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Original Research

ASSESSMENT OF POST INSERTION PROBLEMS AMONG REMOVABLE DENTURE WEARERS IN THREE DENTAL INSTITUTIONS OF CENTRAL MALABAR

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Abstract

Background: Removable partial dentures are an economic and easy treatment modality for edentulous patients, but some patients may encounter few complications during their adaptation period. If these complaints are not addressed properly it can lead to patient disappointment and ultimately removable dental prostheses failure. The present study intends in providing a structuro-functional assessment of complete denture complaints as reported by patients of three Dental Colleges in the Malabar region. **Aims and objectives:** To evaluate the incidence of common post insertion problems and to point out and minimize common post insertion complaints of removable dentures fabricated in dental institutions of central Malabar. **Materials and Methods:** A questionnaire based study was conducted in three dental institutions of Central Malabar. The study was carried out on 120 patients who had undergone prosthetic rehabilitation with removable dental prosthesis from these dental colleges and the post insertion complications were evaluated between them. The questionnaire consisted of questions based on various post insertion complications like pain on insertion and removal, ulceration, aesthetics, difficulty in speech, ill-fitting dentures, difficulty in mastication, reduced tongue space. **Results:** According to the study, 95% were satisfied with the denture and only 4.2% showed dissatisfaction. 48.3% complained about ill-fitting dentures, 42.5% about loss of retention, only 27.5% about pain and discomfort, 10% about cheek bite, 2.6% about radiating pain. 92.5% were satisfied with the denture esthetics, 87.5% were satisfied with teeth shape, 90% with teeth size and 100% with the lip support and 5.8% had a negative response about the sunken cheek appearance. **Conclusions:** Ill fitting dentures were the most frequent complaint among denture wearers in the present study followed by lack of retention. Most of the patients were content with the aesthetic aspect of the denture. The most common reason why patients wanted rehabilitation of the lost dentition was for mastication. The quality of denture in the department can be assessed and further efforts can be made on improving the aspect of denture fabrication by undergraduates and postgraduates.

Key Words: Removable partial denture, Post insertion complaints, Denture wearers, Retention

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Introduction

Removable Prosthodontics denotes the branch of Prosthodontics concerned with replacement of teeth and contiguous structures for edentulous or partially edentulous patients by artificial substitutes that are readily removable from mouth by the patient. Removable dental prostheses can be partial or complete dental prosthesis. Though removable partial dentures are an economic and easy treatment modality for edentulous patients, some patients may encounter few complications during their adaptation period. The major factors that cause post insertion complaints are thick or over extended denture flanges, loose or tight fitting dentures, occlusal interferences or frenal impingement, overextended borders, impingement of clasp and entrapment of movable tissues causing pain and loose dentures due to poor seal or over extension. If these complaints are not addressed properly it can lead to patient disappointment and ultimately removable dental prostheses failure.

Determining the chief cause of a complaint is important not only for its redressal but also to avoid similar mistakes in future. No single factor appears to determine the patient's satisfaction with his complete denture; rather, a concerted action of psychological, biological, anatomical, and technical factors is decisive.

The present study intends in providing a structuro-functional assessment of complete denture complaints as reported by patients of three dental colleges in the Malabar region.

Aims and objectives

- To determine the frequent post insertion complaints associated with removable denture prostheses.
- To evaluate the incidence of common post insertion problems.
- To point out and minimize common post insertion complaints of removable dentures fabricated in dental institutions of central Malabar.

Materials and methods

Systematic random sampling was done. Patients who had worn removable dentures for at least 6 months were the minimum criterion for selection. A verbal and written consent was obtained from each patient. The general information regarding name, age, gender, occupation address, education and socioeconomic status were collected from the patient.

A questionnaire form was designed to determine the most common problems associated with complete and removable partial dentures.

Result

Descriptive statistical analysis were done. Out of the 120 patients studied, 53 were males and 67 were females. The majority of

patients were 50 years or above. 68.3% preferred to replace the denture for improve

function, 11.7% for esthetics and 20% for phonetics. 93.3 % had used denture previously.

Table 1: The questionnaire and the response obtained

Questions asked	Response as "Yes" (%)	Response as "No" (%)
Ill-fitting denture	48.3	51.7
Retention	42.5	57.5
Pain	27.5	72.5
Cheek bite	10.0	90.0
Radiating pain	2.6	97.4
Denture esthetics	92.5	7.5
Satisfactory teeth shape	87.5	12.5
Satisfactory Teeth size	90	10
Sunken cheek appearance	5.8	94.2
Lip support	100	0
Teeth clattering	3.3	96.7
Restricted mouth closure	7.5	92.5
Food lodgment	10.8	89.2
Lisping	10.8	89.2
Whistling	1.7	98.3
Gagging	0.8	99.2

According to the study, 95% were satisfied with the denture and only 4.2% showed dissatisfaction. Assessing the most common complains; 48.3% complained about ill fitting dentures, 42.5% about loss of retention, only 27.5% about pain and discomfort, 10% about cheek bite, 2.6% about radiating pain.

92.5% were satisfied with the denture esthetics, 87.5% were satisfied with teeth shape, 90% with teeth size and 100% with the lip support and 5.8% had a negative response about the sunken cheek appearance.

Assessing the functional problems while using complete denture; food lodgment was given by 10.8%, lisping by 10.8%, restricted mouth closure by 7.5%, teeth clattering by 3.3%, whistling by 1.7% and gagging by 0.8%.

Discussion

Post insertion complications arise due to poor diagnosis, incorrect treatment planning and denture design. Therefore emphasis should be given for careful designing of the denture, improved impression technique with adequate border molding, good occlusal records, and careful denture trial and insertion followed by scheduled post insertion reviews. Patient's acceptance and motivation to use the removable dental

prosthesis also play a significant role in success.

Thus it is important that patients are rigorously counseled during the fabrication process that they will have to come and get the post insertion complaints resolved.

Conclusions

Ill fitting dentures were the most frequent complaint among denture wearers in the present study followed by lack of retention. Most of the patients were content with the aesthetic aspect of the denture. The most common reason why patients wanted rehabilitation of the lost dentition was for mastication. The quality of denture in the department can be assessed and further efforts can be made on improving the aspect of denture fabrication by undergraduates and postgraduates.

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Literature Review

CLASSIFICATION OF COMPOSITE RESINS AND A REVIEW ON NANOFILLED COMPOSITE

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Abstract

Composite resins have progressed from macrofills to microfills and from hybrids to microhybrids. The recently introduced ‘nanofilled composites’ are produced by the nanofiller technology and formulated using nanomer and nanocluster filler particles. The aim of this review is to compile recent evidences related to nanofilled resin composite materials regarding their properties. Special attention was given to mechanical properties, such as strength, hardness, abrasive wear, water sorption, and solubility.

Key Words: nanofilled composite resin, hybrid composite resin, microfilled composite

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Introduction

Composite resins are increasingly been used in modern dentistry due to its desirable qualities, such as esthetic appearance, good physical and mechanical properties.¹ Their clinical applications include restorations, cavity lining, core buildups, luting and more. The Mechanical properties and esthetic appearance of resin composites rely mostly on their composition and microstructure. Despite the improvements in various properties over the years, the major changes to their composition involve the fillers rather than the monomer systems, which were originally developed by Bowen² in 1962.

Classification of resin based composite

Generally, a composite resin include three phases:

- (1) the organic phase (the matrix)
- (2) the interfacial phase (the coupling agents) and
- (3) the dispersed phase (the fillers)³

Based on the manufacturing technique, average size and chemical composition, the filler particles can be categorized into three-

- (1) Traditional macrofillers
- (2) microfillers (pyrogenic silica), and
- (3) microfiller-based complexes.

Table 1: The different types of composites

• ANUSAVICE (-11 th ed)		
Class of composite	Particle size	Clinical use
Traditional (large particle)	1–50 μm glass	High-stress areas
Hybrid (large particle)	(1) 1–20 μm glass (2) 0.04 μm silica	High-stress areas requiring improved polishability (Classes I, II, III, IV)
Hybrid (midifiller)	(1) 0.1–10 μm glass (2) 0.04 μm silica	High stress areas requiring improved polishability (Classes III, IV)
Hybrid (minifiller/SPF)	(1) 0.1–2 μm glass (2) 0.04 μm silica	Moderate stress areas requiring optimal polishability (Classes III, IV)
Packable hybrid	Midifiller/minifiller hybrid, but with lower filler fraction	Situations in which improved condensability is needed (Classes I, II)
Flowable hybrid	Midifiller hybrid, but with finer particle size distribution	Situations in which improved flow is needed and/or where access is difficult (Class II)
Homogeneous microfill	0.04 μm silica	Low-stress and subgingival areas that require a high luster and polish
Heterogeneous microfill	(1) 0.04 μm silica (2) <u>Prepolymerized resin</u> particles containing 0.04 μm silica	Low-stress and subgingival areas where reduced shrinkage is essential

The three types of fillers described above represent the backbone of the classification. The traditional macrofillers, microfillers, and micro-filled complexes are organized into four majorsystems.

Classification

Based on filler particle size and size distribution, resin composites are classified as shown in the table 1above.

Nanofilled composites

The introduction of nanometer sized particles have been one of the recent developments in the field of dentistry and it offers superior esthetics and polishability in addition to excellent wear resistance and strength^{4,5}. The growing interest in nanotechnology and its use in resin composites is based on the ability to utilize the nanosized particles to alter the structure of composite. This in turn may improve the

mechanical, chemical, and optical properties and develop a resin composite that can perform optimally in all parts of the mouth. Consequently, Mitra and others introduced novel nanofillers and then utilized various methacrylate resins and curing technologies to develop nanocomposites. This nanocomposite was then marketed as the Filtek range of restorative materials (3M ESPE, St Paul, MN, USA). Two classes of resin composites that include nanoscale filler particles in their composition have been introduced, namely, nanofilled and nanohybrid resin composites. While nanofilled composites use nanosized particles throughout the resin matrix, nanohybrids include a mixture of nanosized and conventional filler particles. (courtesy :Jum'ah AA, Creanor S, Wilson NH, Burke FJ, Brunton PA. Dental practice in the UK in 2015/2016. Part 3: aspects of indirect restorations and fixed prosthodontics. British dental journal. 2019 Feb;226(3):192-6.)



Nanosized fillers can be categorized as either isolated discrete particles, with dimensions of around 5 to 100 nm, or fused

aggregates of primary nanoparticles, where the cluster size may exceed 100 nm. It has been proposed that finer particles when incorporated into resin composite will lead to less interparticle space, thus protecting the more vulnerable, softer resin matrix. This in turn will result in reduced “plucking” of filler particles from the material surface^{6,7}.

Mechanical properties of nanofilled composites

Strength

The main aim of incorporating nanofillers into resin composites (ie, nanocomposites) is to create materials that can be used to restore both anterior and posterior teeth with a high initial polish and gloss. In addition, they should exhibit mechanical strength suitable for use in high-stress-bearing areas⁵.

Flexural Strength

One of the most commonly tested mechanical properties of dental restorative materials is flexural strength (FS), which is considered important in defining brittle materials. Direct comparison showed that the FS of nanocomposites was equivalent to or even higher than other composites tested with values ranging from 103 to 192 MPa. Mitra and others, who developed nanocomposite materials in 2003, reported FS values ranging from 153 to 177 MPa.

The 2-mm thickness is traditionally used and recommended by the ISO standard (4049) for dental resins⁸. However, it has been

reported that the fracture behavior and the structural reliability does not seem to be affected in highly filled composites compared with composites with lower filler content, such as microfilled resin composites. This is because the volume percent content of the fillers may not be markedly different.

A number of investigators indicated that the filler content and material category had a significant influence on mechanical properties of resin composites, including nanocomposites. Higher strength was associated with spherical filler particles¹⁰, and the highest values of FS were observed at a filler volume of 60%. It is reasonable to conclude that the reported FS of nanocomposites was not superior to that of most hybrid composites but was significantly higher than microfilled composites.

Mitra and others reported CS and DTS values of nanocomposites to be comparable to or higher than the tested hybrid and microfilled composites. Nanocomposites displayed the highest DTS values and comparable CS values to hybrid composites.

Fracture toughness

Fracture toughness (FT) is used for assessing brittle materials in order to identify the material's fracture resistance. It is also used to assess the amount of energy that is needed to cause the propagation of a crack from a well-defined preexisting crack or notch placed in the tested material⁹. Mitra

and others⁵ developed nanocomposites and compared the seven-day FT with hybrid and microfilled composites. The reported values of the two nanocomposites (standard and translucent) were 1.3 and 1.2 MPa=m, respectively, comparable to the hybrid (1.2 MPa=m) and significantly higher than the microfilled (0.9 MPa=m). However, FT of the translucent nanocomposite was significantly lower than other hybrids tested (1.4 MPa=m).

Improved mechanical properties of nanocomposites due to the incorporation of nanofillers into the resin matrix. This in turn leads to a reduction in interparticle space and therefore protection of the organic matrix. Furthermore, nanofillers can act as points that may slow the initiation of or even stop crack propagation⁹. Studies indicate that FT of nanocomposites was not superior to that of hybrids but are higher than the microfilled composite

Hardness

The hardness of commercial resin composites is a property that is closely related to wear resistance and long-term stability of these materials in the oral cavity¹¹. Literatures suggest that a composite is properly polymerized when the maximum hardness of the bottom surface is 80 percent of the hardness value of the top surface.

Mota and others⁴ reported a wide range of Knoop microhardness values of

nanocomposites that were attributed mainly to differences in the filler content (55 to 123 KHN). Several researchers reported higher hardness values for a number of nanocomposites compared to hybrid composites. This was attributed to higher filler content, large and densely packed filler particles, and resin content of the nanocomposite tested. The microhardness of a nanocomposite was found to be inferior to that of a hybrid by several researchers who attributed this to the complex nature of the nanocomposite's filler content, larger filler volume, and greater amount of pigment. Each composite showed a distinct performance in terms of hardness and wear that was attributed to the formulation of each material. A positive correlation between curing method, depth of cure, curing time, and the hardness of nanocomposites were also reported by others. Similarly, Marchan and others¹² reported better microhardness values of tested nanocomposites when light cured for 20 seconds using QTH and LED units compared to 10 seconds.

Abrasive wear

Wear has been defined as the gradual removal of a material as a result of the interaction between two surfaces moving against each other¹¹. Wear of resin composite has been reported to be dependent on filler loading and size in addition to the resin matrix and the adhesion of fillers to the matrix. Hamouda and Abd Elkader¹³ reported that the nanocomposite tested in their study demonstrated a

significantly lower wear value compared to the hybrid composite that was attributed to the higher filler loading and smaller particle size associated with the nanocomposites. Also, a number of researchers reported comparable wear values between nanocomposites and microfilled composites and has reported to display the lowest abrasive wear among resin composites.

Sorption and solubility

Higher sorption and solubility of the nanocomposite is explained by the greater surface area of the nanofillers. This makes them more prone to ion leaching and hydrolysis of the silane coupling agent, leading to the filler particles becoming detached and lost. Higher values of salivary sorption of the nanocomposite were attributed to water accumulation at the filler-matrix interface and inside the aggregates of the nanocomposite. Furthermore, lower the strength values, higher the sorption and solubility values. The lower strength values of the nanocomposite were attributed to the poor silane penetration of the porous nanoclusters. This made the nanocomposite susceptible to degradation when stored in water. The effect of using different storage media on sorption and solubility of resin composites was assessed by several researchers. Almeida et al and Lopes and others demonstrated an influence of storage media on the sorption of resin composites. It was suggested that the higher water sorption was related to the larger ratio of surface area

to volume of the silica nanofillers and the hydrophilic nature of the polymeric matrix. Regardless of media type, the immersion of resin composites presented an increase in solubility and sorption as a function of depth. The above mentioned data indicate higher sorption and solubility of nanocomposites.

Conclusion

It has been shown that commercially available nanocomposite materials do not hold any significant advantage over hybrid composites in terms of strength and hardness. Furthermore, higher sorption and solubility values were found for nanocomposites compared with hybrid composites, and these might influence their clinical performance. On the other hand, the incorporation of nanofillers into resin composite materials was associated with lower abrasive wear of nanocomposites.

However, attention should be focused on the resin matrix composition and not only the filler system to be able to assess abrasive wear behavior. In the current review, nanocomposites demonstrated acceptable clinical performance compared with hybrid resin composites for review periods ranging from one to 10 years. However, there was no definitive report of the superior performance of nanocomposites in the majority of evaluation criteria used.

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Literature Review

DRAWBACKS OF COMPOSITE RESIN AND POLYMERIZATION SHRINKAGE

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Abstract

Composite resins have always been a priority for the restoration of anterior teeth; increasingly, they have also gained prominence in the restoration of posterior teeth. This has been due to their advantages as an alternative to amalgam¹. Their drawbacks however, can include poor marginal adaptation, postoperative sensitivity and cuspal movement¹. These are particularly associated with the polymerization shrinkage accompanying the placement of composite resins. This article aimed at evaluating drawbacks of composite resin with more emphasize on to polymerization shrinkage.

Key Words: composite, polymerization shrinkage, drawback

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Introduction

The use of composite resins in dentistry and the interest have risen markedly in recent years. A wide variety of vastly improved composite materials have been and will continue to be used for the overall purpose of conservative restorative dentistry.^{1,2} Dental composite resins are heterogeneous materials with two components, the resin matrix and the filler particles. The polymeric matrix in dental resins contains a variety of high molecular weight monomers, mainly based on bis-GMA, which is derived bis-phenol.³⁻⁶ The filler particles constitute up to 86 per cent weight,⁷ 71 per cent by volume of the

material, and those used in commercial composites cover the whole range of quartz, borosilicate glass and aluminosilicate glass.^{7,8} The monomer matrix is very viscous diluent monomers are added to improve workability. These are typically difunctional monomers, of lower mass than bis-GMA, Some composite resins also utilize alternative monomer systems in which bis-GMA a partly or wholly replaced by aliphatic or aromatic urethane dimethacrylates⁶. During setting, the resin typically undergoes free radical polymerization to harden with a consequent reduction in volume. The generally preferred mode of cure in dental composites

is photopolymerization,⁹ whereby the polymerization is, initiated by blue light acting on a photosensitive initiator, usually camphoroquinone, present in the monomer phase of the composite resin. These composite resins do not display complete polymerization, and there is considerable residual unsaturation in the final product⁹ with a degree of conversion (DC) ranging from 55 to 75 per cent.^{10,11} Composite resins have gained prominence in recognition of their superior aesthetic qualities along with their fulfilment of the basic requirements of restorative materials. Their drawbacks however, can include their relative cost and difficulty of placement as well as poor marginal adaptation, postoperative sensitivity, cuspal movement. The latter features are particularly associated with the polymerization shrinkage that accompanies the placement of composite resins and as would be expected, the increased use of these resins is accompanied by research into issues specific to them.

Drawbacks of composite resins

Posterior resin-based composites have certain drawbacks that limit their clinical use. These materials are more technique-sensitive than amalgam, requiring more time for placement because they necessitate rubber dam isolation for field control and incremental buildup.⁷

In larger Class II cavity preparations, it is more difficult to obtain proper contour and achieve adequate proximal contact with

conventional composite than with amalgam, because conventional composite is not packable.¹² To improve ease of manipulation the ideal resin-based composite should have a viscosity stiff enough to facilitate placement without adhering to the condensing instrument. The new packable resin-based composites reportedly offer these in handling. Uncured resin at the base of the restoration or gaps at the composite-tooth interface resulting from polymerization shrinkage can cause microleakage, with resultant pulpal sensitivity, staining and recurrent caries. Another concern in the clinical use of resin-based composite restorative materials is their ability to withstand occlusal forces and stresses of the oral environment, particularly in posterior situations. Traditionally, composites have been advocated for use in areas of minimal stress.¹³ Newer composite restorative materials have increased strength owing to both a higher filler content and a greater degree of polymerization, which improves their physical properties. The new packable composites are reported to withstand greater occlusal forces and are recommended for use in situations in which amalgam previously was the restoration of choice.

Polymerization shrinkage

The polymerization of dental composite resins is accompanied by shrinkage. The polymerization shrinkage is dependent on many factors, including the density double bonds, molecular weight and the degree of

conversion. . The polymerization shrinkage is defined as the ratio of the change in length or volume to the original length or volume respectively.



Shrinkage vectors

The direction in which polymerization shrinkage takes place can be indicated by shrinkage vectors. In a free standing block of material, the internal stresses and continuing reaction will tend to cause polymerization shrinkage to be manifested in compliance with the theory that composites shrink towards the light¹. In a tooth cavity, however, external constraints may operate, modifying the shrinkage vectors. These constraints are predominantly the cavity configuration and surface attraction between the cavity walls and the material. Initially, through the use of the acid etch technique and certain primers and bonding agents the resin attaches to the cavity wall, and shrinkage occurs exclusively from the free surface of the filling. Elastic yielding in the material in the region of the bond may alleviate some of the contraction forces. . This degree of flow will

depend on material supply from the free surfaces of the restoration and is thus highly dependent on the three dimensional configuration of the restoration. However, if the net shrinkage forces are greater than those resisting at the cavity walls, then the result will be interfacial bond failure. A gap will be formed along the margin of the filling and contraction will continue relatively unrestricted. This will culminate in a filling with perfect adaptation for part of the margin and a gap for the remainder. Such marginal gaps are a direct consequence of the opposition by the shrinkage of the material to bond between the composite and the tooth structure.¹

Volumetric shrinkage

Contraction stress in composite restorations is the result of polymerization shrinkage taking place under confinement, due to bonding to cavity walls. When monomers in proximity react to establish a covalent bond, the distance between the two groups of atoms is reduced and there is a reduction in free volume, both of which translate into volumetric shrinkage experienced by a composite and is determined by its filler volume fraction, the composition and degree of conversion of resin matrix.

Filler content

Shrinkage values reported for Bis GMA and TEGDMA are substantially higher than those displayed by typical composites, which range between 2 and 3%. This difference is due to the fact that in hybrid

composites, approximately 60% of the volume is occupied by filler particles. Microfilled composites, though their inorganic content is typically about 40 vol%, have shrinkage values similar to hybrids, due to the presence of prepolymerised composite particles, sometimes referred to as “organic fillers”, which render them similar to hybrid composites, in terms of the actual volume fraction of polymerizing resin. Low-viscosity (flowable) composites present volumetric shrinkages upto 5%, in large part due to their reduced inorganic content, which is typically below 50 vol%.

Degree of conversion

In the photoactivated materials, degree of conversion is determined by the product of light irradiance and exposure time (radiant exposure, J/cm²). As curing rate is proportional to the square root of the light intensity applied to the composite, it has been proposed that the method by which light energy is delivered to the composite is capable of delaying the acquisition of elastic modulus, allowing polymeric chains to rearrange and microscopically and macroscopically accommodate the reduction in volume by plastic deformation. It is the so called „rigid contraction“ (sometimes previously referred to as „post-gel contraction“) that is the fraction of the total volumetric shrinkage responsible for stress development. In the photoactivated composites, the fast reaction rate virtually eliminates the time allowed for viscous flow,

and it is estimated that the polymer matrix becomes “rigid” within seconds after a relatively low degree of conversion. As a result, stress begins to build-up almost immediately after polymerization is triggered, and nearly all of the shrinkage occurs after the polymer matrix has reached a significant level of rigidity, the magnitude of which continues to increase with time. Selfcured composites, on the other hand, develop lower contraction stress values than light-cured materials, in part due to their slower reaction rate, but also because the self-initiated reaction generates a smaller number of free-radicals than photoactivation, often resulting in lower degrees of conversion.

Photoactivation methods

Several photoactivation methods have been proposed as alternatives for continuous high intensity irradiation. These curing routines, generically referred to as “soft start”, use of reduced light irradiance during the first few seconds of light activation, switching to high irradiance for the remaining curing time in order to provide the material with sufficient radiant exposure. [It has been reported that these curing methods effectively reduce the shrinkage strain when compared to continuous high intensity photo activation. However, significant reduction in reaction rate do not necessarily correspond to significant reductions in contraction stress. It has been suggested that this discrepancy is due to the fact that dimethacrylate composites develop elastic

modulus at very low conversions. Therefore, even at relatively low reaction rates, the stage in the conversion where the composite ceases to allow significant plastic deformation is reached rapidly. This technique of changing polymerization rate has limitations. Its efficacy varies according to composite formulation. It may alter the nature of the polymer network formed.

Concentration of diluents in the resin matrix

Higher TEGDMA/BisGMA ratios in experimental composites resulted in higher contraction stress values due to increased volumetric shrinkage, as a result of enhanced conversion. Diluent monomers have lower molecular weight than the host monomers and they increase the density of polymerizable carbon double bonds, which may lead to more shrinkage.

Viscoelastic behaviour

Early in the polymerization reaction, composites present a predominantly viscous behaviour and gradually, they become elastic. Viscous flow accommodates a significant fraction of the total volumetric shrinkage and stress build up occurs at a faster rate at high conversions. Faster curing rates do not allow enough time for viscous flow. Moreover, elastic modulus acquisition in composites occurs rapidly which further shortens the time available for stress relaxation. Thus, rate of conversion is a

significant factor affecting the generation of contraction stress in dental composites.

Effect of confinement and configuration factor

The c-factor (configuration factor) is a term used for the ratio of the number of walls bonded to unbonded surfaces. During polymerization the restorative resin shrinks and pulls the opposing walls and floor of the cavity closer together. The magnitude of this phenomenon depends upon the configuration of the cavity. The greatest stress occurs when composite is bonded to five walls of a prepared cavity ($C = 5$) as in Class 1 or Class 5 restorations. The lowest C-factor values are obtained with class IV cavities because the material has enough unbonded surfaces to flow, providing stress relief. A high C-factor creates a risk for debonding of the restoration. Therefore, it is important to have a lower configuration cavity.

Methods to reduce polymerization shrinkage

Material aspect

There has been a general consensus about the addition of reinforcing filler to a resin matrix in a composite resins. This is because these inorganic fillers do not undergo any contraction during the setting reaction. The increase in filler content decreases the polymerization shrinkage. Recently, novel monomer combinations and alterations of the resin-composite formulation have been

developed and evaluated with the goal of decreasing polymerization shrinkage stress. Nanocomposites contain a combination of non-agglomerated 20-nm-size nano silica filler and aggregated zirconia/silica nanocluster (primarily 5- to 20-nm size) filler. The combination of nanomer-sized particles and the nanocluster formulations reduces the interstitial spacing of the filler particles. This reportedly provides increased filler loading, thus, reduced polymerization stress. The most recent modification on the polymer matrix is based on using ring opening polymerization of the silorane molecules. These monomers “open” their molecular structures with local volumetric expansion and this may partly or totally compensate for volumetric shrinkage from C=C or similar polymerization. As silorane-based composite polymerizes, “ring opening” monomers connect by opening, flattening and extending towards each other. The molecules of these “linear monomers” connect by actually shifting closer together in a linear response. SILOANE system has been developed to minimize polymerization shrinkage and polymerization stress, while providing a high performance bond to the tooth.

Incremental layering technique¹

Many researchers have suggested the use of “incremental layering techniques” for resin-composite restoration to reduce the polymerization shrinkage and cuspal deflection. By using an incremental

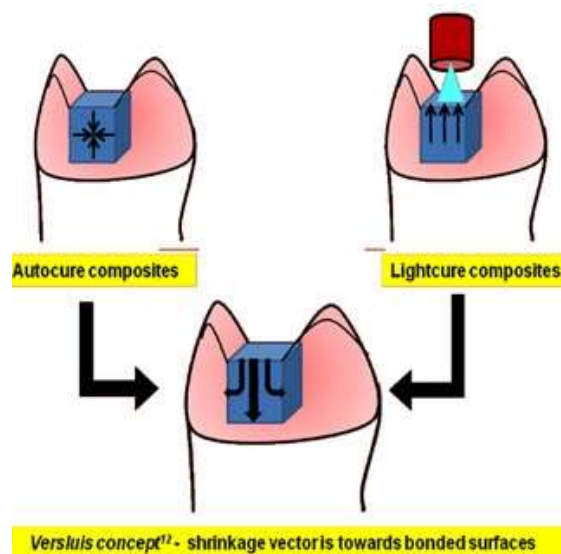
technique, the bonded/unbonded ratio would be reduced and, consequently, the stress level within the cavity might be lower, preserving the bonded area. Cuspal tension from polymerization shrinkage is common. Research shows this tension can be minimized if the composite is placed in at least three increments and each increment is sloped up one cavity wall at a time. [Various techniques include the horizontal occluso-gingival layering, the wedge-shaped oblique layering, the successive cusp buildup technique, and the split-increment, horizontal placement technique.



Effects of curing technique

When composite resins are cured, light passes through the composite attenuates, which means that deeper layers of composite resin are less cured¹. Any factor that decreases the light intensity passing through the composite will lower the conversion rates of the composite resin. If inadequate levels of conversion are achieved during polymerization, polymerization shrinkage

would result and wear resistance is reduced. Curing composite in 2-mm increments is recommended. Even though different curing units have different curing modes, the composite selected affects shrinkage more than the method of curing. The clinical effectiveness of the soft-, ramp-, or pulse-delay cure is questionable. Continued development of composite resins with reduced shrinkage is critically needed.



Stress absorbing layers with low elastic modulus liners

The use of a flowable resin composite as an intermediate thin layer has been suggested as a mean of overcoming polymerization shrinkage stress based on the concept of an “elastic cavity wall” suggested for filled adhesives. According to the “elastic cavity wall concept” the shrinkage stress generated by a subsequent layer of higher modulus resin composite can be absorbed by an

elastic intermediary layer, thereby reducing the stress at the tooth-restoration interface manifested clinically as a reduction in cuspal deflection. However, actual implementation of such a “stress absorbing” material is problematic.

Preheating¹

Recently, preheating resin composites have been advocated as a method to increase composite flow, improve marginal adaptation and monomer conversion. The benefits of preheating composites may have an impact on daily restorative procedures as well, with the application of shorter light exposure to provide conversion values similar to those seen in unheated conditions. The reasons for increased conversion are based on many factors. Increased temperature decreases system viscosity and enhances radical mobility, resulting in additional polymerization and higher conversion. The collision frequency of unreacted active groups and radicals could increase with elevated curing temperature when below the glass transition temperature. Therefore, at raised temperatures, in theory, it would be possible to obtain higher degree of conversion before the vitrification point, decreasing the magnitude of stress. The reasons for increased conversion are based on many factors. Increased temperature decreases system viscosity and enhances radical mobility, resulting in additional polymerization and higher conversion. The

collision frequency of unreacted active groups and radicals could increase with elevated curing temperature when below the glass transition temperature.

Therefore, at raised temperatures, in theory, it would be possible to obtain higher degree of conversion before the vitrification point, decreasing the magnitude of stress. However, real benefits were not fully demonstrated and, until now, there are no published studies showing stress reduction by warming resin composites.

Conclusion

An intense research in the last few years brought many contributions to the knowledge on polymerization contraction stress of resin composites. Nevertheless, several aspects regarding this extremely complex phenomenon remain unclear. Reduction of polymerization shrinkage has been an important issue. Despite considerable efforts, none of the newer developed resins are successful enough to tackle this problem.

Thus, further investigations on visco elastic behavior and reaction kinetics of these materials are necessary. Continued development of composite resins with reduced shrinkage is critically needed. However, judicious selection of composite resins as effective methods to reduce polymerization shrinkage can be used to create more predictable esthetics in resin based composites.

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Literature Review

RECENT ADVANCES IN COMPOSITE RESIN: AN OVERVIEW

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Abstract

Composite restorative materials represent one of the many successes of modern biomaterial research, since they replace biological tissue in both appearance and function. At least half of posterior direct restoration placements now rely on composite materials. These materials were introduced to overcome the inherent shortcomings of amalgam restorative materials. Earlier composites lack in mechanical properties to withstand the masticatory forces. Various filler particles have been added to composite resins to improve their physical and mechanical properties. Filled composite resins exhibit high compressive strength, abrasion resistance, ease of application and high translucency. Depending on the filler size and shapes, various composites have been developed until now. This article is a review of numerous types of composites that are technologically advanced to modify their properties.

Key Words: composite, recent advances, review

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Introduction

Acrylic resin was introduced to the dental profession in the mid 1950s. Since their introduction, acrylic based materials have continued to play a major role in restorative and prosthetic dentistry. The potential for greater application of resins came about with the introduction of the bisphenol A glycidyl methacrylate, or BIS-GMA, by Bowen in the early 1960s. This formulation possessed a higher molecular weight and therefore better mechanical properties and reduced polymerization shrinkage, the newer

polymer offered potential for much greater applications that included anterior and posterior composite resin restorations, indirect inlays/onlays, pit and fissure sealants and more wear resistant denture teeth.

Although Bowen's formulation has been available for more than 30 years, the chemistry has remained relatively unchanged. As a result, the mechanical properties also have not improved substantially. The purpose of this article is to

discuss new resin systems exhibiting substantial improvements in wear resistance and clinical performance.¹⁻³

Condensable/packable or polymeric rigid inorganic matrix material (PRIMM)

This new concept was developed by Dr. Lars Ehrnford of Sweden in 1995.⁴ This system is composed of a resin matrix, and an inorganic ceramic component. Rather than incorporating filler particles into the composite resin matrix, he devised a unique system by which the resin is incorporated into the fibrous ceramic filler network. The filler mainly consists of aluminum oxide and silicone dioxide glass particles or barium aluminosilicate or strontium glasses. The glass particles are liquefied to form molten glass which is forced through a die to form thin strands of glass fibers. The diameter of these fibers being approximately 2-3 μm .



These glass fibers are crushed into small fragments and then reheated to a sufficient temperature to cause superficial fusion of glass fibers at selected sites (silanation).

This forms a continuous network of small chambers or cavities (dimensional interfacial chambers = 2 μm). The manufacturers then infiltrate these spaces within the fibrous network with an optimized resin depending upon the final application use of the restorative material (BISGMA/UDMA resin). This concept provides a basis for fabricating packable or condensable posterior composite resin. Colloidal silica ultrafine particles are also incorporated to control the handling characteristics such as viscosity, resistance to flow, condensability and reduced stickiness. Greater the condensation pressure used, greater is the expression of residual resin, and greater is the density of the inorganic phase. Hence this new concept resulted like better marginal adaptation, lower potential for incorporation of microscopic porosities, lesser polymerization shrinkage (as any polymerization shrinkage that takes place will be localized within the small ceramic chambers/spaces), optimal mechanical characteristics like flexural strength, modulus of elasticity and coefficient of thermal expansion and greater wear resistance.³

Flowable composites

Flowable composites were developed mainly in response to requests for special handling properties for composite resins rather than any clinical performance criteria. Hence their physical properties had limitations. They were created by reducing the filler content of traditional hybrid

composites and retaining the same filler size and adding increased resin to reduce viscosity of the mixture. Since the filler content was reduced in these composites they lack sufficient strength to withstand high stresses and because of the increased resin content these composites show more polymerization shrinkage and have lower elastic moduli and high fracture toughness. They cannot be used in high stress bearing areas and also difficult to manipulate.



Flowable composites have an abundance of uses in dental procedures including as liners and bases as well as for temporary crown repair, veneer cementation, pit and fissure sealing, porcelain repair and small core build up. Flowable composites are probably best known however for their use in Class III, Class IV and Class V restorations. Characteristics of flowable composites may include radiopaque, various viscosity for superior flowability or packing, fluoride release and high polishability. Flowable composites may be self-cure, light cure or dual cure with a range in curing times. Esthetics are an important aspect

in dental restorations, be sure a variety of shades are available for a perfect match. Most flowable composites can be polished to a long lasting high-gloss finish. Flowable composites are mostly delivered via syringe, whether refillable or disposable. When choosing a flowable composite, be sure to research the best composite for the dental procedures in mind. Most vendors provide specs on hardness, comprehensive strength, flexural strength and modulus of elasticity as well as an abundance of other features. Polishability of the surface of the restoration is important for aesthetic and functional purposes. The surface should be able to have a smooth lustrous surface and be able to maintain this desired characteristic. The effect of one-step polishing systems on the surface roughness of various flowable composites. The one- or 2-step polishing systems are a good choice for the polishing of the flowing composites.³

Artglass

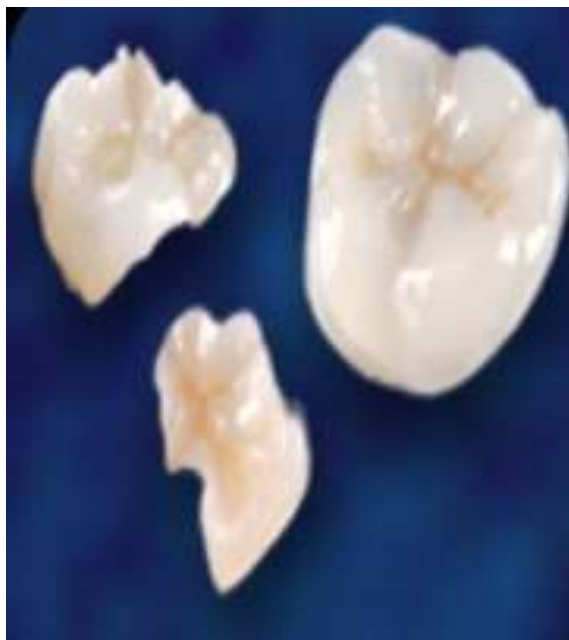
Artglass is a non conventional indirect dental polymer marketed since 1995. It is most commonly used in inlays, onlays and crowns. The resin matrix is composed of BISGMA/UDMA. This configuration provides a higher level of cross linking and better control over the positions along the carbon chain where cross linking occurs.



This aids in improving the wear resistance and other physical and mechanical properties of the resin matrix. Filler is radiopaque barium glass (mean particle size $0.7\mu\text{m}$). A moderate amount of colloidal silica is also incorporated for the purpose of enhancing certain handling characteristics. Artglass is photocured using a special xenon stroboscopic light. The emission ranges from 320-500nm. This range is significant because excitation of the initiator, camphor quinone, is optimized at about 470 nm. Artglass has the advantages of having considerably more wear resistant than conventional light cured composites, good marginal adaptation, esthetics and superior proximal contact.⁴

Belleglass HP

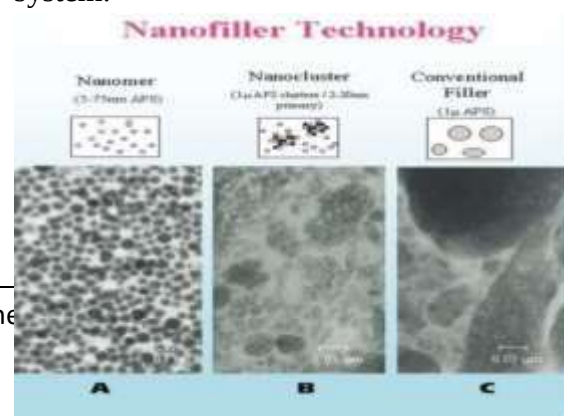
Belleglass HP was introduced by Belle de St. Claire in 1996 as an indirect restorative material. Resin matrix contains BISGMA and fillers.



The Belleglass is polymerized under pressure of 29 psi at elevated temperature of 138°C and in the presence of nitrogen, an inert gas. The elevated temperature increases the polymerization rate. The increased atmospheric pressure reduces the vaporization potential of the monomers at elevated temperatures. Use of nitrogen gas during polymerization process relates to an increase in the wear resistance i.e. nitrogen provides an oxygen free environment, which in turn results in higher levels of polymerization; more translucency of cured mass. Oxygen if gets entrapped in the composite, it interferes with polymerization and reduces translucency.⁴

Nanocomposites

Nanotechnology may provide composite resins with a dramatically smaller filler particle size that can be dissolved in higher concentration and polymerized into the resin system.



The molecules in these materials can be designed to be compatible when coupled with a polymer and provide unique characteristics (i.e., physical, mechanical, optical). Currently, the particle sizes of conventional composites are so different from the structural sizes of hydroxyapatite crystals, dental tubules, and enamel rods, compromises in adhesion between the macroscopic (40-0.7 nm) restorative material and the nanoscopic (1-10 nm in size) tooth structure are potential. Nanotechnology can, however, improve this continuity between the tooth structure and the nanosized filler particle and provide a more stable and natural interface between the mineralized hard tissues of the tooth and these advanced restorative biomaterials. Studies have shown that nanocomposites show greater fracture toughness and adhesion to tooth structure.

Use of nanoparticles in dental composites is not new. Colloidal silica particles of a diameter of approximately 40 nm have been in use in dental microfilmed and hybrid composites for more than 10 years. Nanoparticle filled composites exhibit outstanding esthetics, are easy to polish and possess an enhanced wear resistance. Nanoparticle fillers may include colloidal silica or Ormocers, such as in Ceram X from Dentsply. Similar particles may be used in

resin-based bonding systems. Nanoparticle particle filled dental composites may show an enhanced fracture toughness and adhesion to tooth tissues.⁵

Smart composites/stimuli response material

Smart Composites are active dental polymers that contain bioactive amorphous calcium phosphate (ACP) filler. It is capable of responding to environmental pH changes by releasing calcium and phosphate ions. They possess properties that may be considerably changed in a controlled fashion by external stimuli. Such stimuli may be for example changes of temperature, mechanical stress, pH, moisture, or electric or magnetic fields⁶. These are also called as Intelligent composites. This class of composite was introduced as the product Ariston pHc in 1998. Ariston is an ion releasing composite material. It releases functional ions like fluoride, hydroxyl, and calcium ions as the pH drops in the area immediately adjacent to the restorative materials, as a result of active plaque.



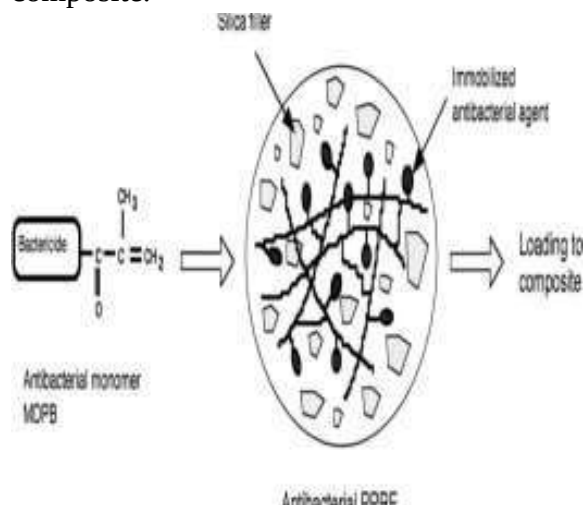
Self healing composite

After a period of use, materials degrade due to different physical, chemical, and/or biological stimuli. This leads to deterioration in the properties of the material finally leading to its failure. Self-healing has become one of the most desired properties in material development. . One of the first self-repairing or self-healing synthetic materials reported interestingly shows some similarities to resin-based dental material; it was the epoxy resin composite.⁷ The first self-healing resin-based synthetic material has been developed by White et al. The material was an epoxy system which contained resin filled microcapsule dicyclopentadiene, a highly stable monomer with excellent shelf life, encapsulated in thin shell made of urea formaldehyde. In response to environmental stimuli, some of the microcapsules rupture and release resin, which further reacts with Grubbs catalyst in epoxy composite, causing a polymerization reaction to take place and repair the crack. The main concern is the potential toxicity of the resins in the microcapsules and from the catalyst. However, their amount is relatively small, and the concentration may well be below the toxicity threshold.

Antimicrobial materials

Antimicrobial properties of composites may be accomplished by introducing agents such as silver or one or more antibiotics into the material. Microbes are subsequently killed on contact with the materials or through

leaching of the antimicrobial agents into the body environment. Silver and titanium particles were introduced into dental composites, respectively, to introduce antimicrobial properties and enhance biocompatibility of the composites. Dental composites containing 1% (w/w) quaternary ammonium polyethyleneimine (PEI) nanoparticles were tested for their antimicrobial activity. The antibacterial properties of these composites were based on contact mechanism rather than on leaching. The mechanical properties were not significantly affected by introducing the PEI nanoparticles. The antimicrobial effect lasted for at least 1 month.⁸ Alkylated ammonium chloride derivatives and chlorhexidine diacetate have also been introduced as antimicrobial agent into dental composite.⁹



Fiber reinforced composite

Fiber-reinforced composites have numerous industrial and aerospace applications because they are light, strong and non-flammable. However, with respect to

clinical dentistry, they are relative newcomers into the spectrum of prosthodontic treatment options. Over the years, these materials have evolved to the extent that they can be used for both direct and indirect restorations. However, with respect to clinical dentistry, they are relative newcomers into the spectrum of prosthodontic treatment options.¹⁰

Compomer

Compomers are recommended for use as a pediatric dental restorative material. These are actually a cross between resin based composite and glass ionomer cement. Compomers were developed in the hope of bringing the favorable properties of resin based composite such as wear resistance, color stability and polishability to the glass ionomers. These materials are soft, non-sticky, do not need to be mixed, and are easy to place. Compomers contain poly acid modified monomers with fluoride releasing silicate glasses and are formulated without water.



Placement of compomer is easy and are packaged in unit dose compules. They require a bonding agent to bond to tooth structure. The materials is to be cured by light in increments of 2 to 2.5 mm.¹¹

Ceromers

New ceramic optimized polymers (ceromers), such as Tetric Ceram (Ivoclar Vivadent, Amherst, NY), now offer versatility and improved handling properties in response to increasing clinical demand for producing high-quality natural restorations¹². The term ceromer stands for Ceramic Optimized Polymer and was introduced by Ivoclar to describe their composite Tetric Ceram. They are micro filled hybrid resins or universal composite resins. This material consists of a paste containing barium glass, spheroidal mixed oxide, ytterbium trifluoride, and silicon



dioxide (57 vol%) dimethacrylate

monomers (Bis-GMA & urethane dimethacrylate).

Uses: Ceromer can be used for veneers, inlay/onlay without a metal framework. Also can be used with Fiber Reinforced composite framework for inlays/onlay, crowns and bridges (3unit) and for crown and bridges including implant restorations on a metal framework. Ivoclar in cooperation with several universities has developed advanced polymer systems and ceramic fillers from which high performance Ceromers (ceramic optimized polymers) have been produced.

Giomers

Giomers are newly introduced hybrid aesthetic restorative materials for dental restorative therapy. Hybrid materials combining the technologies of glass ionomers and resin composites have been developed to help overcome problems of conventional GIC's such as moisture phase of GIC in the restorative and are also known as PRG composites. Giomers employ the use of pre-reacted glass ionomer (PRG) technology to form a stable material.



The fluoroaluminosilicate glass in these materials is reacted with polyalkenoic acid in water prior to inclusions into silica-filled urethane resin. Although, Giomer has been called a light cure, one pack glass-ionomer restorative by the manufacturer (Shofu Inc, Kyoto, Japan), it should be considered as light-cure composite as it does not have a significant acid-base reaction as part of its curing process and cannot set in the dark. This technology also differs from compomers, in which a variable amount of dehydrate polyalkenoic acid is incorporated into resin matrix and the acid does not react with the glass until water uptake occurs into the restoration. Giomers come in a one-paste form. They are light polymerizing and require bonding agents for adhesion to tooth structure. Currently available giomer restoratives include REACTMER (Shofu Inc, Kyoto, Japan), FL-BOND, BEAUTIFIL.

Conclusion

The use of composites is increasing because of its benefits from adhesive bonding to tooth structure, aesthetic qualities and universal clinical usage. When done properly, a composite restoration can provide excellent service for years. A new quality of dental composites may, however, be created if nanotechnology is used and other new developments in material science

and biomaterials are considered in composites in the future. The development of high performance restorative materials is essential to the success of dental treatment. It must be noted that in addition to the restorative material, other aspects are important for success. The future promises to be exciting with substantial progress in the development of adhesive, wear resistant dental polymers.

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Literature Review

A QUICK UPDATE OF ENDODONTIC IRRIGATING SOLUTIONS

*Dr. Subin Bharath

Abstract

Irrigation is a key part of successful root canal treatment. It has several important function which may vary according to the irrigant used: It enables smooth movement of the instrument with in the canal, it improves the cutting efficiency and it has a washing effect and an antimicrobial / ant biofilm effect. Irrigation is also the only way to impact those areas of the root canal wall not touched by mechanical instrumentation. Sodium hypochlorite is the main irrigating solution used to dissolve organic matter and kill microbes effectively. EDTA is required as a final rinse to remove the smear layer. Saline may be used between these two main irrigants. Root canal irrigation is the most important determinant in the healing of periapical tissues along with proper instrumentation and obturation of the root canal. In this review of literature various irrigants and their mode of action, pros and cons, protocols are discussed.

Key Words: Endodontic Irrigation , Sodium Hypochlorite, Chlorhexidine Gluconate
Irrigation Protocols

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Introduction

Debridement of the root canal system is essential for predictably successful endodontic therapy. The significant therapy of the root canal irrigation to endodontics strengthen in the period between 1859 when Tuft recommended frequent syringing of the root canal to remove irritants until the mid-1940's when endodontics become a special fields with in dentistry and the American endodontic society was established.¹

Higher success rate in non – surgical endodontic treatment can be attained by improved debridement of isthmuses and

apical anatomy, effective smear layer removal, disruption of bio-film and removal.²

Instrumentation serves to clear a pathway for effective flow of irrigation by removing debris while maintaining natural canal anatomy and curvatures.³ Improvement in our success will come from improved methods of irrigation. Most of the inter radicular bacteria hide and reside in root

canal anatomy such as ramifications, deltas, fins and untreated pulpal tissues or necrotic debris for working in these critical areas irrigation place an vital role.

Characteristics of an ideal endodontic irrigant

1. Effective germicide and fungicide
2. Non Irritating to the apical tissue
3. Remain stable in solution
4. Have a prolonged anti-microbial effect and have a sustained anti-bacterial effect after use
5. Be active in the presence of blood serum and protein derivative of tissue
6. Be able to completely removed smear layer
7. Have a low surface tension
8. Be able to disinfect the dentin and its tubules.
9. Do not interfere with repair of apical tissues
10. Do not stain tooth structure
11. Be capable of inactivation in a culture medium.
12. Do not induce a cell mediated immune response
13. Have no adverse effects on the physical properties of exposed dentin
14. Have no adverse effect on the sealing ability of filling materials
15. Have convenient application
16. Be relatively inexpensive

Classification of current irrigants

Antibacterial agents:

Sodium hypochlorite (NaOCL),
 Chlorhexidine (CHX)

Decalcification agents

Weak: Hydroxy ethylidene bisphosphonate or etidrona acid (HEBP)

Strong: Ethylene diamine tetra acetic acid (EDTA)

Combinations (antibacterial agents and /or chelating agents +detergent):

MTAD (tetracycline+acid+detergents)

QMiX(CHX,EDTA+detergents)

Smear Clear(EDTA+detergents)

Chlor-Xtra(Naocl+ detergents)

CH plus(CHX+detergents)

Natural Agents:

Green Tea , Thriphala,

Variables affecting the irrigation

Concentration

- Tissue Dissolving ability of NaOCL is greater at the concentration of 5.2% than at 2.5% and 0.5%
- But higher concentration are more cytotoxic than lower concentrations.

Contact

- To be effective the intra canal agent must contact the substrate
- When the canals are sufficiently enlarged the solution can be deposited directly in the apical area of the preparation with a fine irrigating needle.

Quantity of the irrigant used

The ability of the solution to debride is directly related to the quantity of irrigating solution

Gauge of the irrigating needle

Usually a 27 or 28 gauge needle is preferred as it can go deeper in canal for better delivery and debridement action

Surface tension of irrigant

Lower the surface tension better is wettability

Temperature of the irrigant

It has been shown in studies that if NaOCl is warmed before irrigation it is much (60 to 70 ° C) more effective as a tissue solvent

Frequency of Irrigation

A canal should be copiously irrigated during instrumentation. More irrigation causes better debridement of tissue. Always used fresh irrigant.

Canal Diameter

Wider the canal, better is debridement action of irrigant.

1. **Normal Saline**

- Acts by Flushing action
- Causes gross debridement and lubrication
- Commonly used as 0.9% W/V as irrigant
- Used as final rinse for root canal to remove any chemical irrigant left after root canal preparation

Advantages

- Biocompatible
- No adverse reaction even if extruded periapically, as the osmotic pressure is same as that of blood.

Disadvantages

- Does not possess dissolution and disinfecting properties
- Too mild to clean the canals
- Does not possess anti-microbial activity

- Does not remove smear layer

2. **Sodium Hypochlorite**

Surveys from around the world reported that sodium Hypochlorite is the most common irrigating solution used in Endodontics.⁶ It is an effective antimicrobial and proteolytic agent excellent organic tissue solvent and lubricant and fairly quick effects. NaOCL is both an oxidizing agent and hydrolyzing agent. Increasing the temperature of the low concentration improves their immediate tissue dissolution capacity.

Mode of action

Sodium Hypochlorite has a pH of 11. It acts as an organic and fat solvent that degrades fatty acids and transforms fatty acids solves (Soap) and Glycerol (Alcohol), reducing the surface tension of the remaining solution. Sodium Hypochlorite is a strong base (pH11) the anti-microbial effectiveness is based on its high pH is similar to the mechanism of action of calcium hydroxide.⁴ The high pH interferes in cytoplasmic membrane integrity due to irreversible enzymatic inhibitions, bio synthetic alterations in cellular metabolism and phospholipid degradation observed in lipidic peroxidation.

NaOCl can be used in the concentration that ranges from 0.5 to 6 %. It was proven that the lower and higher concentration are equally efficient in reducing the number of bacteria in infected root canal system but the tissue dissolving effect is directly related to

the concentration volume is more critical for disinfection than its concentration.⁵ .Depth of penetration of NaOCL varied between 77 and 300 μ m, and it depends on concentration and time. Even though as many ideal properties, it has some limitations such as being toxic non substantive in effective in smear layer removal, corrosive and has an unpleasant odour. If NaOCl is used as a final rinse bonding of the sealer may be altered.

Limitations of NaOCL

- Toxic
- Not substantive
- Discolours, corrods, exudes,
- unpleasant odour and it is ineffective in smear layer removal

Protective measures during NaOCL irrigation

- Plastic bib to protect patient clothing
- Provision of protective eye wear for both patient and operator
- The use of sealed rubber dam for isolation of teeth under treatment
- The use of side exit Luer-Lok needles for rootcanal irrigation
- Irrigation needle a minimum of 2 mm short of the working length
- Avoidance of binding the needle into the root canal.
- Avoidance of excessive pressure during irrigation
- Placement of rubber stopper on irrigation needle to prevent NaOCL accident

NaOCL Accidents

- The in advertent injection of NaOCL into the soft tissue elicit a violent and frightening response.
- Mechanism of injury is primarily oxidation of proteins followed by inflammatory reaction from the body

1. The amount of tissue destruction depends on volume of

- a. Volume of irrigant .
- b. Concentration of irrigant .
- c. Temperature of irrigant .

2. Sequence of events of NaOCL accidents⁷

- Excruciating pain with in 2 to 5 minutes.
- Burning sensation in affected area.
- Immediat swelling of the tissue in the area with spread to surrounding loose connective tissue
- Profuse bleeding episode either interstitially or through the root canal system
- Stop treatment immediately
- Remain calm and reassure patient
- Immediately irrigate with copious amounts of saline
- Pain control immediately with a nerve block prescribed analgesic corticosteroid for three days.

3. Chlorhexidine Gluconate (CHX):

CHX is a strongly basic molecule with a pH between 5.5 and 7 that belongs to the polybigunate group .CHX IS easily soluble in water and is very stable.

Mode of action

CHX, because of its cationic charges, is capable of electrostatically binding to the negatively charged surfaces of bacteria, damaging the outer layers of the cell wall and rendering it permeable. CHX is a wide spectrum antimicrobial agent, active against gram positive and gram negative bacteria and yeasts.⁸ Depending on its concentration, CHX can have both bacteriostatic and bactericidal effects. At high concentrations, CHX acts as a detergent and exerts its bactericidal effect by damaging the cell membrane and causes precipitation of the cytoplasm. At low concentration, CHX is bacteriostatic causing low molecular weight substances to leak out from the cell membrane without the cell being permanently damaged. Due to the cationic nature of the CHX molecule it can be absorbed by the anionic substrates such as the oral mucosa and tooth structure. CHX is readily absorbed into hydroxyapatite and teeth.

The reversible reaction of uptake and release of CHX leads to substantive antimicrobial activity and is referred to as substantively. This effect depends on the concentration of CHX. The main limitation of using CHX as a primary and sole endodontic irrigant are the following: the inability to dissolve organic matter, no action on smear layer, minor effect on biofilm disruption.

4. Ethylenediaminetetraacetic Acid (EDTA)

(EDTA) is an aminopolycarboxylic acid and colorless water soluble solid. EDTA is often suggested as an irrigant because it can chelate and remove the mineralized portion of the smear layer.¹⁰ Chelating agents were introduced into endodontics as an aid for the preparation of the narrow and calcified root canals in 1957 by Nygaard –Ostby.

Mode of Action

Direct exposure for extended time EDTA extracts bacterial surface proteins by combining with metal ions from the cell membrane which can eventually lead to bacterial death. Chelators such as EDTA form a stable complex with calcium when all available ions have been bound; equilibrium is formed and no further resolution takes place. EDTA when used as an endodontic irrigant, it cannot remove smear layer effectively, a proteolytic component such as NaOCl, must be added to remove the organic components of the smear layer. EDTA is normally used in a concentration 17 % and can remove the smear layer when in direct contact with the root canal wall for less than 1 minute.

5. HEBP

Etidronic acid, a substance that prevents bone resorption. Has been used in medicine for patients suffering from osteoporosis or Paget's diseases and was suggested as a substitute for traditional chelators due to fewer effects observed on dentine structure. It is considered the unique chelator that can

be mixed with NaOCL without interfering with an anti-microbial property.

6. Bio Pure MTAD and tetra clean

Two new irrigants based on a mixture of antibiotics citric acid and a detergents have been developed. These irrigants are capable of removing both the smear layer and organic tissue from the infected root canal system. MTAD, Introduced by Torabinejad and Johnson at Loma Linda University in 2003 is an aqueous solution of 3% doxycycline a broad spectrum antibiotic 4.2% citric acid a demineralizing agent and 0.5 % polysorbate 80 detergents.¹¹ It is mixed as a liquid and powder prior to use. MTAD has been recommended in clinical practice as a final rinse after completion of conventional chemo mechanical preparation. Doxycycline citric acid and tween 80 together may have a synergistic effect on the disruption of the bacterial cell wall and on the cytoplasmic memberane.MTAD was developed as a final rinse to disinfect the root canal system and remove the smear layer.

7. Qmix

Qmix was introduced in 2011, it is one of the new combination products introduced for root canal irrigation. It is recommended at the end of instrumentation. Mix contains a CHX analog (N-Cetyl-N, N, N-trimethylammonium bromide) and EDTA as a decalcifying agent, it is intended as antimicrobial irrigant as well as to be used in the removal of canal wall, smear layer and

debris. QMiX is suggested as a final rinse. It NaOCL is used throughout the cleaning and shaping, saline can rinse out NaOCL and then QMiX can be used.

8. Ruddle's Solution

- Introduced by Dr Clifford J Ruddle
- Based on the use of HYPAQUE –M,a radio opaque,high contrast injectable dye

Composition

- 5% NaOCL
- HYPAQUE –M
- 17 % EDTA

9. Citric Acid

- Used in concentration ranging from 10 to 15 %.
- Can remove smear layer
- 10 % citric acid was more effective in dentine demineralization than 1% Citric acid,which was more effective than 17 % EDTA .

Disadvantage

- It can cause erosions
- Decreased hardness of dentine when compared to EDTA.

10. Natural agents

- Thriphala: Consist of dried powdered 3 medicinal plants:Terminalia bellarica, Terminalia Chebula, emballica Officinalis¹²
- These contains fruits rich in citric acid
- Green tea: Is a polyphenols.It shows significant anti-bacterial activity against

E faecalis biofilm formed on tooth substrate. It takes 6 minute 100 % killing of E faecalis .

- Morinda Citrifolia : it contains anti-bacterial compound L-asperuloside and alizarin
- Neem leaf extract: it shows anti-viral, anti-fungal, anti-microbial and anti-bacterial. It was highly efficient against E- faecalis and candida albicans with in the root canal.

Advantages

- Easy availability
- Cost effectiveness

11. Other combination Irrigants

- Smear Clear : EDTA + Detergents
- Chlor-Xtra: NaOCL+ Detergents
- CHX Plus : Detergents

Irrigation Protocol

Many protocols are suggested for root canal irrigation:

- 1- 2.5 to 5% NaOCL throughout the instrumentation procedure until final shape of the canal is achieved
- 2- Activation or heating of fresh NaOCL with the aid of ultra-sonic, sonic, or laser activation for approx 30 seconds with fresh solution per canal.
- 3- Apical negative are optional to enhance apical irrigaton without extrusion Eg : Endovac
- 4- Smear layer removal using EDTA Citric acid etc.

5- Final rinse

- Fresh NaOCL for approximately 1 minute or
- CHX QMiX or
- Alchohol or
- Dry with paper points and obturate .

Conclusion

Irrigation has several key function, the most important of which are tissue dissolutions, killing of microorganisms and removal of the bio films.¹³ Apical Irrigation is a special challenge with regard to effectiveness and safety. Several new different irrigation solution have been developed in recent years. Today there is still no ideal irrigation model for all purposes. The challenge continues for the development of more appropriate and realistic models to study and improve the effectiveness and safety of root canal irrigation.

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