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Desirable Impression Material and Technique Used For partial Dentures among Prosthodontist

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Abstract

Impression materials are used to record intraoral structures for the fabrication of definitive restorations. Accurate impressions are necessary for construction of any dental prosthesis. The relationship between static and mobile oral structures must be reproduced accurately for an optimum cast. Making a cast in gypsum materials from an impression of dental anatomy aids dentists in designing and constructing removable and fixed prostheses. The accuracy of these final restorations depends greatly on the impression materials and techniques. This study aims to identify the type of materials and the methods used by Prosthodontist in their clinics to construct conventional partial dentures and to specify the type and design for removable partial dentures (RPDs); and to then compare them with those taught in dental schools. In conclusion, the polyvinyls and polyethers are more stable to deformation after setting has occurred. All have specific protocols for disinfecting that must be followed to prevent distortion of the material before pouring casts; however, the polyvinyls seem to be most impervious to different disinfection protocols.

Keywords: Impression, Dentures, Material, Prosthodontist .

Introduction

Removable partial denture (RPD) prosthesis is defined as any prosthesis that replaces some teeth in a partially dentate arch that can be removed from the mouth and replaced. RPDs are still used in the conventional rehabilitation partially edentulous patients (1,2).

According to Douglass and Watson's study (1), the needs for RPD rehabilitation will increase by 15 percent from 2005 to 2020 in the United States. Although there are no available data on the predicted rates of partial edentulism, an extended lifetime and a large increase in the number of elderly individuals are expected in the future (1).

Therefore, there will be a large number of patients in need of RPDs, and prosthodontic programs that include RPD education are still necessary to meet the dental therapeutic needs of the society. The traditional methodology for the fabrication of RPDs can be summarized as follows. After an initial impression is made using an irreversible hydrocolloid (alginate), all necessary mouth preparation is completed, followed by an impression by an elastomeric impression material or alginate using a custom tray. A border molding is also required to obtain a detailed impression of the distal extension edentulous areas. The determination of the design of an RPD using a dental surveyor is an essential component of RPD fabrication (4). The majority of RPD frameworks are made from alloys based primarily on nickel,

cobalt, or titanium as the principal metal component. Noble alloys may also be preferred. Apart from metallic structure, these dentures also contain acrylic component for the mounting of artificial teeth, which are produced from either acrylic or porcelain (4).
Petropoulos and Rashedi6 reported that, in 18 percent of dental schools in the United States, RPDs were not clinical requirements for graduation; they attributed this finding to the increased use of dental implants in partially edentulous patients. Although there is extensive evidence in the literature that dental implants are successfully used in the treatment of partially edentulous patients with RPDs, dental implant treatments are not within the clinical practice of undergraduate dental education programs in Iraq. This does not simply that patients treated in the student clinics are not offered the opportunity to receive an implant where indicated. The patients are always informed of such an option. This is a review article intends to assess the selections concerning impression technique and material used for partial denture in prosthodontist via review of various published articles.

The Historical Evolution of Impression Material

In the mid–seventeenth century, early references to making impressions in wax to reproduce parts of jaws and teeth were recorded by a German military surgeon, Gottfried Purman. Then, in the eighteenth century, there were reports of an impression technique that involved pressing a piece of bone or ivory on the oral tissues that were painted with a colouring material and then carving out the fitting surface at the chairside (5). Philip Pfaff in 1756 was the first to make an impression of an edentulous jaw with 2 pieces of wax and then join them and making a cast using plaster of Paris (5). Other impression materials used were zinc oxide eugenol impression paste and compound, although their applications were limited by their inability to surpass undercuts without distorting or fracturing (6). Reversible hydrocolloids were introduced in 1925, followed by the irreversible hydrocolloids becoming available in 1941 (7). The disadvantage of the hydrocolloids is shrinkage caused by the loss of water, leading to inaccuracy. In 1953, polysulfide was used as an impression material along with condensation reaction silicones, but they both show significant shrinkage over a period of several hours, mainly because of the evaporation of low-molecular-weight by-products (7, 8). In the late 1960s, polyether was proposed as an alternative polymer because of its improved mechanical properties and low shrinkage (8). In the 1970s, polyvinyl siloxane (PVS) appeared on the market and became very popular, in part because of its high dimensional stability.

Definition of Impression

A dental impression is an imprint of the teeth and mouth from which shaped items can be formed (Figure. 2). Dental impressions produce a close replica of your teeth and oral tissue. A metal or plastic "horseshoe" shaped tray is chosen to fit the teeth and gums comfortably. A tray can be molded for either the top teeth, the bottom teeth, or both (9).

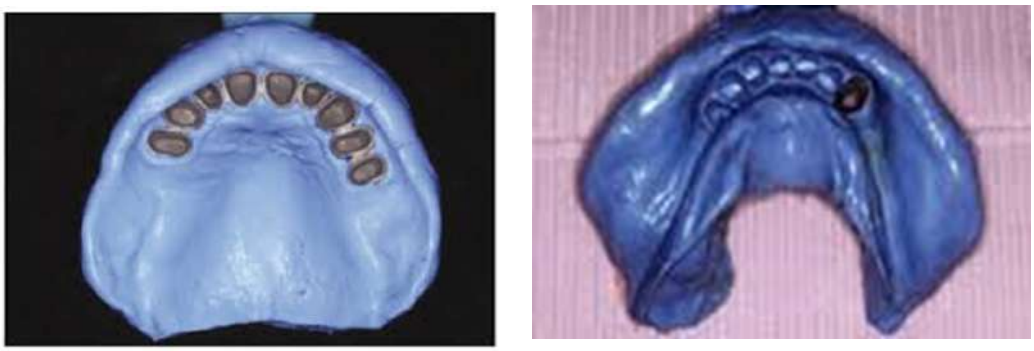

Figure.1: Dental impression

Classification of Impression Material

Impression material can be classified according to their composition, setting reaction, and setting properties, but a commonly used system is based on the properties after the material has set (Figure. 2). At present, the most popular types of impression materials for removable, fixed, and implant prosthodontics are irreversible hydrocolloids, polyethers, and PVSs. The impression materials were classified into:

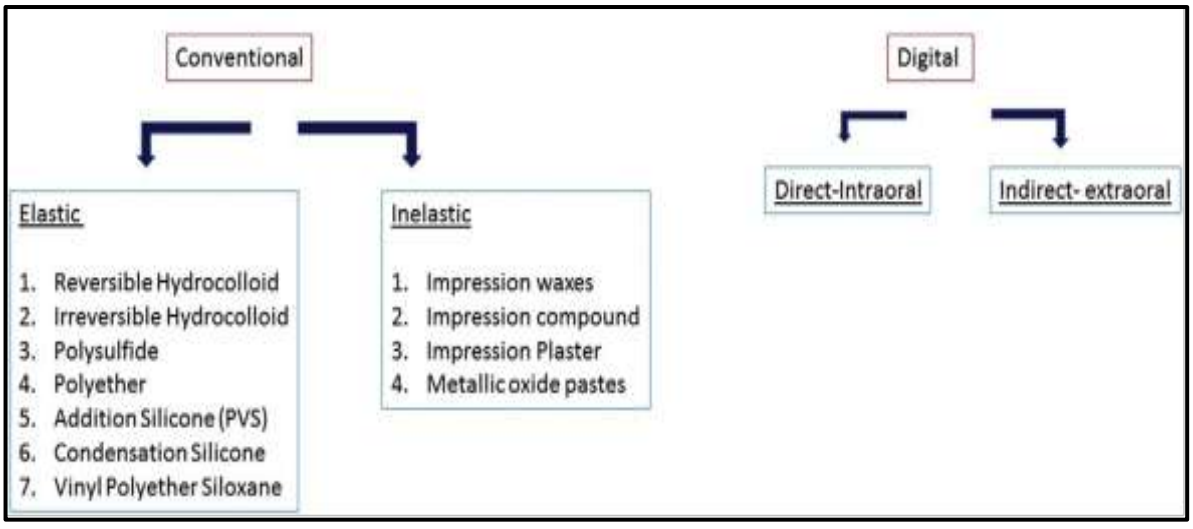

Figure.2: Classification of impression materials

Elastic impression material

Irreversible Hydrocolloids (Alginate)

Alginate impression materials are used for full-arch impressions because of their low cost and good wetting properties, making them a popular choice to fabricate diagnostic casts (Figure. 4). They can also be used for impression of partial removable dental prosthesis frameworks and for the fabrication of immediate/interim complete or partial denture prostheses (6) . The hydrophilic nature of the material allows it to be used in the presence

of saliva and blood with a moderate ability to reproduce details. Its poor dimensional stability caused by loss of water creates distortion and shrinkage if it is not poured within 10 minutes (10, 11) and it can be poured only once because of distortion and low tear strength.

Figure 4: Irreversible Hydrocolloids (Alginate)

This material is flexible and easy to remove from the mouth compared with other materials if they flow into undercuts. They are easy to use and easy to mix with sufficient setting time to be handled and placed in the oral cavity (11)**.**

Advantages of Alginate

1. Can be used in the presence of moisture saliva.
2. Hydrophilic and pour well with stone.
3. Pleasant taste and odor.
4. Non-toxic, non-staining, and inexpensive.
5. Alginate, unlike agar, does not require any special equipment and easy to manipulate.
6. Displace blood and body fluids, could be disinfected.

Disadvantages

1. Easily teared.
2. Must be poured immediately after removal from the mouth unless stored in humid environments.
3. Dimensionally unstable due to syneresis and imbibition.
4. Alginates, like agar, retard the setting of the gypsum model and die materials when in contact and should be washed with tap water well before pouring

Polyethers

Polyethers were introduced in the late 1960s. The setting reaction for these materials is via cationic polymerization by opening of the reactive ethylene imine terminal rings to

unite molecules with no by-product formation. These material are hydrophilic, allowing them to be used in a moist environment. Their good wetting properties also allow gypsum casts to be made more easily (12).

Newer polyether impression materials are slightly more flexible than the older products, making them easier to remove from the mouth. Because of the nature of the material absorbing water, the impression should not be submerged in water for a period of time because it could lead to distortion (12).

These materials are available in low, medium, and high viscosities (Figure.5) and can be used as a single-phase material or with a syringe-and-tray technique (Figure .6). The most popular method of dispensing this material is via a motorized mixing unit (Figure.7).

Figure.5: Polyether with medium viscosity

Figure.6: Polyether applied by syringe technique

Figure.7: Polyether applied by motorize mixing unit

Silicone Impression Materials

The silicone impression materials are more accurate and easier to use than the other elastic impression materials. There are different type of silicone impression materials:

a- Condensation silicones

Have a moderate (5 to 7 minutes) working time that can be altered by adjusting the amount of the accelerator. They have a pleasant odor, moderately high tear strength, and excellent recovery from deformation (Figure. 8).
These materials can be used with a compatible putty material to form fit a custom tray. Silicone impression materials are hydrophobic, which can make cast formation a problem. These materials can be disinfected in any of the disinfecting solutions with no alteration in accuracy. Ideally, these materials should be poured within 1 hour.

Figure. 8: Condensation silicon impression

b- Addition silicones impression

This material considered most accurate of the elastic impression materials. They have less polymerization shrinkage, low distortion, fast recovery from deformation, and moderately high tear strength. These materials have a working time of 3 to 5 minutes, which can be easily modified with the use of retardants and temperature control (Figure. 9, 10).
They are available in both hydrophilic and hydrophobic forms, have no smell or taste, and also come in putty form, to assist in form fitting the impression tray at chairside .The putties for these materials have a relatively short shelf life, and they are more expensive than the other elastic impression materials (12).

Figure.9: Addition silicon impression

Figure. 10: Impression by heavy &light body of addition silicon

Mercaptan (polysulfide) Impression Materials

The Mercaptan rubber–base (Thiokol) impression materials can also be used for removable partial denture impressions and especially for secondary corrected or altered cast impressions (Figure .11). To be accurate, the impression must have a uniform thickness that does not exceed 3 mm (1/8 inch). This necessitates the use of a carefully made individual impression tray of acrylic-resin or some other material possessing adequate rigidity and stability. Polysulfides are supplied in two tubes of base and catalyst. Polysulfides are available in low, medium, and high viscosities. Those materials that are highly cross-linked (medium and heavy body) do not recover well from deformation and should not be used when large or multiple undercuts are present. The accuracy of Mercaptan rubber base is acceptable for making impressions for removable partial dentures (13).
Rubber-base impression materials possess a longer setting time than the irreversible hydrocolloid materials and lend themselves better to border molding in adequate supporting trays; but they have disadvantages of having bad odor and staining.

Figure. 11: Polysulfide impression material

Tray selection

Custom and Stock Trays

Custom trays allow uniform impression material thickness, minimizing distortion and material waste, and are also more comfortable for patients. Custom trays have been shown to produce impressions of higher accuracy; however, newer PVS materials can still provide a quality single-unit impression when used with non-rigid stock trays (11).
Custom trays are still indicated for clinical situations in which multiple teeth are being restored or when the arch form and size do not allow the use of a stock tray.

Use of non-rigid plastic trays may result in flexure of the side walls of the tray during the impression procedure; subsequent tray rebound on removal from the mouth produces an inaccurate cast and, ultimately, poor restoration fit. In contrast, use of rigid (metal) stock trays requires additional care to block out any existing undercuts on adjacent teeth or areas where the material could flow and cause problems on removal, such as pontic sites.

Dual-arch Impression Trays

The dual-arch impression method became popular in the late 1980s (13,14). It is a closed mouth technique that allows dentists to captur2+0.6e the preparation, opposing teeth, and occluding surfaces in a single-step procedure. This technique is more comfortable for the patients and requires less time and material, making it a popular technique among dentists. In 2008, 1403 impressions that were submitted to a dental laboratory to fabricate fixed indirect restorations over a 3-month period were examined to provide data with regard to tray selection, captured teeth, and overall impression quality. The study revealed that 73.1% of the submitted impressions were made using the dual-arch impression technique. However, the investigators noted that the recommendations for the use of this method were not followed in a large portion of the cases (15,16).

Dual-arch impression trays should be used for single-unit prostheses or short span (up to 3-unit) fixed dental prostheses. Both adjacent teeth, as well as the antagonist of the prepared abutment, should be intact. Occlusal requirements for optimal results when using this technique include a stable maximum intercuspation with absence of interferences, canine guidance or other type of posterior cross bite, angle class I occlusion, and intact dentition (17).

When using the dual-arch technique, care should be taken so that the canine is registered on the impression in order to eliminate the potential of occlusal interferences in the final restoration. There are many types of dual-arch trays available (full or partial arch, metal or plastic, possessing side walls or sideless), and selection is based on clinical parameters, such as arch form and size or position of the teeth (18).

A small number of studies are available on accuracy of metal versus plastic partial dual-arch trays; plastic trays have been found to provide better accuracy compared with metal trays and have also been reported as being more comfortable for the patients (19,20)**.**

However, other studies found metal dual-arch trays to be more accurate compared with plastic ones, because they have less flexure during the impression process (20).

Removable partial denture Impression techniques

Anatomical impression technique

This technique used pressure free impression record teeth and soft tissue in their anatomic form. It is used for tooth supported removable partial denture. It does not contribute to support.

Physiological or functional impression technique

This type of technique records the teeth in their anatomic form and soft tissue and ridge in their functional form. It is used in tooth tissue supported dentures; it contributes to support. Furthermore, one anatomical impression is made of the entire ridge and one physiological or functional impression is made only on the edentulous portion. The

functional impression is made by applying occlusal load on the impression tray while making the impression .Thus the tissues are displaced during impression making. The common techniques employed to record a physiological dual impression are (14)**.**

McLean's Physiologic Impression

Principle of this technique is two impressions are made in this procedure. A functional impression of the edentulous ridge is made. The second impression is made over the functional impression and it records the structures in their anatomic form (14). A custom-made impression tray is fabricated over the edentulous areas of the preliminary cast. A spacer is not adapted because we intend to record only the supporting tissues with this tray (Figure.12).

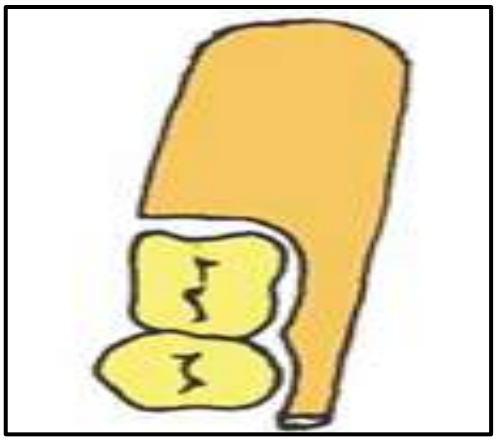

Figure. 12: McLean's technique step1

Occlusal rims are made on the custom tray. The tray loaded with the impression material is inserted into the patient's mouth and the patient is asked to close on the occlusal rims built over the tray (Figure.13).

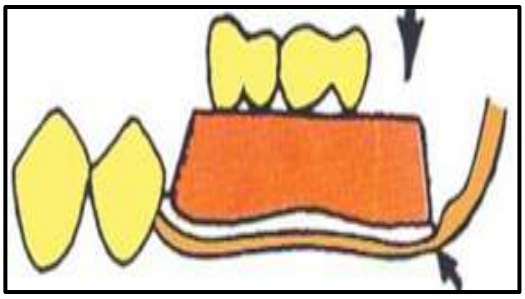

Figure 13: McLean's technique step2

After making the impression, the custom tray should not be removed from the mouth. An alginate over-impression (this impression is made over the existing impression) is made using a large stock tray (Figure.14).

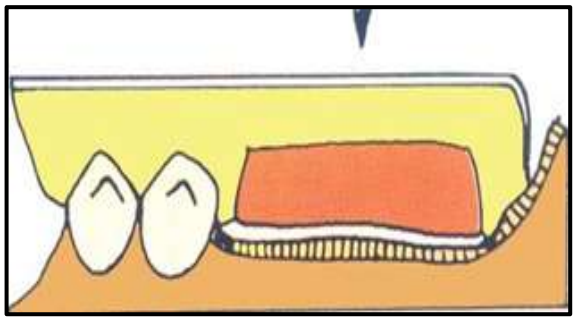

Figure.14: McLean's technique step 3

When the over impression is removed, the functional master impression comes along with it (Figure.15). A cast is poured into the impression. This cast will reproduce the teeth in the anatomical form and the tissues in the functional form.

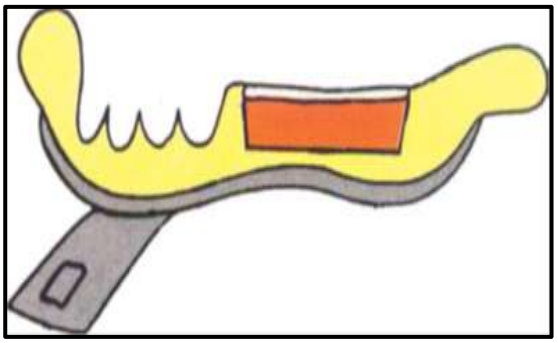

Figure. 15: McLean's technique step 4

Disadvantage

Finger pressure used to settle the functional impression while making the over impression is not equal to the biting force used while making the functional impression. Secondly, there will be a small quantity of alginate between the occlusal rim of the custom tray and the over-impression stock tray. This alginate may act like a buffer and prevent the transfer of the entire load (finger pressure) applied on the stock tray to the special tray.

Hindle's Modification technique

It is similar to McLean's technique. Hindle modified McLean's technique to overcome the disadvantages mentioned before.

Method

A special tray with an occlusal rim is fabricated using the primary cast. The special tray should have stoppers to avoid excessive pressure on the tissues. The stoppers should be placed on the tray extending over the stress-bearing areas. The special tray is used to record the supporting tissues under rest (anatomical impression). The special tray with the impression is left untouched in the patient's mouth. A special stock tray with large holes is used to make the over impression. While making the over-impression, the

clinician should place his finger into the holes of the stock tray and apply steady constant pressure on the occlusal rim built on the special tray. Pressure should be held till the alginate sets completely (Figure.16).

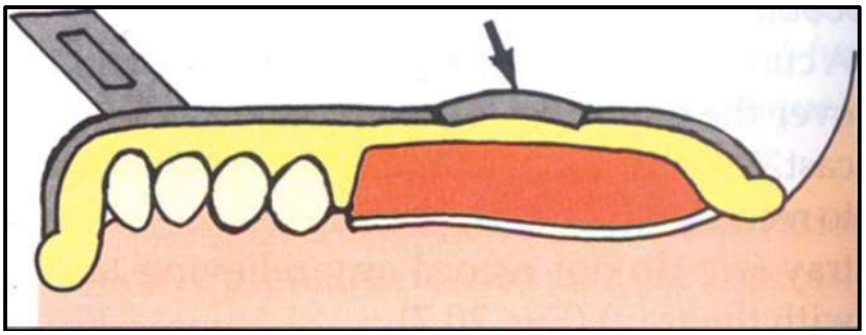

Figure.16: Hindle's modification of McLean's technique

Disadvantages

Since the tissues are constantly compressed there will be excessive bone resorption. Bone resorption occurs due to two reasons:
1. Constant pressure stimulates the osteoprogenitor cells to form osteoclasts. Osteoclasts resorb bone.
2. Constant pressure decreases the blood supply to the bone which again through a series of chemical mediators stimulate osteoclasts.

Selective Pressure Functional Dual Impression Technique

In this technique one anatomical impression and one selective pressure functional impression is made. A master cast is prepared from the anatomical impression and is later altered according to the selective pressure functional impression. This technique differs from the previous techniques in that the second functional master impression is a selective pressure functional impression (14).

Advantage

It equalizes the stress acting on the abutment teeth and the soft tissues. The rate of ridge resorption is reduced because relieving areas that cannot withstand any load are not stressed.

Procedure

The special tray is fabricated on the master cast made from an anatomical impression. The tray is fabricated without a wax spacer. The tissue surface of the special tray is trimmed with burs to provide adequate relief. (About 1mm of acrylic is trimmed along the crest of the ridge and the stress-bearing areas in the tray are left untouched). The impression material (preferably zinc oxide eugenol) is loaded on the prepared special tray and inserted into the patient's mouth. The patient is advised to keep his mouth open. The

impression is recorded under finger pressure. Only the stress-bearing areas will be compressed during impression making.

Altered cast technique

Altered cast impressions were made on any edentulous area that had no posterior abutment, either maxillary or mandibular.
Since the Maxillary RPD is so well-supported by the major connector, little additional support is gained with an altered cast impression for a maxillary distal extension area, especially if the final impression was made in a custom tray. The difficulty of capturing the total denture space of the mandibular distal extension in the final impression has made the altered cast impression essential for all mandibular Class I and II situations.
The objectives of altered cast technique are to obtain the maximum possible support from the distal extension base of the RPD and accurately relate the soft tissue surface of the denture base to the metal framework.

Steps of altered cast technique

- Primary impression is taken using irreversible hydrocolloid (alginate), and study cast is fabricated.
- Mouth preparation is carried out after the design is decided; impression is taken using additional silicon in a custom tray fabricated of acrylic.
- A metal cast framework is obtained (laboratory work); and checked to fit the cast.
- The cast metal framework is tried intraorally for the accuracy of fit.
- An acrylic resin custom tray is fabricated to the framework (saddle area).
- Border molding is carried out with green stick tracing; a final impression is taken with light body silicon using the framework custom tray.
- In the laboratory, bedding the final impression is carried out, the cast is cut on each saddle area, grooves are made on the cast at the site of cutting, and framework is seated to the cast and fixed by sticky wax and boxing procedure, then poured with die stone. Then the usual steps of denture fabrication are carried out (22).

Digital impression

Digital impressions allow dentists to create a virtual, computer-generated replica of the hard and soft tissues in the mouth using lasers and other optical scanning devices. The digital technology captures clear and highly accurate impression data in mere minutes, without the need for traditional impression materials that some patients find inconvenient and messy. The impression information then is transferred to a computer and used to create restorations (23).
Dental computer-aided design and computer-aided manufacturing CAD/CAM system consists of three components:

1. A scanner or digitalizing instrument that transforms physical geometry into digital data.
2. Software that processes the scanned data and creates images of the digitalized objects.
3. Fabrication technology that transforms the digital data of the restoration into a physical product.

Benefits of Digital Impression

1. Speeding up patient treatment and reducing the need for multiple office visits.
2. Less chair time
3. No need for impression materials that cause gaging to some patient
4. Reduced possibility of errors and material inaccuracies
5. The digital impression can be stored electronically providing feedback to make correction immediately
6. Provide improved precision and consistency
7. Allow dentist to design the restoration while visualizing the opposing dentition.
8. Digital impressions increase efficiency, productivity and accuracy.
9. Possibility to e-mail the virtual impression to the laboratory.

Figure.16: Digital impression machine

Disadvantages

1. Initial cost of equipment and software maintenance fees
2. Learning curve can be difficult for some individuals
3. Scan bodies needed for implant systems that are compatible with the design software
4. Difficult to capture occlusion information for complex prosthodontics treatments
5. Closed systems restrict options for transferring STL (standard tessellation language) files.
6. Cannot capture subgingival margins if obscured with blood, saliva, or tissue
7. Unable to accurately capture images of the edentulous arches
8. Scanning patterns need to be followed as per manufacturer's recommendations

Discussion

Impression materials for various uses are the goals of dentists. Various materials received a lot of attention because of their physical and handling properties including the irreversible hydrocolloids, polyethers, polyvinyl, and polysulfides. The polyvinyl

(addition silicones) and the polyether's are used in making the impression materials especially in fabricating fixed partial dentures, removable appliances, and implant prostheses. The hydrophilic addition silicones and polyethers flow easily, result in fewer retakes, and produce more bubble-free casts when used under appropriate guidelines. The polyvinyl siloxane materials are intrinsically hydrophobic (water repellent) by nature, so they must be made hydrophilic by adding surfactants. When these surfactants come into contact with moisture, it has to migrate to the surface, and seperate the hydrophilicity from complety growing during operating and setting times. Polyether is hydrophilic by nature of its chemical makeup, and moisture does not interfere as much with achieving void-free impressions. The condensation silicones, polysulfides, and irreversible hydrocolloids have qualities that make them more sensitive with respect to handling considerations and mix-and-pour techniques because they exhibit more changes over time after setting, which may affect accuracy in detail reproduction. The polyvinyls and polyether's are more stable to deformation after setting has occurred. All have specific protocols for disinfecting that must be followed to prevent distortion of the material before pouring casts; however, the polyvinyls seem to be most impervious to different disinfection protocols.

Conclusion

The current review approved that an accurate impression is vital for the success of partial denture treatment, so, proper selection of impression material, technique and the skill of the dentist play a key role in the success of overall treatment. However, no available knowledge of the person making the impression material will produce results greater than the skill and knowledge of the person making the impression.

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