

SOFT TISSUE MANAGEMENT AROUND IMPLANTS

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Abstract:- *The use of dental implants to replace the missing teeth has become a preferred alternative. Implant therapy has evolved significantly, regardless of the type of edentulism. The periimplant area primarily comprises the crestal bone and the healthy soft tissue around it. They are considered necessary for the long-term success of implant-supported restorations. If these two parameters are respected, implant therapy can be a reliable treatment with an impressive outcome. There are multiple aspects of diagnosis that are essential for the development of an appropriate treatment plan necessary for a successful outcome in aesthetic implant dentistry.*

Key words: - implants, soft tissue, periimplant, crestal bone

INTRODUCTION

With the gained awareness and the improved quality of life, analyses indicates that patients perceive their oral health status as improved by their experience with dental implants. Implant therapy has evolved significantly, from being one of the treatments of choice for edentulous arches to becoming a routine procedure to replace lost dental elements, regardless of the type of edentulism.¹ With this development, the objective of implant therapy has expanded from the functional restoration of the missing dentition to include the re-creation of the lost hard and soft tissues.² Natural teeth are surrounded by gingival soft tissues that provide a biologic seal between the oral cavity and the inside of the body.

This unique structure is composed of epithelium and soft connective tissue that are continually bathed in a transudate called gingival fluid.

Gingival Tissues:

The gingiva is masticatory mucosa that covers the tooth and underlying attachment apparatus. It encircles the necks of erupted teeth and firmly attaches to tooth and alveolar bone. The coronal part of the gingiva rests on tooth and forms a scalloped configuration.⁸ The gingival sulcus is the space between the marginal gingiva and the tooth. It is bordered on one side by the tooth surface and on the other by the epithelium lining the sulcus and covering the gingiva.¹

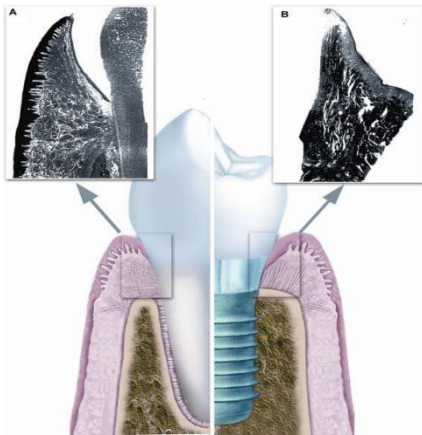


Figure : Normal Peri Implant Anatomy
Cross-section of the buccal dento-alveolar region (A) and of the buccal and coronal part of the periimplant bone and mucosa (B). Similar anatomical components (i.e. sulcular epithelium, junctional epithelium and connective tissue) are present in both periodontal and peri-implant mucosa.

The periodontal attachment apparatus is responsible for creating and maintaining a seal or barrier around the teeth, which are constantly exposed to the oral microbial flora. Healthy, non-inflamed periodontal tissues are resistant to gentle periodontal probe penetration and tissue retraction away from teeth. When periodontal health is maintained, long-term soft tissue attachment and stability are predictable.

Periodontal Health/Disease

Periodontal health is essential for the achievement and maintenance of soft tissue aesthetics. Gingivitis and periodontitis are bacterial-driven inflammatory diseases that cause swelling and edema of soft tissues adjacent to contaminated tooth surfaces.

PERI-IMPLANT ANATOMY

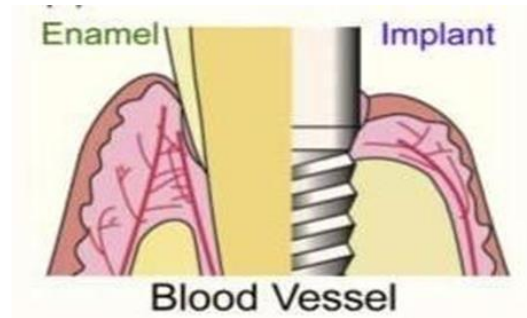


Figure : Blood vessel in natural tooth versus implants

THE BIOLOGIC WIDTH

The term biologic width refers to the entire dimension extending from the connective tissue attachment to the apical extent of the junctional epithelium.¹⁷

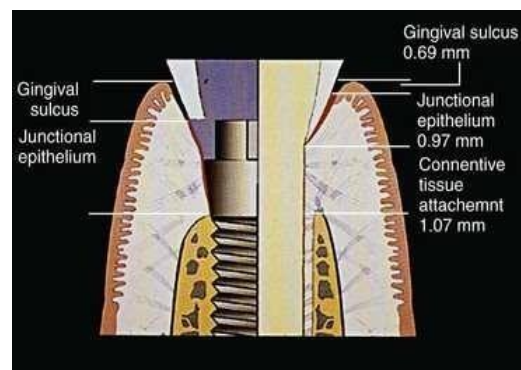


Figure . Biologic Width around Tooth and Implant

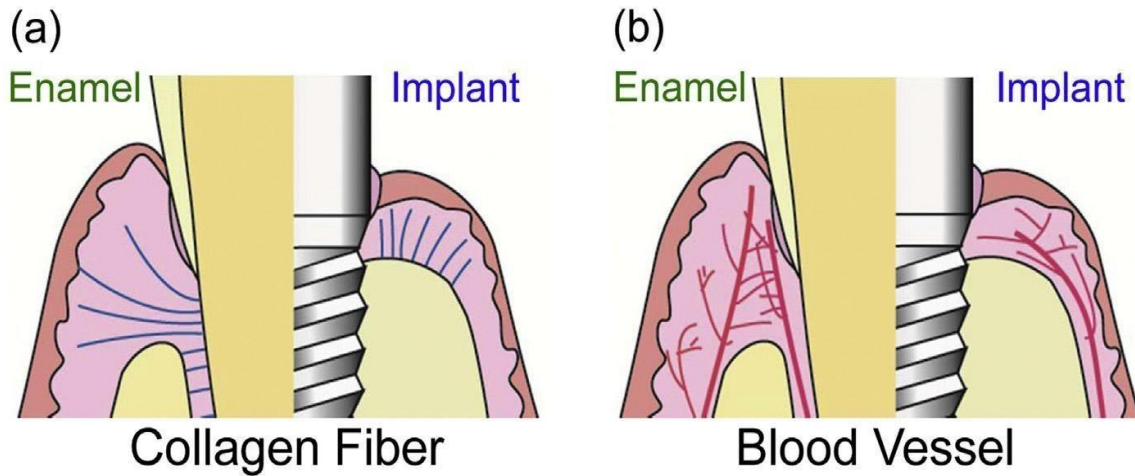


Figure. – Locus of collagen fibers and blood vessels in gingivae.

(a) Natural tooth has collagen fibers perpendicular to the cementum surface, whereas around implants, these fibers extend from the bone and run parallel to the implant surface.

(b) Normal periodontal soft tissue is supplied by blood from vessels running both outside the alveolar bone and through the periodontal ligament; in contrast, the peri-implant tissue has a reduced blood supply as the periodontal ligament source is not present.

TISSUE COMPLICATIONS AROUND IMPLANTS

The presence of peri implant mucosal recessions may significantly affect the esthetic outcomes, patient satisfaction, biological and clinical stability.

The etiology of peri implant mucosal recessions may be related to various factors such as the gingival phenotype (e.g., thick or thin), the presence of an insufficient width of attached/keratinized mucosa

Features		Tooth	Implant
Clinical Characteristics	Biologic width	Supracrestal	Subcreastal
	Probing depth	Normal 2-3mm	Increased \geq 4mm
	Bleeding on probing	Reliable Inflammatory sign	Less reliable as bleeding on probing is unrelated to the amount of inflammation in the peri-implant tissue
Tissue quality	CT composition	Low collagen and high Fibroblast	High collagen and low fibroblast
	Vascular supply	Increased (supraperiosteal, vascular plexus of PDL) Resilient connection	Less (supraperiosteal only) Rigid connection
	Hard tissue interface	Bone-periodontal ligament-cementum connection	Osseointegration, periodontal ligament and cementum absent
Soft interface tissue	Connective tissue Fibers	Perpendicular insertion into cementum	Collagen fibers parallel to the tooth surface
	Junctional Epithelium	Originates from the reduced enamel epithelium	Originates from the adjacent oral epithelium

Table 1: Differences Between The Peri-Implant Mucosa And Gingiva

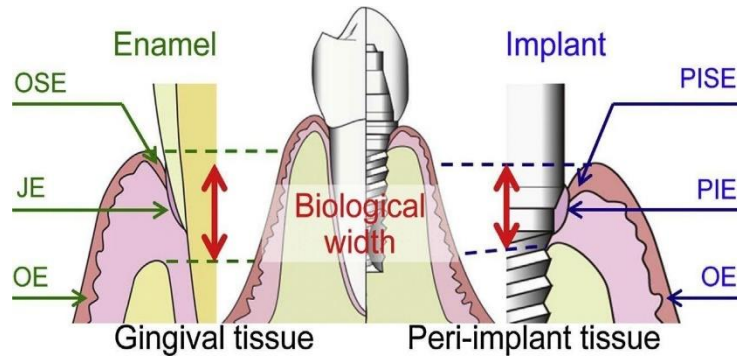


Figure. Landmarks of peri-implant and periodontal tissue. Diagram shows the key landmarks of the soft tissue attachment to natural tooth tissue (left panel) and their functional equivalents in the soft tissue attachment to an implant surface (right panel). (JE: junctional epithelium, OSE: oral sulcular epithelium, OE: oral epithelium, PIE: peri-implant epithelium, PISE: peri-implant sulcular epithelium).



Figure: Implants in position of teeth #12 and #23 presenting soft tissue recessions. These recessions result from improper positioning of implants, and problems in soft tissue handling during implant placement. There are no clinical signs of inflammation, no bleeding on probing, and probing pocket depth of 3-4 mm. These implants do not present any peri-implant disease but pose an esthetic problem and long-term risk to the implant biological stability



Figure: Thin soft tissue on the buccal aspect of implant #13 together with a concavity in the tissues apical to the crown margins leading to a shadow

PERI-IMPLANT PLASTIC

SURGERY

Definition : Peri-implant plastic surgery focuses on harmonizing peri-implant structures by means of hard tissue engineering and soft tissue engineering, and includes: bone structure enhancement; soft tissue enhancement; precision in implant placement; and quality of the prosthetic restoration.¹⁰

PRESERVATION OF SOFT AND HARD TISSUES PRIOR TO IMPLANT PLACEMENT

Post-extraction treatment modalities adopted to minimize the hard and soft tissue resorption are:

- Ridge preservation
- Socket preservation
- Immediate implants
- Orthodontic extrusion before tooth extraction

Principles of soft tissue management around implants at stage 1 and stage 2 surgery aims at:

1. Modified flap designs and suturing techniques
2. Augmentation of keratinized mucosa
 - Increase the width of KT
 - Increase the gingival thickness (biotype)

Techniques for Soft Tissue

Augmentation

Many of the techniques for soft tissue augmentation around dental implants have been adopted from periodontal soft tissue augmentation procedures.

Techniques include free gingival grafts (FGGs), pedicle grafts, subepithelial connective tissue graft (SCTGs), and various non-autogenous materials.

UNCOVERING TECHNIQUES

When a submerged approach is selected, a second surgery is performed for several purposes: it enables the implant to be uncovered and verifies the achievement of clinical osseointegration, it enables the healing abutment or the provisional restoration to be connected to the fixture.

TISSUE-PUNCH UNCOVERING TECHNIQUE

This approach finds its origin in the original description of the second-stage surgery by Dr. P.-I. Brånemark (Garber & Belser 1995). The technique was originally devised for implant-supported restorations of fully edentulous patients and did not consider the final aesthetic outcome of the peri-implant soft tissues.³

SURGICAL APPROACHES FOR SOFT TISSUE MANAGEMENT

Surgical approaches to augment the width of deficient mucosa are usually performed prior to implant placement or when undesired exposure of submerged implants occurs.

1. Apically positioned flaps (APFs) using a midcrestal/ lingual positioned incision.
2. APF/Vestibuloplasty (APF/V) in combination with autogenous tissue [subepithelial connective tissue graft (SCTG)/free gingival graft (FGG)].
3. FGG.
4. Epithelialized palatal graft technique.
5. SCTG technique or a soft tissue substitute [acellular dermal matrix graft (ADMG)/collagen matrix (CM)].
6. Vascularized interpositional periosteal connective tissue flap vascularized interpositional periosteal connective tissue (VIP-CT flap).⁴

NONSURGICAL APPROACHES FOR SOFT TISSUE MANAGEMENT

1. Lengthening of the contact area.
2. Use of custom tooth form healing abutments.
3. Repeated scaling and curettage of the interdental papilla region every 15 days for 3 months.
4. Use of gingiva colored porcelain.
5. Implant collar surface characteristics
6. Use of zirconia abutments

CONTRAINDICATIONS FOR SOFT TISSUE AUGMENTATION PROCEDURES AROUND IMPLANTS

Certain medical conditions are considered general contraindications to surgical intervention. Collagen disorders such as erosive lichen planus and pemphigoid may pose a risk to the viability of autogenous connective tissue grafts placed on a recipient bed that exhibits a pathologic healing response. However, currently there are no published data to either support or discourage the use of soft tissue grafting techniques in such cases. Smoking is another relative contraindication. It is well established that a key determinant of soft tissue augmentation success is revascularization of the graft. Nicotine in cigarettes causes vasoconstriction to the surgical site, often resulting in necrosis of the graft.

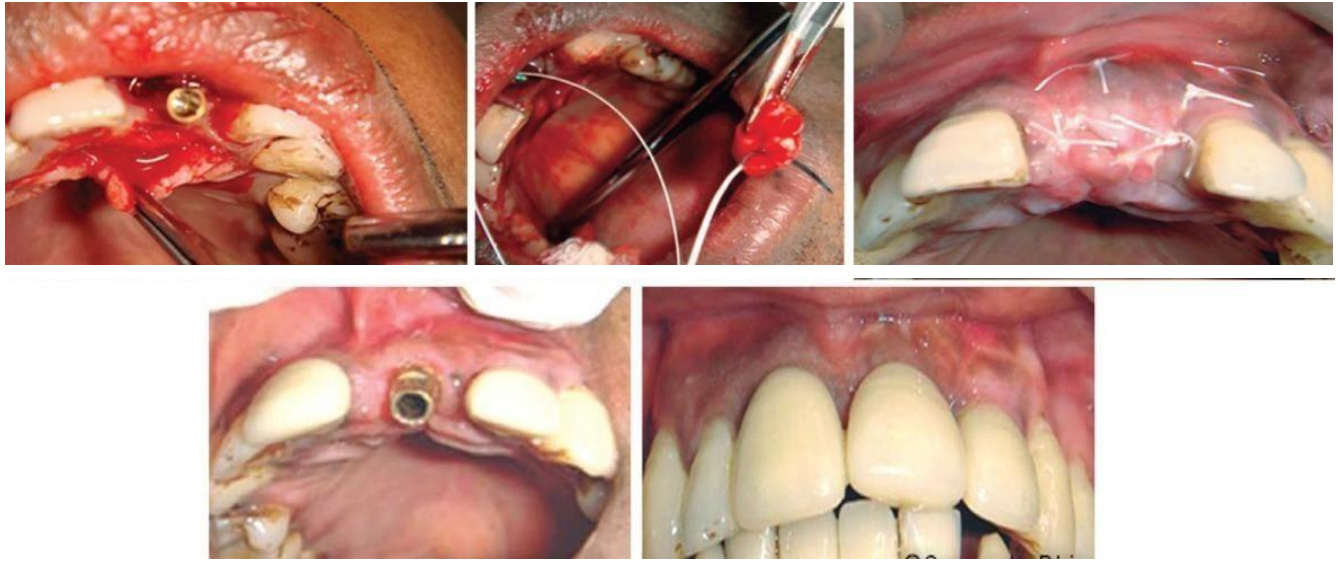


Figure : connective tissue graft for augmentation of buccal keratinized tissue (purse string technique): (a) connective tissue graft donor site (palatal) in relation to 21 (b) CTG graft threaded on the ptfe suture (c) CTG graft sutured (d) 2 months postoperative augmented buccal tissue with prosthetic abutment (e) final prosthesis irt 21

This nicotine associated vasoconstriction, in combination lack of adherence of the fibroblasts and alteration in immune response, diminishes the likelihood of a successful outcome. Preoperative assessment should attempt to identify such at risk patients, whereby the clinician must inform the patients of the potential adverse effects associated with smoking. Local factors that may also limit patient selection include lack of adequate tissue thickness at the palatal donor site, or restricted surgical access to intra oral donor sites such as the posterior of the hard palate .¹⁴

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Impression Materials And Techniques Used For Complete Denture Fabrication Amongst General Practitioners- A Survey In And Around Chengalpet District

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Abstract:- Aim: The aim of this article is to conduct a questionnaire based survey on the numerous impression materials and techniques used for complete denture fabrication amongst general practitioners in and around Chengalpet district. **Materials and Methods:** A survey questionnaire was prepared and distributed randomly to 50 practitioners in Chengalpet district irrespective of their field of specialization. The survey included a set of 11 questions regarding the choice of impression materials and techniques for complete denture fabrication. Each respondent was allowed to choose only one option from the given set of answers. **Result:** Irreversible hydrocolloid was the most commonly used material for primary impressions. Most practitioners adopted the selective pressure theory while making the impressions. Majority of the practitioners used a spacer covering only the secondary stress bearing and relief areas. The thickness of the spacer was decided based on the amount of relief by most dentists. A spacer was used along with light body polyvinylsiloxane impression material by the majority. Green stick compound is the material of choice for border molding the custom tray. Polyvinylsiloxane has taken over eugenol pastes as the material for making final impressions. Consideration for excessive movable tissue is provided by making relief holes. The cost of the material did not significantly influence the choice of material.

Keywords: Impression materials, Technique, spacer design

INTRODUCTION

Perfect impression procedure is necessary to get good retention and peripheral seal and provides support and stability for complete denture^[1,2]. Ideally, the established borders of final impression should be similar in thickness and length to denture flanges^[1,3]. Following the predefined progressive steps make sure a successful complete denture^[3,6,5]. These include primary impression, custom tray fabrication, border molding, and final impression. Techniques of Impression making had developed with the establishment of new material and techniques, nowadays. A wide range of materials and techniques are available for many clinical

situations which mandate the complete understanding of impression concepts and principles. In spite of the advances, material choice usually relies on personal preference and experience.

This current study aimed to identify choice of impression materials and techniques used for complete denture fabrication amongst general practitioner including Prosthodontists in and around Chengalpet district.

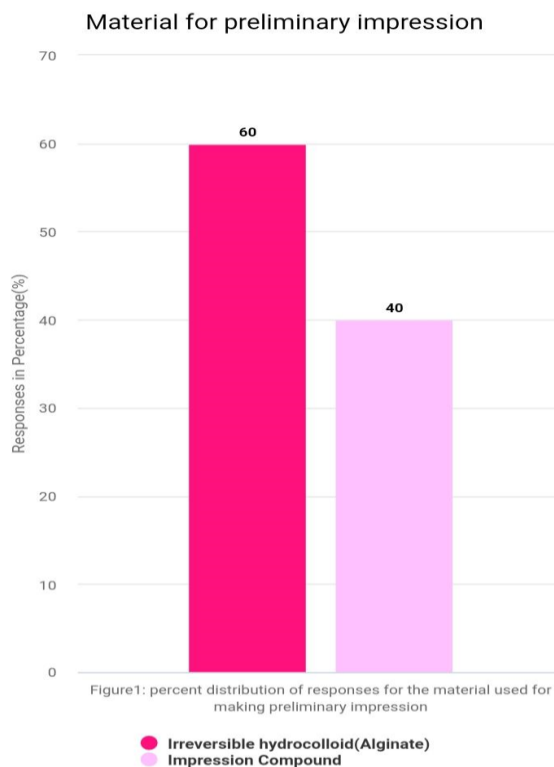
Materials and methods

A survey questionnaire was prepared and circulated to the general practitioners including the Prosthodontist in chengalpet district.

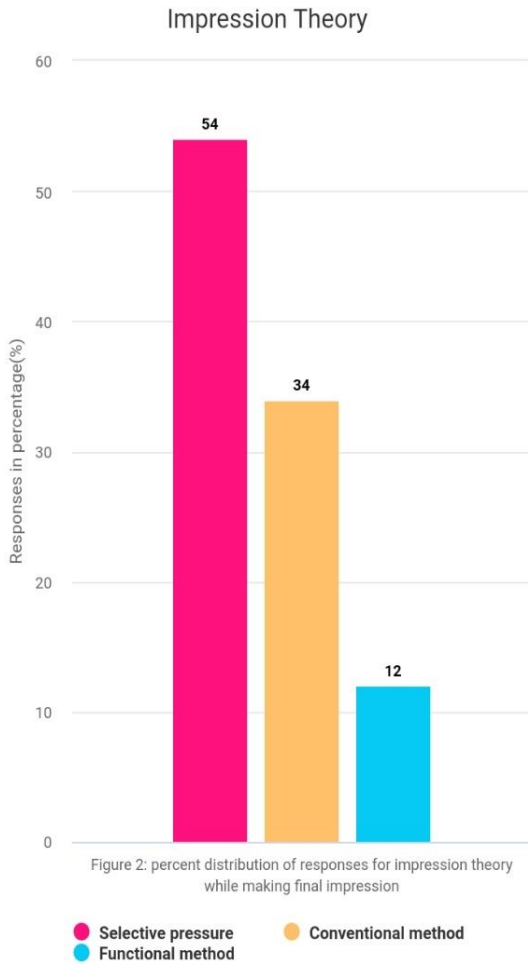
The survey comprised of two sections. In the first section, focus was on the type of impression material used during the primary and secondary impressions which include elastic and inelastic impression materials. The second section focused on techniques employed in fabrication of final impression and the spacer designs that will be used in final impression procedures. The questionnaire was prepared based on the survey which included 11 multiple choice questions which was circulated to the respondents. Every respondent were allowed to choose only one option for each question. The response from the respondents were kept confidential throughout the survey. The results were calculated based on the response received and it was converted to percentage distribution.

RESULTS

It was ensured that all 50 questionnaires were filled with no question left unanswered. (All percentages in the article have been rounded to the nearest whole number). With regards to the choice of material used for making preliminary impression, 30 respondents (60%) indicated the use of irreversible hydrocolloid (alginate) and 20 (40%) still preferred using impression compound (figure1).

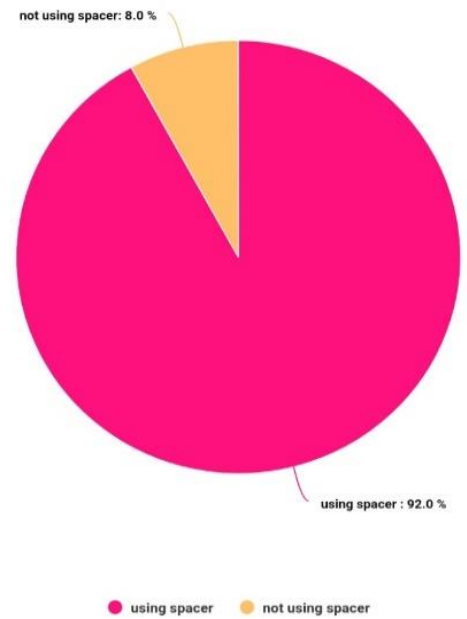


27 respondents (54%) use selective pressure technique while making the final impression, while 17 of them (34%) use the conventional method and 6 respondents (12%) use the mucocompressive or functional method (figure2).



A majority of the practitioners 46(92%), used a spacer in the design of the custom tray and the rest did not use a spacer (figure3).

Figure 3: percent distribution for using spacer design in the custom tray



Among the ones that use a spacer, 29 of them (58%) use a spacer covering only the secondary stress bearing and relief areas, 11 respondents (22%) use full spacer not covering the major stress areas with additional relief if required and 10 of them (20%) use a full spacer with tissue stops and additional relief (figure 4).

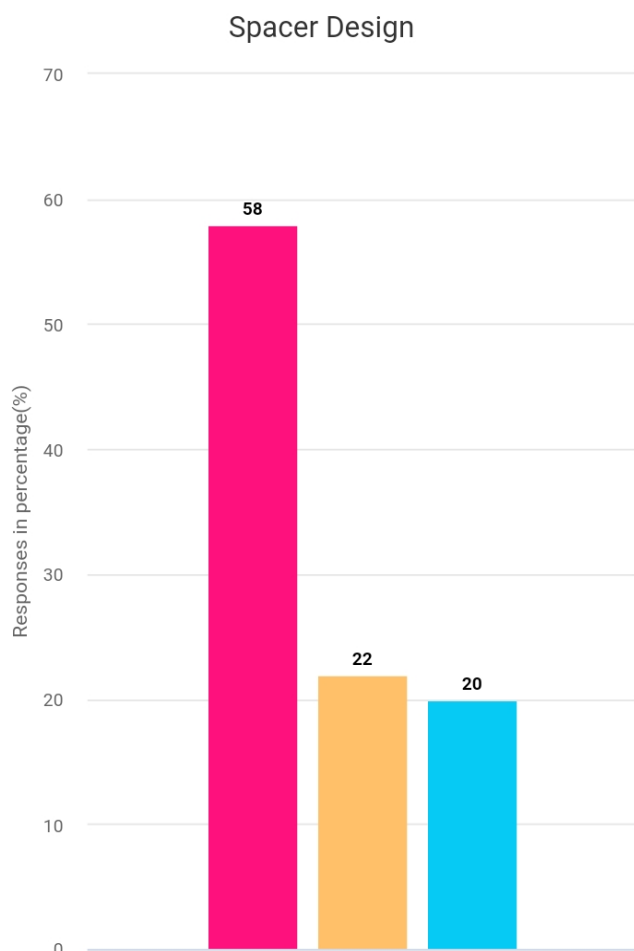


Figure4: percent distribution of responses for spacer design

- use a spacer covering only the secondary stress bearing and r...
- use full spacer not covering the major stress areas with additio...
- use a full spacer with tissue stops and additional relief .

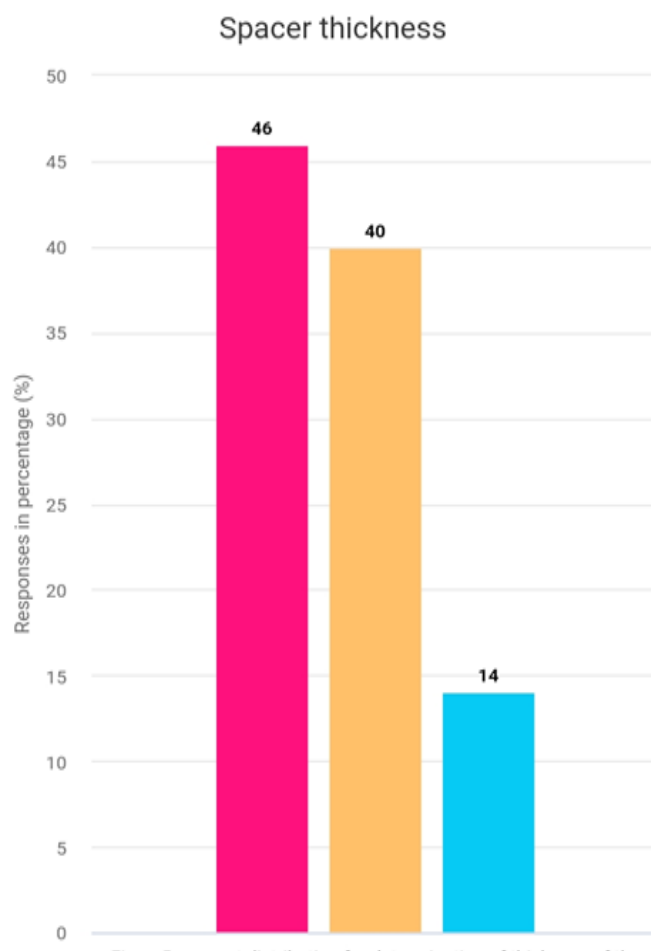
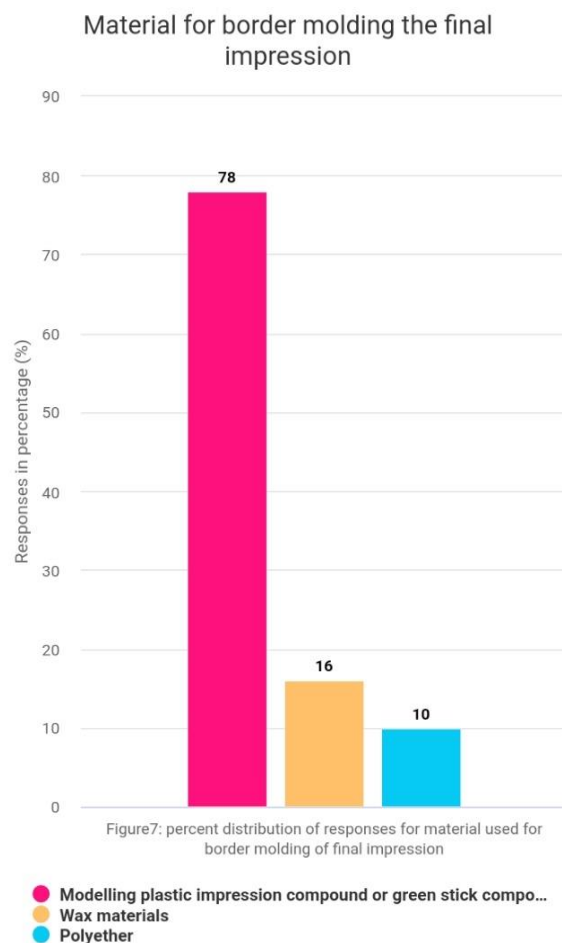
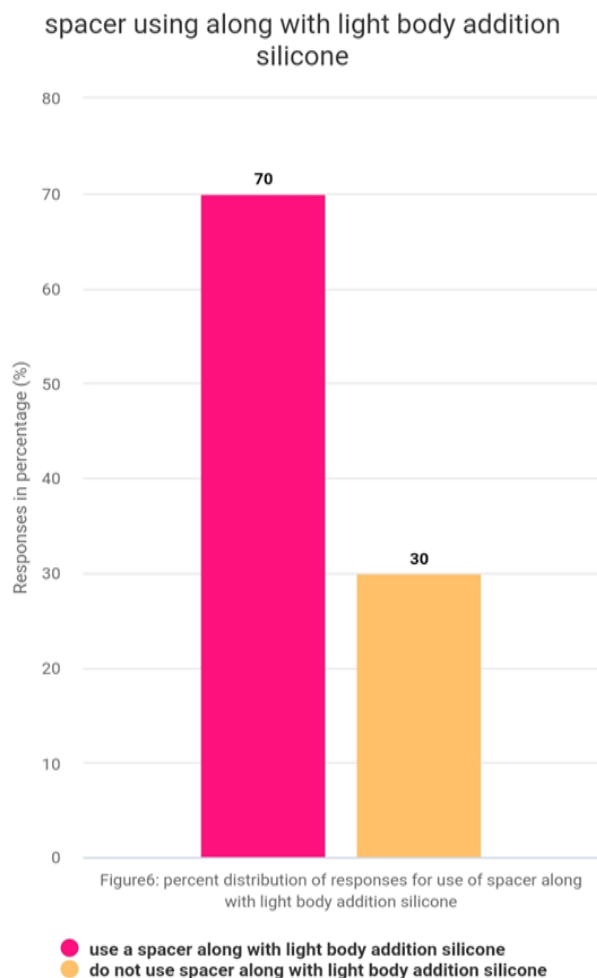


Figure5: percent distribution for determination of thickness of the spacer

- Based on the amount of relief
- Arbitrary Regardless of Impression Material Used
- type of impression material used

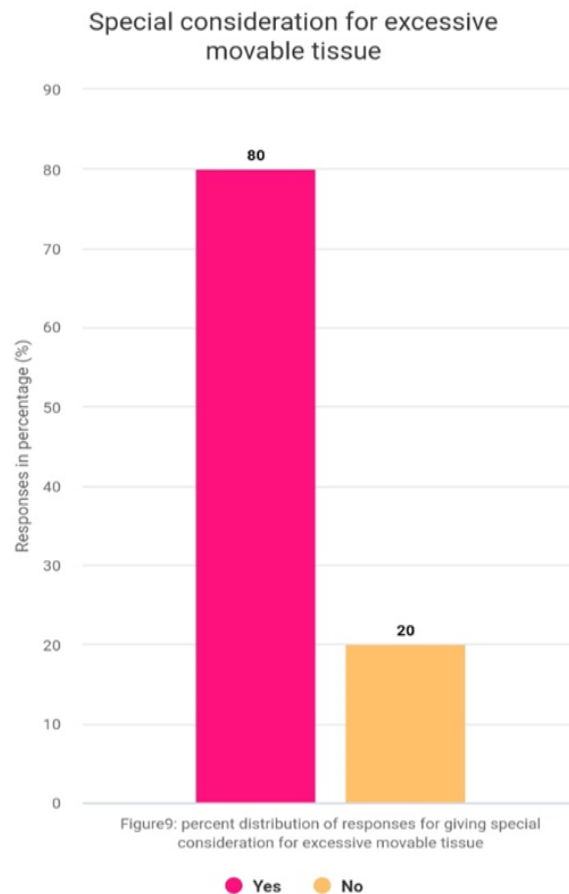
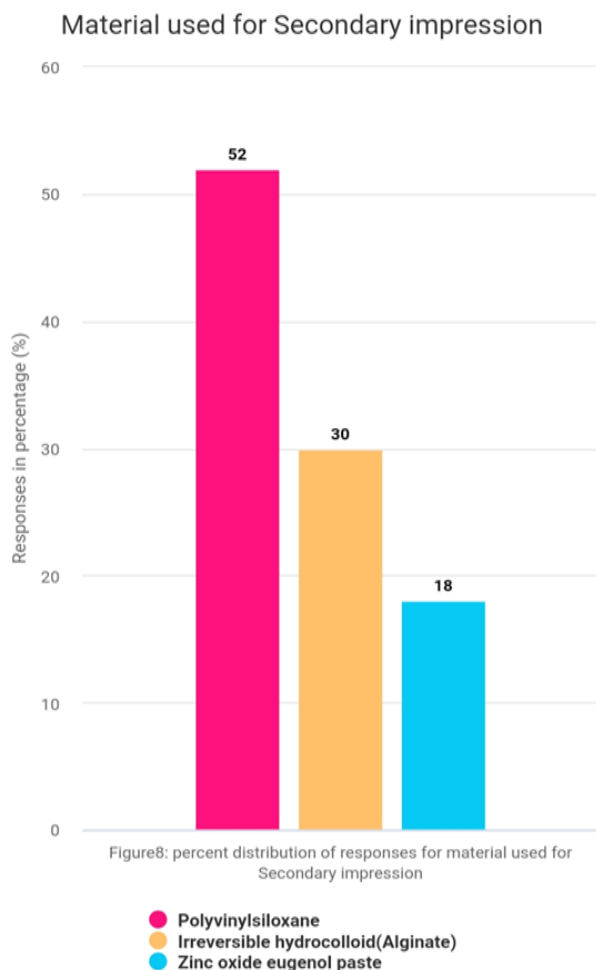
The thickness of the spacer was decided based on the amount of relief by 23 (46%) respondents. 20 of them (40%) decided it arbitrarily whereas 7 of them (14%) correlated the thickness of the spacer with the type of impression material used (figure 5).

A majority of the respondents 35(70%), use a spacer along with light body addition silicone while the rest of them, 15(30%) do not use it (figure 6).



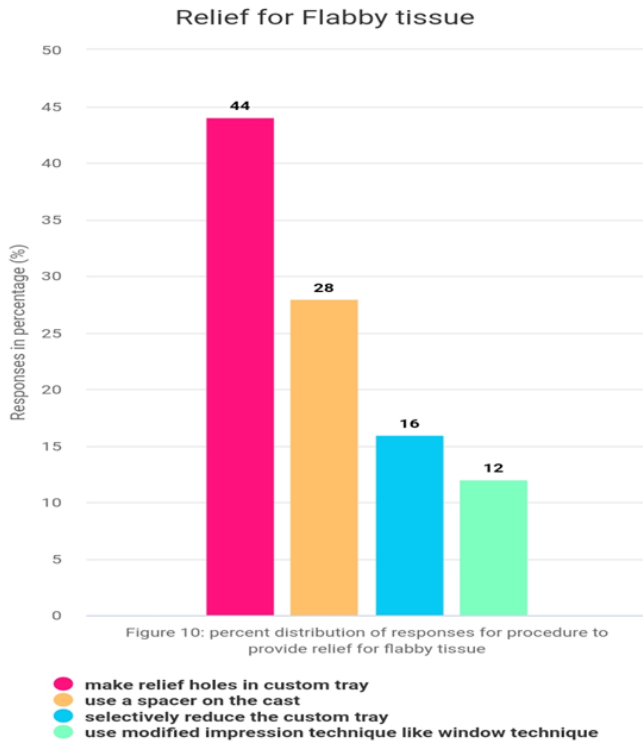
It was found that most respondents border molded the custom tray prior to making the final impression. 39 respondents (78%) use modelling plastic impression compound or green stick compound for border molding, 8 of them (16%) use wax materials and 5 of them (10%) use polyether (figure 7).

With regards to the material used for making secondary impression, 26 respondents (52%) used polyvinylsiloxane, 15 respondents (30%) used irreversible hydrocolloid (alginate) and 9 of them (18%) used zinc oxide eugenol paste (figure8).



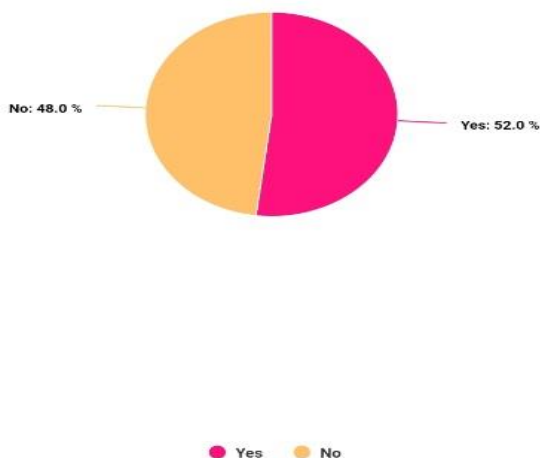
Majority of the respondents 40 (80%) gave special consideration for excessively movable tissue (figure9).

22 of them (44%) made relief holes in the custom tray, 14 of them (28%) used a spacer on the cast, 8 respondents (16%) selectively reduced the custom tray and 6 of them (12%) used modified impression techniques like window technique (figure 10).



The cost of the material seemed to influence the choice of impression material for 24 respondents (48%) (figure 11).

Figure 11: percent distribution of responses for influence of cost of material on choice



DISCUSSION

The Dental Surgeons participating in the survey correspond to different specialities and performed impression making as a part of their treatment plan at some point or another. With differing period of experience, the dentists were able to give their personal opinion regarding each and every question, thus providing better awareness into the subject.

The most commonly used primary impression material in this survey was irreversible hydrocolloid (60%), impression compound being used only by 40% of the respondents. This is in confirmation of the survey conducted by Rupal *et al* [7] and Kakatkar[8] where they described that impression compound was used by maximum of the practitioners in India. Although a study conducted by Singh G *et al* [9] in four major Indian cities revealed that alginate was used by 71% of the practitioners. Surveys conducted in United Kingdom[10] and U.S Dental schools[11] have also reported alginate to be the material of choice for making primary impressions.

Most of the practitioners (54%) used selective pressure technique for making the final impression followed by 34% of the respondents using the conventional method. This is in agreement with previous surveys conducted in India and other countries [7,12,13]. Selective pressure technique makes it possible to confine the forces to the stress bearing areas and the non-stress bearing areas

In this survey, 92% of the respondents recommend the use of a spacer in the design of a custom tray and a spacer covering only the secondary stress bearing and relief areas is used by the majority (58%). Previous surveys conducted to analyse the design of spacer used have also shown same results.

Respondents were also asked the criteria used to decide the thickness of the spacer. Most of them (46%) decided the thickness based on the amount of relief, the rest made the decision arbitrarily (40%) or based on the choice of impression material (14%). In a survey of U.S dental schools, majority of them (45%) used a layer of base plate wax for relief [12]. A. Roy Macgregor recommends the following thicknesses of the spacer based on the impression material used: 2.5mm for impression plaster, 0.5 mm for zinc-oxide eugenol paste, 2mm for alginate and 1.3-3mm for elastomeric impression materials [14]. 66% of the respondents used a spacer when using light body addition silicone as the impression material of choice. This is in agreement with the fact that some amount of tissue compression occurs when using elastomeric impression materials [15].

Modelling plastic impression compound is the most popularly used material (78%) due to its low cost, dimensional stability, little material wastage, long shelf life, ability to be added in increments and ease of adaptation.

Surveys conducted by U.S school have indicated a increased trend of the use of elastomeric materials for border molding[16]. The advantage of using elastomeric impression materials is that it is less time consuming and all borders can be recorded simultaneously. A clear majority (52%) use polyvinylsiloxane as the material of choice for making the final impression. This is in contrast to previous surveys conducted in India where Zinc-Oxide Eugenol pastes were more commonly used [7,8]. The advantage of using elastomeric impression materials like PVS and polysulfides is their ease of handling and manipulation, dimensional stability, adequate working and setting time and improvement in overall properties. The main disadvantage of Zinc-Oxide Eugenol pastes is that it is inelastic, sticks to skin and mucosa and causes a burning sensation.

A special consideration to excessive movable flabby tissue was made by 80% of the respondent, with majority of them (44%) preferring to place relief holes. This is contrast to a previous survey by Mehra *et al* [17] where majority of them used the window technique i.e modified impression technique.

The cost of material often influences the choice of impression material. 48% of the respondents considered the cost of the material before using a material. No significant correlation has been made between the cost of the material and choice of material in previous surveys.

CONCLUSION:

This study explained the current trends regarding impression materials and techniques for complete denture fabrication amongst general practitioners in and around Chengalpet district.

Based on the results of the study and within its limitations, the following conclusions can be drawn.

- Majority of the respondents used Irreversible hydrocolloid impression material for preliminary impressions.
- Most of the practitioners preferred the selective pressure theory during making the impressions.
- Maximum of the practitioners use a spacer covering only the secondary stress bearing and relief areas.
- A large number of practitioners decided the thickness of the spacer based on the amount of relief.
- Most of the dentists used a spacer along with light body addition silicone.
- Vast majority of practitioners selected low fusing modelling plastic for border molding the custom tray.
- Most of the dentists used polyvinylsiloxane as the material for making final impressions.
- Most of practitioners followed the principles of mucostatic impression wherever excessively mobile tissues were found.
- The cost of the material does not significantly influence the choice of material.

- Maximum of the practitioners use a spacer covering only the secondary stress bearing and relief areas.
- A large number of practitioners decided the thickness of the spacer based on the amount of relief.
- Most of the dentists used a spacer along with light body addition silicone.
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Conflict of interest: Nil

Role of Prosthodontist in patient identification in forensic odontology - An Overview

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Abstract:- *Victim identification is important in cases of natural and manmade disasters, especially in mass casualties. Dental Records have proven to be one of the useful methods of identification when all other methods fail. Prosthodontists play a key role in forensics by incorporating patient's records into the prosthesis they provide, by implant identification and also by using rugae anatomy in edentulous patients. Denture marking/labeling should be made mandatory and should be followed as a standard routine procedure as they provide valuable information and easy identification. This article will emphasize the role of prosthodontist in forensics, especially the various techniques and methods to incorporate a patient's dental records in the prosthesis.*

Key words: - denture marking, denture labeling, forensic odontology, victim identification, patient identification

INTRODUCTION

Forensic dentistry is that branch of dentistry, in the interest of justice, related with handling, examination, evaluation, and dental findings presentation.^[1] Victim identification in natural calamities, mass accidents especially in cases of unknown records or in demorphed cases is very important. The most commonly used methods of victim identification are visual identification, fingerprints, DNA profiling and dental records.^[2] Dentists play a major role in identification of the deceased in forensics. Dental records and the resistance of the dental structures in case of disasters make them valuable records for patient identification.

Dental records created before the death of the individual can be used for comparison of postmortem records. The records should be updated without any delay in the patient's record to prevent inconclusive identification or misidentification.^[3]

Prosthodontists can be of prime importance in patient identification by incorporation of patient records and details during the denture fabrication. They can be very useful in forensics by providing clues to the deceased or demorphed victims.^[3,4] Denture marking or labeling can be done routinely as a standard procedure which will be very much helpful.^[5] It also facilitates the identification of a patient in cases of unconsciousness, loss of memory and dementia especially in geriatric patients.^[6] In case of implant patients, the use of implant identification systems can be helpful in tracking the identification.^[7]

Rugae anatomy have been found to be specific and unique for individuals and rugoscopy has been tried as means for identification in edentulous patients in whom teeth cannot be utilized for identification.^[8]

This article will emphasize the role of prosthodontist in forensics, especially the various techniques and methods to incorporate a patient's dental records in the prosthesis and its use in victim identification in forensic odontology.

Denture Labeling/ Denture Marking:

Denture labeling is a well-documented technique useful in the victim identification in cases of disasters and also for patients who suffer from loss of memory.

Requisites of Denture Labeling/ Marking System:

The British Council on Prosthetic Services and Dental laboratory Relations has given standard guidelines on the requirements for denture markers:^[9]

- The strength of the prosthesis must not be compromised;
- It should not be technique sensitive, must be easy and inexpensive to apply;
- The identification system must be efficient;
- The marking must be visible and durable;
- The denture marker must withstand humidity and fire;
- The Labeling should be aesthetically acceptable;
- The mark should be biologically inert.

The marking should be permanent and resistant chemically and mechanically to daily cleansing procedures.

Significance of Denture Labeling in forensics:

1. It helps in identification of the dead or deceased when all other means have failed.
2. It helps in identification of individuals for forensics, social and legal reasons.
3. Identification of victims in mass disasters like terrorism, bombings, earthquakes, hurricanes, mass aviation crashes and road traffic accidents.
4. Identification of demorped/ mutilated and decomposed bodies

Denture Labeling Methods:

They can be broadly classified into

- Surface Marking methods
- Inclusion methods

Surface Marking Methods:

Scribing or Engraving method:

In this method the engraving is done directly on the denture with the help of a round bur on the tissue surface of the denture. The disadvantage of this technique is there is a possibility of food lodged on the surface irregularities of the engraving which may create an environment for bacterial infections.^[11-12]

Embossing Method:

In this method the patient's details are scrapped on the surface of the master cast and after the processing the details are transferred to the prosthesis on the intaglio surface. This technique is not recommended as there was a report of carcinoma due to constant irritation.^[11]

Invisible Ink Method:

In this method the patient's details are written with an invisible ink that will be visible only using an ultraviolet light. This method can be used in patients who are more aesthetically concerned. The disadvantage of this technique requires special conditions to view the identity details.^[13]

Fibre tip pen method:

This is a temporary method of denture labelling by writing using a fibre - tip pen on the surface of the denture and applying a layer of clear varnish over it.^[11]

Heath's Method:

In this technique the identity mark was made with spirit based pen or pencil and covered with a clear base polymer dissolved in chloroform. As chloroform is carcinogenic, this technique was later modified by the author by replacing chloroform with dental sealants.^[10]

Stevenson's Method:

Identification mark is made using a scalpel blade on the distobuccal flange of the denture and then the mark is highlighted with a graphite pencil. But the disadvantage is the mark did not last for long.^[10]

Wecker's Electro Pen Method:

The patient's details are engraved using an electopen on metallic removable and fixed partial dentures.^[10]

Laser Etching Technique:

This technique is used in cases of cast partial dentures. The etching was done using a copper vapor laser and the patient's details are etched into the metal surface of a partial denture. The copper vapour laser beam is focused and delivered to the material surface by the two-axis scanner mounted with mirrors.^[12]

Onion Skin Paper Method:

The patient's identification details are written on an onion-skin paper with a carbon marker and incorporated in the denture during the packing state at the trial closure. The onion paper is peeled from the denture after processing is complete, which leaves a carbon impregnation of the details on the surface layer of acrylic resin.^[10]

Denture Barcoding Method:

Barcoding is now commonly used for product details and billing in all the commercially available products. A bar code consists of a machine-readable code of a series of bars and spaces printed in defined ratios. Denture bar coding technique involves printing a number code on paper, photographing the paper and transferring the negative on a piece of silk. The barcode is directly placed onto the denture surface and cyanoacrylate resin is painted to conceal the marking.^[12]

Inclusion methods

These are methods where in the patient's details are incorporated within the contours of the denture without any alteration of the surface contour of the denture. These methods are more preferable as they don't alter the surface contour of the denture. Disadvantages include technique sensitivity, dislocation of the materials during the process of packing of the denture.

The different inclusion techniques are :

Lose Inclusion Method:

This is a simple and inexpensive technique wherein the patient's name is written on a piece of onion skin paper and incorporated within the fitting surface of the denture during the packing procedure.^[10]

Young's Method:

In this technique, a groove of 0.5–1 mm deep is created using a round bur in the buccal flange of the denture. The patient's name is written using a pen in the trough and sealed with fissure sealant.^[10]

Dippennar's Method:

Engraving of the patient's detail is done on a soft metal band and incorporated into the denture after making space in the denture. The metal band is resistant to fire accidents.^[10]

Reeson's Method:

Stainless steel tape of 9.5 * 0.125 mm thickness is engraved with patient's details and incorporated into the fitting surface of the denture during trial packing.^[14]

Resin T-bar Method:

A clear acrylic resin bar constructed in the shape of the letter T. Patient details are printed on label and fixed against the flat section of the bar with

the print facing inward. The surface of the resin is polished to produce a clear window displaying the identity label.^[10]

Oliver's Method: The patient's details are written with a permanent marker on a 0.3 mm thick rectangular sheet of heat cure acrylic resin strip and packed during the trial closure stage and covered with a thin layer of acrylic resin dough. Using acrylic resin sheet as marking material provides advantages that even if the tag moves during packing, and a corner protrudes through the denture surface, it can be corrected easily.^[15]

Lenticular Card Method:

Lenticular lens technology is used to produce images with an illusion of depth, morph or the ability to change or move as the image is viewed from different angles. Lenticular printing is a multi-step process consisting of creating a lenticular image from at least two or more existing images, and combining it with a lenticular lens. Each image is sliced into strips, which are then interlaced with one or more of the other images. They are printed on the back of a synthetic paper and laminated on the lens. The materials used for making lenticular images are polyvinyl chloride (PVC), amorphous polyethylene terephthalate (APET), acrylic, spectra, and polyethylene terephthalate glycol (PETG). The lens is incorporated in the recess cut on the denture and auto-polymerizing clear acrylic resin is added around the identifier.^[16]

Barcoding:

A barcode is an optical machine-readable representation of data which can be read with a barcode scanner. QR (Quick response) code is a form of bar code which is widely used nowadays. The patient's details can be entered in the qr code generator website and a QR code can be generated and printed on to paper or metal strips according to the desired size. The code is placed into the denture by creating space in the denture and covering it with autopolymerizing resin. The code can be read using a QR code application in smart mobile phones.^[17] In the technique described by Priya et al, they fed the patient's Aadhar unique ID in a QR code generator and obtained a QR code label which was incorporated into the denture.^[18]

Radio-Frequency Identification Tag:

Radio-frequency identification (RFID) is a wireless electronic communication technology used during World War II to identify aero planes. In this technique the patient's details are stored in a microchip. The RFID tag will be incorporated into the denture and the details can be read using a reader. The reader converts the radio waves transmitted by the transponder antenna into digital information which is then passed to a computer with applications to interpret it. This technique requires special equipment for reading the data.^[19,20]

Lead Foil Technique:

Lead foil with patient details on it is sandwiched between two layers of resin during processing of the denture. A radiograph of the denture will help in visualizing the patient details marked in the lead foil.^[21]

Metallic ID Bands:

In this technique foil of metal band (6*3 mm) with patient's details are incorporated within the denture by making space for the metal foil by creating recess using a round bur in the denture and sealing the band using clear acrylic resin. Example: Swedish ID bands. The Swedish ID-Band is a stainless steel band engraved with a ten figure personal number of patient details. The personal number consists of a letter (S- for Sweden) and a ten-figure number. The first six digits are the patient's birth date, date month, year with zero as a prefix to numbers smaller than ten. The next three digits is the birth number and the last digit indicates the sex.

This technique is easy and simple, the bands are corrosion resistant, temperature resistant but not more than 1100 deg C, do not require any special equipment and esthetically acceptable.^[22]

Photograph Inclusion Method:

In this technique the patient's details are written on a photograph with a graphite pencil and then incorporating the photograph in a clear acrylic denture base.^[23]

Incorporation of Min. I. Dent:

The Min. I. Dent denture identification strip is used for typing the patient information and then the strip is heated in an oven at 325 deg C for 30 sec to 1 min, which causes the letters to shrink and it becomes a chip. This chip is incorporated into the denture after creating space in the denture and clear acrylic resin is covered over the chip.^[24]

Data Matrix Code:

Thermally resistant substrate wafer consisting of two dimensional data matrix of light and dark colored regions representing binary 0 and 1 is scanned using a handheld scanner. It was found that auto polymerizing resin causes the wafer to dissolve partially making it unusable. So, direct laser engraving of the code into ceramic discs was carried out. The coded discs were incorporated into the heat cured clear resin at the packing stage of denture fabrication.^[25]

Micro Labeling Technique:

The following are the different techniques that have been used for micro labeling:

- (i) In the technique described by Coss, the patient's information was printed either on a 9 or 12 mm, white or clear label tape and it was incorporated at the time of denture processing or can be inserted after denture finishing.^[26]
- (ii) Ibrahim proposed his technique wherein, micro label was in a graphic image after incorporating patient details and recording the image on an instant Polaroid slide film. The patient information was keyed into the PowerPoint slide making format with a font size of 22 to produce a 15* 3 mm label. The graphic image on the computer was sent to the Polaroid digital palette, which contained an instant digital slide film. Then it was transformed into a 35 mm slide which was later cut as per the requirements and placed into a 1 mm groove prepared on the denture surface. The label was sealed using auto polymerizing clear acrylic resin.^[27]

(iii) In Ling's method the patient details are printed and photocopied onto a transparent film with 50% reduction in size and then treated with cyanoacrylate resin.^[28]

(iv) In the modified Ling's method the patient data is directly printed onto the overhead transparency sheet. Cyanoacrylate adhesive is applied over the printed matter and a same size blank transparency sheet is placed over it. This prevents the monomer from deteriorating the printer toner.^[10]

(v) In the technique proposed by Kamath, the patient's data is typed on a strip of absorbent tissue paper and placed on the tissue surface of the denture.^[29]

Incorporation of Embossed Identification Plate into Partial Denture Framework:

In this method, casting of the partial denture is done after incorporation of an embossed tape with patient details embedded into the major connector portion of the plastic pattern of the partial denture framework. As the marking is on the metal framework the identification is possible even in extremely disastrous conditions.^[21]

Ceramic Crown Engraving Method:

This method was tried in order to incorporate denture identification in fixed dental prosthesis. But the main disadvantage is the lack of space to incorporate the details. Here, the patient's initials are carved with a brush during the application of dentin porcelain and stains are applied over it followed by application of enamel porcelain.^[29]

Incorporation of Memory Card:

Memory card is an electronic storage device which can be used to store data files such as audio and video files, images and text documents. The patient's details such as personal information with the photograph can be stored in the memory card. The memory card is enclosed in a cellophane sheet and incorporated on the external surface of the palatal aspect of the denture and covered with a layer of auto polymerizing acrylic resin. This technique is simple and easy does not require special equipment and lies within the contours of the denture.^[30]

Implant Identification:

There are a wide range of implant systems with different designs available in the market of over 230 implant systems worldwide. Implant Recognition Software (IRS) is a software algorithm that helps in matching the implant, based on the data available in the web portal database. There are nine questions to be answered even if not all the information is known, then the data bank will be searched and those implant systems which meet the criteria will be listed. The following details are required: radiographic images of the implant, clinical images of the implant from above showing the trans-mucosal connector, and clinical images of the implant itself can be checked against the patient. Once the software has identified the implant system then a summed up report of that implant system outlining all the implant features, contact details for the implant manufacturer (e-mail addresses, web- page and conventional address and phone numbers) is provided.

This software program could be very much useful in victim identification by tracking the implant manufacturer, dealer, the dentist and the probable location of the patient.

Implant systems from StraumannTM, Nobel biocare and Ankylos contain batch numbers etched within the implants which are also useful tools in implant identification and also victim tracking.^[7]

Advantages of denture

Labeling/Marking^{[21]:}

- Patient identification
- Appliance identification
- Retrieval of dental records
- Diagnostic and decision support
- Recording and storage
- Quality assurance and quality control
- Complete and assurance documentation
- Improved accountability for purchasers/providers
- Ability to trace suppliers, materials, equipment

Rugoscopy:

The study of palatal rugae is called rugoscopy. The rugae are soft, irregular, asymmetrical ridges of mucous membrane extending laterally from the incisive papilla located in the anterior part of the mid palatine raphe. The arrangement pattern of rugae is considered to be unique to an individual. They can be used in cases of edentulous patients without dentures for identification. But the ante mortem data of the rugae pattern has to be stored by the dentist which can be utilized for comparison after death.^[8]

Conclusion:

Prosthodontists can play a major role in victim identification in forensic odontology by incorporation of the patient's details in the appliance or the prosthesis they provide. Different techniques have been proposed by various authors for denture marking. The technique should be simple, easy to fabricate, made of material which will withstand high temperatures and should be easily readable without any requirement of specialized equipment. Denture marking should be made mandatory and as a standard routine procedure as it provides valuable information in victim identification. In the future, more studies have to be done to incorporate patient details in fixed prosthesis.

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