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REVIEW ARTICLE

DIE MATERIALS AND DIE SYSTEMS – REVIEW

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ABSTRACT

Aim: This study was aimed to review the role of die systems in prosthodontics and how it is relevant to fixed prosthodontics. **Methodology:** A systematic literature search was performed electronically and also hand-searched with terms. The search was carried out through Medline via Pubmed, Wiley online library, Ebscohost, Science Direct, and the Google Scholar for articles published from 2000 to 2019. A total of 172 articles were found. A total of 111 articles were found relevant to the topic. Articles selected were critically appraised to evaluate their quality. **Results:** Different articles described various die systems its advantages and disadvantages. The literature search revealed 33 articles in PMC. 56 articles were found on Wiley online library, 32 articles in google search, 22 articles in Ebscohost. Additional 29 articles were identified by hand search. **Conclusion:** An accurate working cast with removable dies is essential to make a well-fitting restoration. Detailed reproduction of die materials for fixed prosthesis affect the accuracy of operating casts and was expounded to the compatibility between the die and impression materials.

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INTRODUCTION

As direct fabrication of patterns for extra coronal restorations in the mouth is inconvenient, difficult, time-consuming, and virtually impossible, practically all wax patterns are made in the laboratory with the indirect technique. This technique requires accurate reproduction of the prepared tooth, the surrounding soft tissues, and the adjacent and opposing teeth. A cast-and-die system captures the necessary information so that it can be transferred to the laboratory.¹

MATERIALS AND METHODOLOGY

PubMed/Medline, Wiley online, and Google search were the electronic resources used to review the biomedical literature, using the following keywords. Die system, Pindex system, Accutrac system, Die pins. In total, we found 172 relevant articles. The literature search revealed 33 articles in PMC; 56 articles were found on Wiley online library, 32 articles in google search, 22 articles in Ebscohost. Additional 29 articles were identified by hand search.

As a criterion for selecting these studies, we included only the articles published in English; after reading the abstracts, we selected 111 articles that fit these criteria, with the publication dates ranging from 2000 to 2019.

Definitions

DIE: The positive reproduction of the form of a prepared tooth in any suitable substance.²

WORKING CAST: This is the replica of the prepared teeth, ridge areas & other parts of dental arch.¹ (figure-1).



Figure 1.

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DIE PIN: A metal pin used in stone casts to remove die sections and replace them accurately in the original position.² (Figure 2).



Figure 2.

Requirements for die:¹

- All surfaces will have to be as it should be duplicated & no bubbles or voids can be authorised.
- All the details of the prepared tooth should be reproduced.
- The unprepared tooth surface right away cervical to complete line should be appropriately reproduced to prepare an accurate finish line in the wax pattern.
- Adequate access to margins is necessary.

Requirements for die materials

- Should have accuracy and dimensional stability.
- Should have a smooth, hard surface which should not easily abrade.
- Should be compatible with impression material.
- Should have high strength.
- Should have good color contrast.
- Economical.
- Should be able to manipulate easily and fast.
- Have ability to reproduce fine details & sharp margins.

Materials used for die fabrication

- Gypsum products
- Amalgam dies
- Epoxy resins
- Electro deposition of metals
- Flexible die materials
- Refractory materials for die preparation.

Gypsum products

Advantages

- Compatible with all impression materials.
- Have the ability to reproduce fine detail and sharp margins.
- Dimensional accuracy and stability are good.
- Easy to use.
- Disadvantages :
- Susceptibility to abrasion.

Amalgam dies

Advantages

- Exhibit superior strength.
- Resistance to abrasion.
- Reproduce fine details and sharp margins.

Disadvantages

- Can be packed only into a rigid impression.
- Time taking procedure.
- It has a high thermal conductivity, so can cool a wax pattern rapidly & may lead to distortion of the pattern.

Epoxy resins

Advantages

- More abrasion resistance.
- Less brittle than stone dies.
- Can be carved at room temperature.

Disadvantages

- Shrinkage on polymerization i.e., 0.02%.
- Less dimensional stability.
- Expensive.

Electroplated dies

Advantages

- Dimensionally stable.
- Higher strength, hardness and abrasion resistance.

Disadvantages

- Time consuming.
- Special equipment is needed.
- Not compatible with all impression materials.

Flexible die material

Advantages

- More rapid setting – 10min.
- Ease of removal of provisional restoration.

Cast and die systems

Working cast with a separate die

Working cast with removable dies

- Straight dowel pin
- Curved dowel pin
- Di-lok tray
- Pindex system
- Accutrak system

DVA model system

Zeiser model system

Working cast with a separate die system: It is the simplest method of fabrication.

Advantages

- Easy to fabricate.
- Keeps relation between abutments fixed.
- Better contours and emergence profile whilst wax pattern fabrication.

Disadvantages

-The wax pattern must be transferred from die to cast - destroy internal adaptation of wax.
-Sometimes it is difficult to seat wax pattern on the cast because of different impressions, when the second pour of impression is damaged or either due to different thickness of spacers.

Procedure

Both working cast and sectional die can be obtained by:

- Pouring impression twice
- Making two impressions.

Preparation of separate di

- Add stone in small increments.
- If large amount of stone dropped into preparation voids may be formed due to air trapped.
- Build to height of approx 1 inch.

Ditching

- Finish line highlighted with red pencil, not to use black graphite pencil.
- Take the die away and excess stone gingival to finish line is trimmed with no. 25 blade or with Pear shaped acrylic bur.(figure-3)
- Handle should be 1 inch long.

Drawbacks of ditching:

Because the instrument used for finishing the margins of wax pattern will rest on this area, its angulation can be exaggerated by the undercut.

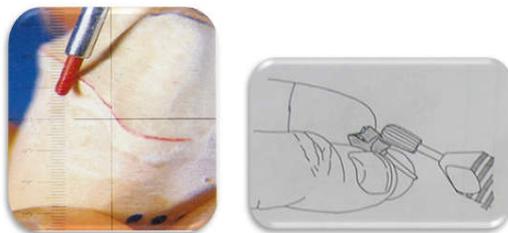


Figure 3.

This will result in thick gingival area on restoration and axial contour that is not conducive to good gingival health. Apply die spacer.

Die spacers / die relief agents

Objectives

- To provide space for cement while cementing final restoration in mouth.
- It allows accurate adaptation of casting on die.
- Materials used – Enamels and lacquers.

Die spacers / die relief agents

Objectives

- To provide space for cement while cementing final restoration in mouth.
- It allows accurate adaptation of casting on die.
- Materials used – Enamels and lacquers.
- Thickness – No. of coats are applied to produce a relief 10-15µm.
- The tooth preparation of die is painted within 0.5mm of finish line for proper adaptation of casting at the finishing line.

Die lubricators

- Die-lubricators such as die lub can be used to coat the die directly over die spacer.
- It helps in easy removal of wax pattern without adherence to die.

Working cast with removable dies

Working cast with removable dies

Advantage

- Convenient to use.
- Various drawback of separate die are overcome.

Disadvantage

- Risk of introducing error in the pattern if die does not seat accurately in the working cast.

Pre pour technique

Devices are oriented in the impression before it is poured.
Ex: Conventional dowel pin systems.

Post pour technique

Attached to the underside of the cast that has already been poured.

Ex: Pindex system.

Dowel pins

Types of antirotational dowel pins

- Flat sided single dowel pin
- Single curved dowel pin
- Double dowel pins with single head
- Two separate parallel dowels.

- (Pindex system)
- Keyed plastic outer tray

Straight dowel pin

- A no. of items found in dental laboratory are commonly used for orienting the dowels, such as anesthetic needles, paper clips, bobby pins.
- The flat sided brass straight dowel pin is most commonly used in preparing die.
- Serrano J.G et al (1998) found that, it is most accurate in terms of resisting horizontal movement and rotation with least occlusolingival reseating discrepancy i.e. vertical deviation.
- Place the dowel pin between the arms of bobby pin with the round side of dowel pin in one of the corrugations and flat surface of dowel against flat arm of pin.
- Position the bobby pin buccolingually across the impression so that dowel pin will be centered directly over preparation.

Placing head of a dowel too deep in impression may weaken the die.

- Positioning the dowel at incorrect angle may make die removal impossible.
- Stabilize the dowel pin with bobby pin and the bobby pin with straight pins & sticky wax. Pour die stone in impression, filling impressions of teeth covering the dowel pin.
- For small preparations thin instrument may prove helpful to place stone in most critical area.
- Stone is teased into preparation along axial walls by tilting impression & guiding material.
- Lubricate the stone around each dowel with thin coat of petroleum jelly of facilitate removal of die from working cast. Excess lubricant is removed.
- A filler is placed in the lingual space and base is poured.
- When it is set base is trimmed to remove excess.
- Utility wax is removed with sharp knife.
- When the stone is hard and dry, a saw frame is used with blade to cut this layer of die stone.
- Cuts should be on mesial and distal side of each die. They should be parallel to each other or, little fit tapered towards each other towards the pin.
- Then dies are reseated into the cast.
- Cast is ready for mounting.
- Utility wax is placed at the tips of dowels.
- When the stone is set, the wax is removed insuring that no debris is remaining.

Curved dowel pin

Can be used by pre-pour or, post-pour technique.

Pre-pour technique

- To install pin before pouring the impression, use finger pressure to insert tip of dowel into large opening of position bar.
- Hold the bar faciolingually, so that head of the dowel is 1-2mm into the proposed area of impression.

- The tail of dowel extends facially.
- Insert a straight pin into one of 3 holes into the facial aspect of bar and into the facial flange of impression and another pin into lingual flange through lingual holes of bar.
- The dowel should not touch the impression and its head should be parallel to long axis of prepared tooth or teeth.
- This procedure is repeated for all abutments and pontic areas.
- One pin is placed near the center of each segment of unprepared teeth, this will help in removal of segment for better access of gingival wax pattern.
- Impression is poured with die stone until it covers heads of dowel. This will fill the impression about 4 mm above gingival finish line.
- The straight pins and positioning bar are removed as soon as stone is set.
- To orient the large segments of unprepared teeth, 2mm deep holes are made with acrylic bur on either side of the each dowel pins.
- Petroleum jelly is applied on stone and also an exposed part of dowel so that can easily separate from base. Impression is boxed with modeling wax with tips point outside wax.
- Base is poured with stone.
- After stone is set, vertical saw cuts are made on both sides of dies without damaging prepared finish lines.
- Cuts must extend through die stone to underlying base, then separate each segment from the working cast by pressing or tapping on the protruding tail of curved dowel with a knife handle.

Post-pour technique

- Pour the impression with die stone to form a horse-shoe shaped working cast.
- Trim the bottom of cast flat to level 10mm from the necks of teeth.
- This is done because thin cast are easy to saw and short dowels are more stable than larger ones.
- Drill a 0.5mm hole directly below the center of each prepared tooth, pontic area, and segment containing unprepared teeth.
- This can be made with 2mm diameter drill in hand piece or drill press.
- Clean the dowel holes, insert the curved dowel pin properly and then adjusted for proper fit.
- Seat the heads completely with tail pointing facially.
- Then same procedure of pouring base and preparing dies is repeated.

Di-lok tray system

- In this system, a snap apart plastic tray with internal orienting grooves and notches is used to reassemble working cast and dies.
- Dilts, Podshadly, Sawyes and Netman (1971) found that this system has least vertical error.

Care to be taken

- Should be kept clean for greatest accuracy.
- When the casts must be mounted near upper member of articulator or, near hinge axis, examination of mounting

casts on articulator should be done to determine whether there is space for bulky tray.

Disadvantage: tray design makes articulation difficult.

Pindex system

Coltene, Whaledent, Makwak, MJ

The Pindex system consist of

- A special drill press
- Brass dowels and plastic sleeves
- A stone cast trimmed to horse shoe shape.
- Allow the cast to set for 60-min and then remove it.
- Thoroughly wet cast prior to trimming to prevent accumulation of sledge of prepared teeth.
- The bottom of cast is then trimmed flat and its thickness from base to prepared finish line should be minimum 15mm.
- Remove any excess stone in palate / tongue area with arbor band on lathe.
- Use a pencil to mark the desired location of the pins on occlusal surfaces of teeth or preparations.
- There should be 2 pins for each die, two for each pontic area and two for segment containing unprepared teeth.
- Place the cast on worktable of drill press with red pilot light on.
- Align the first pencil mark with illuminated dot from light beam.
- Using both hands, exert firm downwards pressure on the cast with thumbs.
- Raise the handle bar with slow, even pressure and the drill assembly moves upwards cutting the pinholes.
- When proper depth is achieved, red light goes off.
- Same procedure is repeated with each mark.
- For better results, cast is made slightly damp to prevent dust formation.
- Compressed air and brush is used to remove debris from holes.
- Short pins are cemented on lingual / palatal side first, then longer ones on facial side, this facilitates easy removal.
- When cement is dried, place the plastic sleeves over pins with flat sides of their bases facing each other.
- Apply a thin coat of petroleum jelly on bottom of cast as separating agent.
- Place small amount of molten wax at the end of short sleeves to prevent the sleeve from filling with stone when base is poured.
- Run a strip of utility wax on long pins to facilitate removal of die later.
- Place a small ball of wax on ends of isolated pins.
- Allow the cast to dry before sectioning, the pinned cast is removed from base which permits sectioning from downside.
- Utility wax is removed from tips.
- Saw cuts are marked on facial and lingual aspects.

Accutrak System

- Can be used for fabrication of veneers (similar procedure).
- It is a modification of plastic tray with internal orientation grooves and notches.

Zeiser Model System

Advantages

Allows advantage of allowing for the expansion of stone which is relieved by saw cuts.

Disadvantages

Use a precision drill & special baseplates that are aligned & drilled to provide die removal.

DISCUSSION

Nomura. G.T, Reisbick. M.H, Preston.J.D³ did a study on epoxy resin dies and evaluated the accuracy, fit, detailed registration, and Knoop hardness of 3 commercially available resin dies, the keep an eye on used was advanced stone, Impressions had been manufactured from each, and every MOD and whole crown preparation, a Complete of 80 dies have been acquired, 40 die registrations had been additionally made, 10 of each and every subject material. Four dentists had been decided to look the master castings on every die and evaluate it as fit or non-fitt. They are compatible with each casting was once shown by way of seating it on the die upon which the wax development used to be made. The author concluded that complete crown epoxy resin dies are undersized, MOD onlay epoxy resin dies are accurate, Detail duplication of epoxy resins dies is comparable to die stone. The hardness values of epoxy resin are less than those of stone. Covo L.M., Ziebert GJ, Balthazar Y, Christensen LV⁴ in 1988, Conducted a learn about at the accuracy & comparative balance of three detachable die systems, i.e., Accu-Trac system, Pindex system, & Conventional brass dowel pin positioning technique and evaluated the stability in 3 directions. They concluded that In horizontal direction – no significant differences were found between the mean displacements. In vertical direction – slight displacement did occur in an upward course with the Pindex machine & Conventional dowel pin device, while a significant displacement in a downward route was found with the Accu-Trac gadget. Wee ChengRyan⁵ conducted a study to check the accuracy of 3 conceptually different die systems used for implant casts.3 different die systems tested: double – pour (Pindex), plastic base(DVA), and die tray (K.O. tray). They concluded that using a double pour or plastic base die system is recommended when sectioned dies are needed for a multi - implant-retained prosthesis.

Conclusion

An excellent impact and an accurate die are step one towards the fabrication of a correct recovery, whether its inlay, onlay, or crown. The correct number of die material and its manipulation are paramount to achieve accuracy in the die.

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