

1.Gold – 45-81 wt %

2.Silver - 8-30 wt %

3.Copper -7-20 wt % with small amounts of Tin, Zinc and Phosphorus to modify fusion temperature and flow qualities. They are high fusing with a fusion temperature range of 750- 900° C

SILVER SOLDERS : Used in orthodontic appliances.They have fusion temperature of 600-750°C.Used with stainless steel or other base metal alloys.

Composition:

1.Silver -10-80 %

2.Copper -15-30%

3.Zinc -4-35%

4.Small amounts of cadmium, tin and phosphorus.

Traditional gold solders are classified as ,

Group I-Preceramic solders

Group II-Post ceramic solders

Preceramic and post ceramic solders which are used before or after porcelain application

For FPDs consisting of metal-ceramic units, the soldered connectors may be made either before the ceramic application with high-fusing solder (approximately 1100° C, or 2012° F) or after the ceramic application with lower-fusing solder (750° C, or 1382° F). Soldering before ceramic application is called *preceramic application soldering* or *presoldering.*.Soldering of metal-ceramic crowns after their completion is referred to as *postsoldering.*

PRECERAMIC CERAMIC SOLDERING:

Preceramic solders-these are high fusing alloys,fusing only slightly beneath the softening point of parent alloy to be joined.Presolder melting range-1110-1127 degrees. This has the advantage of allowing the connected prosthesis to be tried in the mouth in the unglazed state. Any necessary adjustments can be made to the porcelain, which fuses at a lower temperature than the preceramic soldered connector.

A disadvantage results from having to apply the porcelain to a longer structure, which needs support during firing to prevent high-temperature deformation or sag. Sag can be a particular problem with the high-gold content ceramic alloys because they have a lower melting range. High palladium-content or base metal alloys exhibit little sag during firing. Presoldering requires a gas-oxygen torch.

POST CERAMIC SOLDERING:

Postceramic soldering is necessary when regular gold and metal-ceramic units are being combined in an FPD. The regular gold will melt if it is subjected to the high temperatures needed for porcelain application; therefore all porcelain adjustment and firing, including that for the final staining and glazing, must be completed before the soldering. If further corrective adjustment is needed after soldering, the porcelain will have to be polished, or the joint will have to be separated, after which additional porcelain can be added as needed, the restorations can be reglazed, a new index can be made, and the FPD can be resoldered.

Because the proximal areas are shaped before soldering, a postsoldered connector can often be made to look more natural than a presoldered or cast connector

SOLDERING TECHNIQUES :

The different techniques are,

Soldering all metal FPD:

Gold Alloy soldering

Soldering metal ceramic FPD:

Pre ceramic soldering

Post ceramic soldering

Soldering based on heat source:

Oven soldering

Torch soldering

GOLD ALLOY FIXED PARTIAL DENTURE SOLDERING :

ARMAMENTARIUM

1.Autopolymerizing acrylic resin

2.Zinc oxide-eugenol paste

3.Impression plaster

4.Mixing bowl

5.Spatula

6.Small brush

7.Waxing instrument

8.Sticky wax

9.Baseplate wax

10.Sprue wax

11.Soldering investment

12.Glass slab

13.Flux

14.Solder

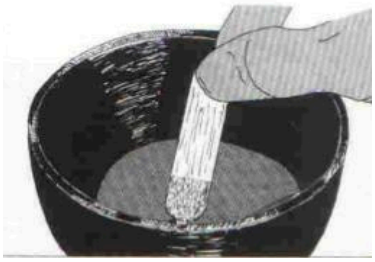
15.Tongs

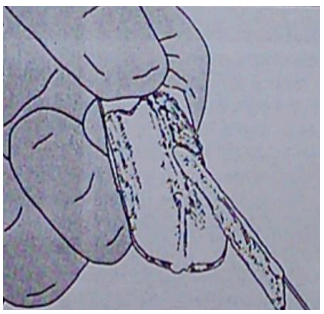
16.Pickling solution

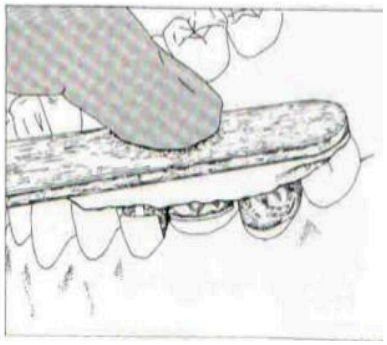
Remove the provisional restoration from the patient's mouth make certain that there are no temporary cement left on the tooth preparation. Try in the single retainer first and then retainer pontic combination, verify the marginal fit .Mix a small amount of fast setting impression plaster & place it on plastic index tray or thoroughly wet tongue depressor

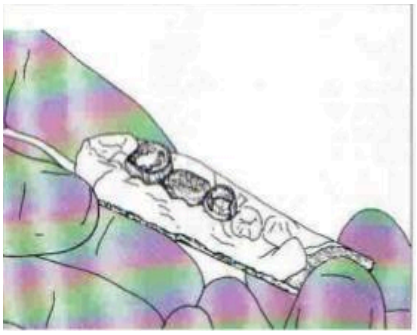
Once the plaster set, remove the template and check for the accuracy .Trim the excess plaster so that after seating the template, it is possible to cover their margins with soldering investment.lute the castings with the sticky wax. Gap width is measured using business card.Wells are cut along the edges of crown and pontic imprints to provide space for sticky wax

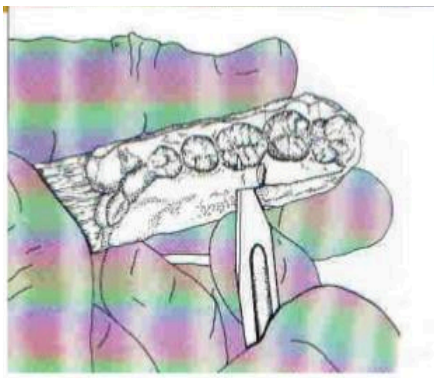
Sticky wax is used in the well to attach the FPD.A triangular shaped piece of utility wax is extended facially and lingually from the solder joint area. A strip of boxing wax 2.5cm wide is wrapped around the index .Investment is brushed into the retainers.Once the investment has set ,the strip of boxing wax is removed from the index .The index is separated from the block of investment .Buccal and lingual notches are carved in the investment .Flux is placed in the solder joint area .The investment casting is preheated over a Fisher burner for 10-15mins.The flame is directed against the investment from all sides .Solder is placed into the lingual notch .When the solder in the joint appears to “roll”,the flame is taken away.











METAL CERAMIC ALLOY SOLDERING:

PRE CERAMIC SOLDERING :

Once the metal ceramic framework has been assembled by pre-ceramic application soldering,the subsequent procedures are the same as if it had been cast in one piece.

*Advantage :*It allows the connected prosthesis to be tried in the mouth in the unglazed state and any necessary adjustments made in porcelain

Disadvantages :

1.It is necessary to apply porcelain to a longer structure which needs support during firing

2.Single piece FPD casting with right canine and left lateral incisors retainers with unattached canine retainer

3.Alignment of surface to be joined

4.Crown to be joined by soldering are attached with autopolymerising acrylic resin

5.Quick setting plaster index made in the mouth

POST CERAMIC ALLOY SOLDERING :

This application is necessary when regular gold and metal ceramic units are being combined in an FPD.Proximal areas are shaped before sodering ,a post soldered connector are made to look natural than a presoldered connector.

ARMAMENTARIUM

1. Autopolymerizing acrylic resin
2. Zinc oxide-eugenol paste
3. Impression plaster
4. Mixing bowl
5. Spatula
6. Small brush
7. Waxing instrument
8. Sticky wax
9. Baseplate wax
10. Sprue wax
11. Soldering investment
12. Glass slab

13. Flux
14. Solder
15. Tongs
16. Pickling solution

OCCLUSAL SOLDERING INDEX :

Grind the connector surface of finished castings .Seat the castings.Post ceramic application joints are indexed.Make an impression plaster registration

INVESTING:

Seat each casting into the index and lute it with sticky wax.Flow wax in to the connector area.To create a space that will help the solder spread ,adapt sprue wax gingival to the solder joint .Box the assembly with a suitable sheet of wax.Investing is done. Allow the investment block to bench set prior to preheating

AUTOPOLYMERISING RESIN SOLDERING INDEX :

A plaster or ZOE occlusal index is less suitable for the registration of anterior restorations. The thinness of the incisal edges of these units makes them less stable, and accurate repositioning is more difficult.Auto polymerizing resin is recommended where the units are joined together with auto polymerizing resin. Apply the resin with a bead technique .Warm a sheet of wax and push the cervical aspect of the restorations through it. Then seal it along the axial wall with a warmed instrument. This will protect the porcelain from contact

with the soldering investment. Fill the castings with soldering investment Seat the restorations on the patty.

WAX REMOVAL AND PREHEATING :If a plaster or ZOE index was used, remove it after the investment has fully set. Flow a little flux into the joint space while the soldering block is still warm from wax removal. This will prevent small particles from falling into the gap.

Preheat the investment in a burnout furnace to 650' C (for low-heat soldering) or 850' C (for preceramic soldering)Acrylic resin indexes are removed by heating slowly to 300' C (5720 F) A small amount of soldering flux is added in the connector area by capillary action.Placed in the burn out furnace

TORCH SOLDERING :

An oxygen-gas or an air-gas torch is the preferred means of applying heat for dental soldering procedures because,

(1) Access and visibility are maximal throughout the procedure

(2) Laboratory technician can apply heat differentially to the work.

3) Oxidation and reduction reactions can be controlled directly

(4) Heat can be removed immediately after solder flow

(5) The addition of solder to the partially completed joint can be made readily.

Disadvantages :

(1) The uneven distribution of heat created during soldering can warp or damage portions of the prosthesis

(2)Overall control of temperature is imprecise

(3) Pressurized supply of the necessary gases must be available.

TORCH SOLDERING(Low Heat) : Transfer the assembly to a soldering stand with a Bunsen flame underneath and place a piece of solder above the gap .Adjust the gas-air torch give a sharp blue cone and then reduce the air for a softer "brush" flame. The reducing zone of the flame is used to heat the investment block. Heat evenly and slowly, moving the tip of the flame constantly. When the solder "spins" in the joint, remove the flame

TORCH SOLDERING(high heat) :

Wear dark glasses for eye protection . Gas-oxygen torches for high-heat preceramic soldering use a miniature needle tip so that the flame can be pinpointed on the joint space .Place the solder above the gap and concentrate the reducing zone of the flame on the joint space .When the solder melts, draw it into the joint and quickly "chase" it around with the flame .

OVEN SOLDERING :

Furnace or oven soldering is performed under air or vaccum .A piece of solder is placed in the joint space and the casting and solder are heated simultaneously.It does not allow the moment of solder fusion to be observed.Longer the solder remains molten,the more it will dissolve the parent metal and weaken the joint

INFRARED SOLDERING:

Infrared soldering can be used for low-fusing connectors as well as preceramic soldered joints. A specially designed unit that uses an infrared light as its heat source is used. The connector area of the soldering assembly must be positioned precisely relative to the focal point of the reflector that concentrates the heat. The operator observes the soldering procedure through a dark screen and cuts off the electrical supply when solder flow is observed. Good accuracy is possible with the system

LASER WELDING :

Laser welding is a welding technique making use of strong thermal effect of laser beam concentrated on a minute spot.Relative ease and time saving.Can be done directly on the cast.Less distortion ,higher strength,and reduced corossion .High cost and technique sensitive.It produces hazardous effect.

SPARK EROSION :

Spark erosion is a metal removal process using electric current under carefully controlled conditions.Also called electric discharge machining (EDM). It is a process by which, a metal is precisely contoured into a desired shape by erosion by using accurately controlled electric discharge through two conductive objects immersed in a liquid medium

1.A space is maintained between the electrode and work piece through out the machining process which is known as the cutting gap
2.As the voltage increases, the hydraulic ram brings the electrode nearer to the work piece
3.Ionization channel is established
4. Vapor cloud formation which gradually expands .When voltage at the cutting gap exceeds the reference voltage, the power gets cut off.This drastically reduces the temperature at the

cutting gap,triggering a collapse of the vapor bubble and generates a high energy spark.The eroded particles are flushed away by introduction of fresh di-electric fluid.

Advantage :

1.Passive fit of restorations is achieved.

2.An extremely thin work piece can be machined without distortion .There is decreased stress on the work piece due to the cooling action of the di-electric fluid.

3. Smooth finish of final restoration is ensured.

4.There is decreased oxidation of metals during the procedure.

5.It is rapid, efficient and accurate

6.Frameworks with porcelain can be spark eroded without any stress on the porcelain due to the cooling action of the di-electric fluid.

Disadvantage :

Skilled personnel and specialized lab equipment is mandatory.The high cost of the technique which limits its usage

PROBLEMS	**CAUSE**	**MANAGEMENT**
Soldered prosthesis	Prosthesis warped during soldering	Break joint,check fit,resolder

unable to reseat on tooth		
	Inaccurate plaster template technique	Break solder,relate template and joint
Inadequate joint size	Insufficient solder	Add solder to joint,break solder and rejoint
	Improper design for prosthesis	Remake prosthesis and resolder
Pitted joint	Insufficient gap Contamination Excess flux Over heating	Break joint,clear surface,rejoint
Solder flow outside the joint	Excess flux,no antiflux,improper heat application	Add solder to joint if needed and remove excess
Prosthesis melting	Inadequate metal thickness,margins inadequately protected by investment	Remake prosthesis and resolder

CONNECTORS:

Connectors are those parts of a fixed partial denture or splint that join the individual retainers and pontics together. Usually this is accomplished with rigid connectors The size, shape, and position of connectors all influence the success of the prosthesis. Connectors must be sufficiently large to prevent distortion or fracture during function but not too large; otherwise, they will interfere with effective plaque control and contribute to periodontal breakdown over time. Adequate access (i.e., embrasure space) must be available for oral hygiene aids cervical to the connector. If a connector is too large incisocervically, hygiene is impeded, and over time periodontal failure will occur

REQUIREMENTS OF CONNECTOR

1.Connector should be sufficiently strong to resist all the forces of mastication

2.Depth of connector should always be sufficient to provide adequate strength

3.The tooth must be prepared so as to preserve the interproximal embrassure and occupy the normal anatomic interproximal areas

4.It should occupy a gap width of about 0.25mm

TYPES OF CONNECTOR

RIGID CONNECTORS:

Cast or soldered

NON RIGID CONNECTORS:

1.Tenon –mortise

2.Loop connectors

3.Split pontic

4.Cross pin and wing connectors

5.Dove tail

RIGID CONNECTORS

Indications:

1.They are used to unite retainers and pontic in a fixed partial denture

2.These connectors are used when the entire load on the pontic is to be transferred directly to the abutments

Contraindications:

1.In cases where the existing diastema is to be maintained

2.In case of tilted abutments

3.In long span bridges

DESIGN INCORPORATION IN RIGID CONNECTORS :

The design of rigid connector is incorporated into the wax pattern.Connectors that are to be soldered are sectioned in the wax pattern with a ribbon saw so that they can be joined on a flat ,parallel and at a controlled distance of 0.13mm

NON-RIGID CONNECTORS

Indications:

1.To relieve stress

2.To accommodate malaligned fixed partial denture abutments

Dove tail

Split pontic

Tapered pins

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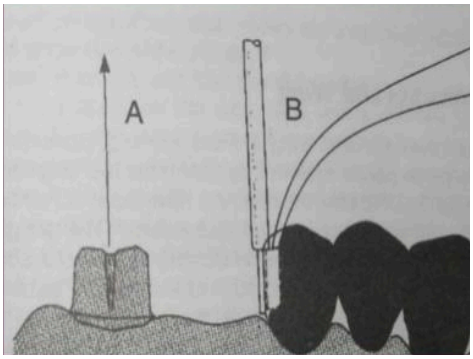
DOVE TAIL

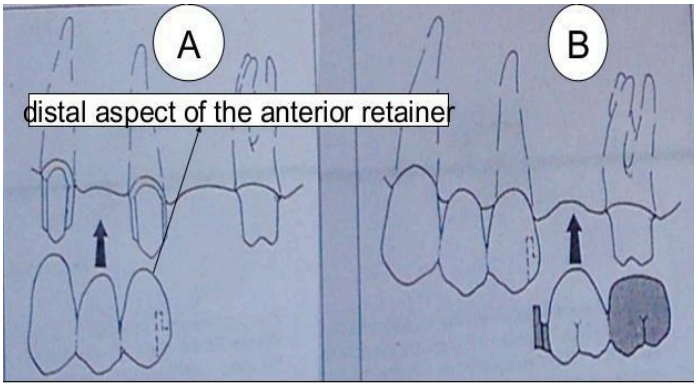
It is best suited for relieving stress at midspan on long pontics.It consists of a mortise prepared within the contour of the retainer and the tenon attached to the pontic .It is used in periodontally weak weakened abutments and in long span FPD

PATTERN OF FABRICATION

The wax pattern for the retainer on the pier abutment is fabricated on the working cast.When a plastic pattern is used for the key and key way ,a deep box form is carved on the distal surface of the wax pattern to create space for placement of plastic key way pattern.It

must be parallel to the path of withdrawal of the other retainer .Place the working cast, with the wax pattern seated, on the table of a surveyor. Assemble the key and keyway portions of the connector, and lock the mandrel that extends from the top of the key portion of the pattern into the vertical spindle of the surveying instrument.Manipulate the surveying instrument. Manipulate the surveyor table until the mandrel and attachments are parallel with the path of insertion of the distal preparation





Then lower the plastic pattern to the middle retainer wax pattern and lute it in place with sticky wax .Remove the key portion and complete the middle retainer wax pattern by blending the distal surface with the keyway.After the casting has been cleaned and air abraded, carefully cut off any part of the keyway portion of the attachment that protrudes above the occlusal surface. Place the casting on the working cast, and place the prefabricated plastic pattern for the key into the keyway. At this point the pontic wax pattern is attached to the pontic key. Mesial segment of keyway Cemented first followed by distal segment .

CROSS PIN AND WING

The cross pin and wing are the working elements of a two-piece pontic system that allows two segments to be rigidly fixed after the retainers nave been cemented on their respective abutment preparations

Indications:

1.The design will be primarily used to accommodate the abutment teeth with disparate long axis.

2.Used in case of tilted molars

FABRICATION OF CONNECTOR

1.Attach a vertical wing, cut out of a piece of base plate wax, to the mesial surface of the distal retainer wax pattern.

2.The wing should parallel the path of insertion of the mesial abutment preparation

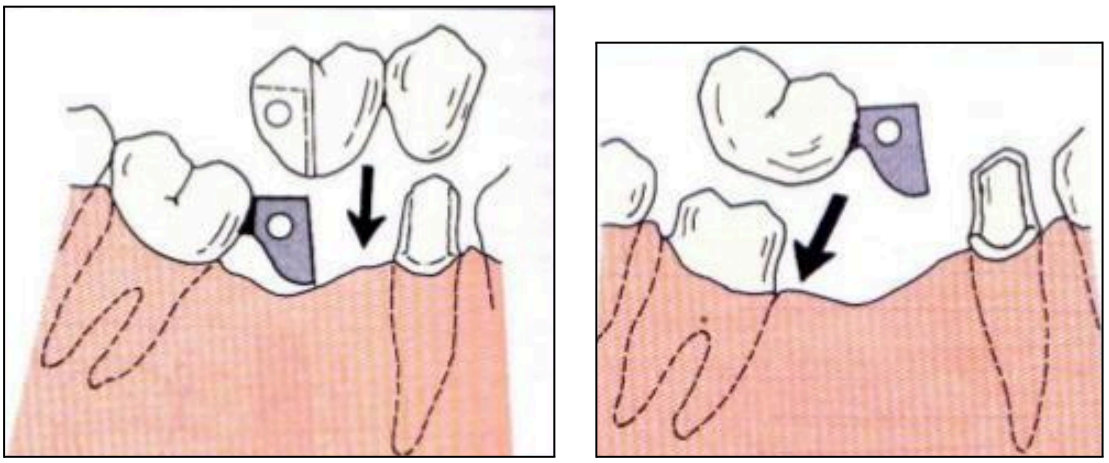
3.It should extend out 3.0mm mesially from the distal retainer

4. Have 1.0mm thickness faciolingually, be 1.0mm short of the occlusal surface

5.Have an undersurface that follows the intended contour of the underside of the pontic

6.Seat the retainer on the cast, and drill a 0.7mm hole through the wing with a twist drill in a hand piece. Place a 0.7mm diameter pencil lead through the hole and build the wax pattern around the lead and the wing

7.Assemble the two parts of the fixed partial denture on the working cast.



Advantage:

1.No need to remove the whole assembly if required

2.Reduces the amount of force on abutments

3.Stress distribution

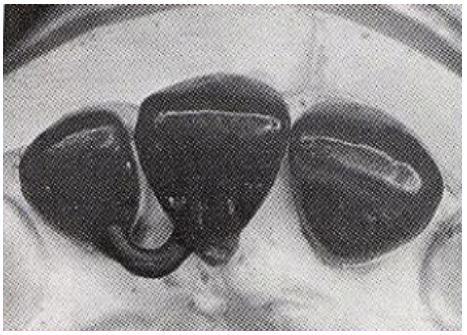
Disadvantage:

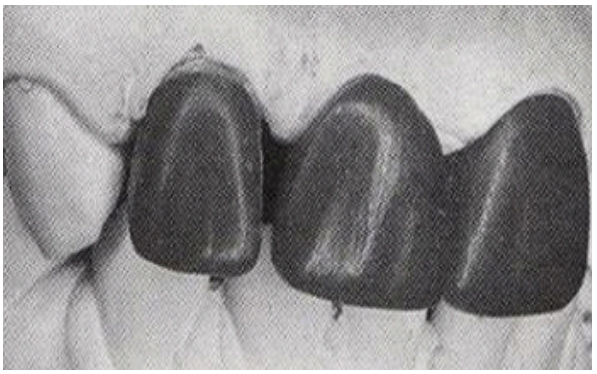
1.Technique sensitive

2.Additional lab procedure required for fabrication

LOOP CONNECTORS

Used when the existing diastema is to be maintained in the fixed prosthesis.It Consists of loop on the lingual aspect of prosthesis that connects adjacent retainer or pontic





SPLIT PONTIC

Indications :

1.This is an attachment that is placed entirely within the pontic.

2. It is particularly useful in tilted abutment cases, where the use of a conventional dovetail would necessitate the preparation of a very drastic box in the distal aspect of the pier abutment

3.The wax pattern of the anterior three-unit segment (mesial retainer-pontic –pier retainer) is fabricated first, with a distal arm attached to the tissue-contacting area of a pontic.

4.A surveyor is used to position either the key or the keyway segment of fpd pattern, pointing occlusally. This segment must align with the distal abutment preparation

Advantage :

1. Allows some degree of movement and prevent abutment overloading
2. Stress distribution
3. Acts as splint

4. When problem occurs the affected segment alone can be repaired

Disadvantage :

1. More time consuming

2. Cost factor

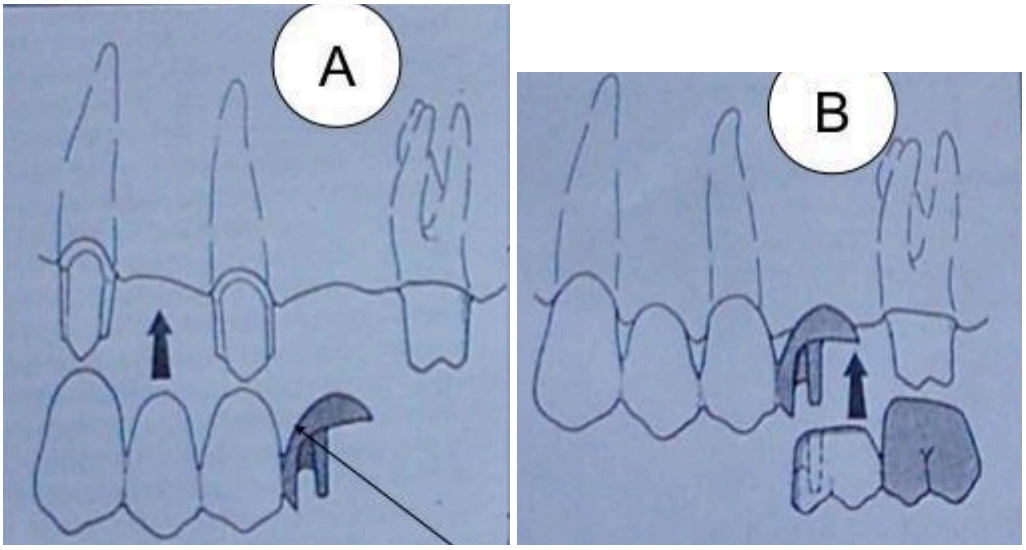
3. Invest, burnout and cast the mesial three- and –a-half –unit segment. After preliminary finishing, seat the cast segment on the working cast.

4. Wax the distal retainer and the disto- occlusal two-thirds of the pontic pattern

5. Cement the mesial segment first, followed immediately by the distal segment.

6. No cement should be placed between the two segments of the pontic

7. Mesial segment which is cemented first had the distal shoe that is gingival portion of pontic .Distal segment covers the mesiogingival part of pontic when the distal retainer is cemented.



CONCLUSION:

Alloys have been considered to be of paramount importance in the field of fixed and removable prosthodontics. These alloys along with the use of solders and connectors has proved to have accurate fit and excellent mechanical properties which are the essential for success of the restoration.Long span prosthesis, of which alloys are an integral part, may often require joining of one or more individual castings to obtain better fit, occlusal harmony, accuracy and esthetics which can be obtained by solders and connectors.

Author name;

Dr. Sheela, Reader

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Department of Prosthodontics