

A Comparatively evolution of Mechanical Properties of Three Tissue Conditioners: In vitro study

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Abstract

Tissue Conditioner (TC) is a short-term soft liner built by amorphous polymer prepared by the integration of polymer powder and the liquid plasticizer. Tissue conditioners (TC) are dental materials used to address inflammation or pressure points on the alveolar ridge, temporary relining of partial and complete dentures, and the creation of functional impressions for denture fabrication or restoration. These soft relining materials can be divided into temporary and long-term solutions. Some requirements for both types of materials overlap. An ideal material of this type should have the following characteristics: resistance to fungal and bacterial growth, low water absorption, increased color stability, stain resistance, tear resistance, strong bonding with the denture base, dimensional stability, low glass transition

temperature, easy processing, long shelf life, biocompatibility, high energy dissipation, and good elasticity. One of the main problems with TC is their susceptibility to colonization of microorganisms due to water solubility and degradation, which can exacerbate denture stomatitis.

Keywords: Tissue Conditioners, Phthalate-Free Alternatives, Gelling Time, Denture Fabrication, Biocompatibility.

Introduction

Tissue conditioners are usually used as a temporary relining material to prevent the transfer of masticatory load and evenly distribute the external stresses on the mucosa of the basal seat. In this manner, tissue conditioners possess broad applications in treatments of traumatized soft tissues, mucosal lesions, and surgical

wounds. One of the main problems of the tissue conditioners is their susceptibility to the colonization of microorganisms due to their water solubility and degradability, which can result in the exacerbation of denture stomatitis. To overcome this difficulty, various antifungal drugs such as polyenes, azoles, antibiotics, and antiseptics have been prescribed. Since in the case of denture stomatitis microorganisms usually stay in the site of the mucosa, topical delivery of these drugs can better target the infection. In this approach, incorporation of the drugs into the tissue conditioner can lead to a lower cost, simultaneous treatment of the injured mucosa and the infection, and a more convenient method due to reducing the procedural steps.

The mean displacement of soft tissue in any arena because of external abuse is about 0.05 to 0.03 sq inch, resulting in losing the denture tend. If the denture is removed at an appropriate time it ceases to the deformation of the mucosa. This led to circumstances when patients have to keep old dentures away from mouth prior and during the formation of other dentures. In order to get rid of these circumstances the alternative approach is tissue conditioning material. TC is practiced to restore the well-being of the tissue of the denture created prior impressions are made by relining the denture with short time denture reliners. "In 1945, the first synthetic resin made of plasticized poly vinyl resins was developed and the silicone rubbers followed in 1958."

Tissue Conditioner (TC) is a short-term soft liner built by amorphous polymer prepared by the integration of polymer powder and the liquid plasticizer. The characteristic of TC is frequently utilized to enhance the fitting and the functioning feature of ill-fitted dentures which are substituted by TC. Moreover, they are appropriately suitable to treat abused mucosal tissue

beneath ill-fitted acrylic dentures. Denture relines significantly beneficial from prosthodontic perspective-

- Functionalized to enhance fit of ill-fitting dentures.
- To prevent traumatic damage to the mucosa.
- To retain over denture bar attachment.
- To retain extra oral prosthesis.
- To distribute occlusal force
- To enhance the operational life of prosthesis.
- To substitute the fitting outer cover of formal hard

Application of Tissue Conditioners

TC possesses a soft resilient nature of a wide range of diagnostic and medicational in order to provide better oral health. Usually, it is used to restore the well-being of vulnerable or inflamed denture supporting tissue providing a movable impression to mucosa. The utility of tissue conditioner is integrated with modeling plastic to enhance the adaptability of surgical obturator after maxillary resection. An ideal TC is applicable to provide impressive functioning based on their material to provide shape of the denture bearing mucosa involving serviceable distress such as chewing, talk, deglutition among others with several characteristics like high compatibility, smooth surface and based on viscoelastic impression material. Because viscoelastic properties and other physical properties that can be transformed with other materials enhance the efficiency of TC and make it more impressive. This shows that TC perform distinguishably based on their material and its suitability varied because of the material.

Thus, a single TC may not be appropriate to provide its effective functioning to different users. Some of the properties that make functional impression material for TC rely on its rheological characteristics, dimensional stability, ability to reduce the day and undercuts. It is very essential to identify the transformation that takes

place in viscoelastic features of material with the time and its harmony with plastic. It is also used for drug delivery to provide protection from oral cavity, for instance antifungal agent delivered through the tissue conditioner inhabited by *C. albicans*. Tissue conditioners also possess certain limitations that adversely impact the oral health because of its physical characteristics which influence frequent replacement of the material used for TC.

The main intention of the review is to comprehensively analyze the Tissue Conditioner through different aspects such as its utility, its physical and biological properties, additives like antifungal, antimicrobial along with nanocomposite material combination with TC, its challenges and way forward to deal with issues in the prosthodontic domain.

Discussion

The discussion section threw light on physical properties of TC and substitution of antifungal, and antimicrobial ingredients that improve the physical properties of TC. TC is one of the revolutionary tools used in dental treatment. There are several characteristics they possess from heart acryl liners to the noble silicon-based liners. The ingredients that are used in the TC which increases its impact comprising antifungal, anti microbial, anti bacterial properties are combined into liners for preventing fungal growth in the oral cavity. Other characteristics is to combine organic or herbal ingredients to liner in order to mitigate the adverse impact as well as curb the growth of resistance for the transactionally obtainable antifungal ingredient.

Incorporation of the TC ingredient to denture-based material (DBM) is a crucial challenge along with maculation and biofilm growth. Based on the smaller weight the most usual reason behind the unsuccess of Softline denture was loss of bond between the liner and

DB. Relation to the DBM is one of the most prominent challenges specifically when it comes to the material like silicon and related elements. When the incorporation comes between the DB resin and silicon rely on lining elements that depend completely on adhesive. The unsuccessful between liner in the denture formulate a capable interface for leakage, plague, and calculus. Hence there is a need to formulate a significant incorporation that enhances the longevity of TC.

The challenge of TC was obtained from the impact of the dental surroundings on their physiological Characteristics; these impacts can be swiftly replaced by the material utilized for its formulation. The dental surrounding allows the plasticizer and ethanol to be percolated out into saliva and absorbed into water by the polymeric stage of the gel. In 7 days, the water absorption is identified and noted under the value of 0.2 - 5.6 milligram per centimeters and the solubility comes under the value of 0.03 to 0.40 milligram per centimeters. Nevertheless, it was identified that the % of plasticizer destroyed from the elastic liner after 2 weeks in medical use was around 31% which fluctuated plus minus 12%. Distinguished in the methodology has been identified the most promising result in the variations. It was suggested that patients need to clean the elastic liner beneath flowing tap water and without applying denture with cleansing ingredients.

In the discussion section the review comprehensively analyzes the number of in vitro and in vivo articles that emphasize the combination of antimicrobial/ antifungal agent with TC to eliminate microorganism attachment. The ingredients that are mostly utilized as antifungal agents such as “Nystatin and Fluconazole”, some organic ingredients are also identified like organum oil, neem. The study also explores antimicrobial agents such as silver nanoparticles combining it with TC. Although

the combination of several antimicrobial and anti-fungal agents alter the physical and chemical characteristics of TC. The review also addresses nanoparticles and its applications in TC.

Development of TC

In the composition of TC, the polymer powder is used which comprises with PEMA having a molecular weight value from 1.7×10^5 to 3.2×10^5 . The plasticizer which is used is based on ester and aqueous solution usually extracted from ethyl alcohol solution without acrylic monomers. Its molecular weight was very low because of its aromatic nature that can be formulated by “dibutyl phthalate, butyl phthalyl butyl glycolate, butyl benzyl phthalate, and benzyl benzoate”. The main function of them is to reduce the “polymer glass transition heat of the acrylic polymer” and emollient it because it can become a rigid polymer. The blending of the powder and the aqueous provides a macromolecular chain which can be converted into coherent gel having specific features like viscoelastic that can be effectively utilized in medication procedure. PEMA, atoms are sluggishly pertaining by the vast component of plasticizer, as well as the ethanol is used to swell the polymer which accelerates the procedure of penetration to formulate appropriate gelation that are utilized by the therapeutic. If the alcohol is not used the plasticizer did not penetrate to formulate gelation due to slow penetration and large sized components.

The things should be kept in mind that the molecular weight of polymer powder, plasticizer, alcohol content, and aqueous ratio all ingredients influence the property of viscoelastic. The factors that influence formation can take place by fluctuating the range of polymer molecular weight (PMW) and specifically alter the ethanol components. Other factors that also influenced the procedure were the polymer powder, blending of

aqueous and “powder, plasticizer and the temperature” in the procedure accomplished along with the molecular weight of the ingredients. Because molecular weight is directly proportional to the procedure as “gelation time” is subdued when the PMW is increased and vice versa. Similarly, the temperature also plays a key ingredient if the temperature is increased it reduces the procedure time. If the alcohol quality is increased it adversely impacts on the production as it is not only responsible for weight loss but also shrinks the material in the mouth cavity. It was evidence that a large quantity of alcohol in the TC intensifies the material malleability and elasticness after gelation. In order to maintain the flexibility of the TC adequate proportionality of powder and the aqueous solution is needed during formation of gelation.

Physical properties of a TC

For serviceable impressing the material with an appreciable fall is needed and based on the characteristic of ingredients that enable quality like steady, and flexibility. The chemical formation of these ingredients is “polymethyl methacrylate or copolymer powder” that is muted on combining with aqueous to build a gel having “ethyl alcohol and aromatic ester” without associated activities. “The gel acts as a viscoelastic medium forming under a steady load and serving as a resilient cushion under denture”. Effective bonding prerequisite for the longitudinal of resilient liner dentures to enhance its bonding capability to accomplish only by restricting outflow of liquid between the liner and DB. This adherence also improves by offering an unsmooth covering acrylic DB. It was identified that because of the rough surface the addition property is increased to double in comparison to smooth surface and also provide improvement in mechanical features of a soft material.

A major difference was found in rheological parameters among most of the variables of materials. An ideal condition for soft linear is it should demonstrate elastic features address chewable force to convert the energy needed for smashing food. Similarly, the viscosity to behavior is intended to distribute the force, suck up energy and forbid transmittance of force to the denture compartment cells by means of cushion effects.

The viscoelastic property should stimulate attributes under classic chewable function and vulnerability to minimum pressure affected by mucosal tissue reversion to its usual condition. VC and CC are appropriate ingredients for repair of ill-treated tissue due to the altering rate of their properties being very minimal. “GC soft liner and FITT” is also considered as a proper

Table 1: Comparison of four TC.

Type of Tissue Conditioners	Code	Powder	Liquid		P/L (% W)
			Plasticizer	EtOH	
Visco-gel	VG	PEMA (86%), PMMA (14%)	BPBG (87%), DBP (8%)	5%	5%
GC Soft-liner	GC	PEMA (100%)	BPBG (81%), DBP (4%)	15%	15%
FITT	FITT	PEMA (79%), PMMA (21%)	DBP (80%)	19.6%	19.6%
Coe Comfort	CC	PEMA (100%)	BB (87%), DBP (4.5%)	8.2%	8.2%

The table describes the TC material which consists of polymeric powder, usually polymethylmethacrylate (PEMA), aqueous which is a blend of “plasticizer and ethyl alcohol”. After “liquid immersion water is absorbed into material and ethyl alcohol and plasticizer are leached out”. It was identified that SL is proposed after aqueous submersion and absorption of water percentage was quite lower in comparison to solubility

material for transitory relying due to their high thickness property. The table below describes the thickness of four TC materials without mold practice and was vitally distinct without having any meaningful effect on thickness except viscogel. The comparison shows that viscogel because of reduced “initial viscosity and lowest viscosity” change steadily is proper ingredients for TC under denture. FITT and GC soft liners are reliable ingredients for transitory lines because of their wider thickness and broader flexibility. All the characteristics and viscoelastic characteristics of few TC ingredients are for short duration apart from viscogel and it does not significantly impact on tissue conditioner material for a long time.

of water. This shows that the range of least out “ethyl alcohol and plasticizer” was much larger in comparison to submersion. The table shows different water absorbing PL values for different TC materials.

Effects of antifungal/ antimicrobial agents on properties of tissue conditioners

Combination of supplements can transform the physical and mechanical composition of tissue conditioner. A

series of studies determine the characteristics such as dimensional alternation and strengthening of TC was enhanced after additives specifically when TC is blended with antifungal agents. When antifungal agent was amalgamated with TC it shows intensify intensive strength, hardness, and surface roughness. Some of the research also explores organic ingredients like neem, silver zeolite, origanum oil among others which shows improved dimensional stability. However some studies indicate that minor or no change in the physical and mechanical characteristics like modification in the hardness and roughness of TC with the passage of time. Several combinations of TC are investigated along with antifungal ingredients to determine the management of denture induced stomatitis. Series of incorporation significantly subdue the candidal growth and number of colonies; however, various criteria for identifying the effectiveness of results have been utilized to determine

their consequences. Antifungal and antimicrobial characteristics of the alternated TC were determined. Some studies indicate that adherence of *C. albicans* to the surface of the soft liners or denture base. One of the significant outcomes was that the combination is utilized to protect against plague.

In this review several natural and inorganic ingredients along with herbal components were analyzed having antifungal and anti-microbial characteristics. One of the components was lemongrass oil which is used as a microorganism combined with *C. albicans*. This enhances the properties of physical features. Some other antimicrobial elements like lemongrass, origanum oil, Coe-comfort was one of the most usually used TC incorporated with natural ingredients and effectively utilized for enhancing the physical property along with drug delivery.

Table 2: Antifungal and antimicrobial combination with TC.

TC	Antifungal Agent/ Antimicrobial	Consequences
GC soft liner	Nystatin and Fluconazole	Efficiency is accomplished for short-term.
Viscogel	Origanum oil	Significant in subdue fungal adherence
Coe-Comfort	Lemongrass oil (<i>C. citratus</i>)	Highly efficacious similar to nystatin
GC Soft-Liner	Silver nanoparticles	Incorporation of TC with antimicrobial ingredient is used to manage dental plague
Viscogel	Nystatin, Clotrimazole, Ketoconazole	Significantly used in drug delivery
Viscogel and Coe-soft	Fluconazole, Clotrimazole, Neem	Enhancement of TC after adding antifungal ingredient

TC is operated in dental tissue healing of the ill-treated, antifungal activities enhances the physical properties of TC. The three antifungal agents used in study such as

fluconazole, oregano oil and virgin coconut oil are added in TC (Viscogel). When viscogel combines with fluconazole, the finding shows that they possess

exclusive tensile bond strength while impairment in viscoelasticity. However, TC when combined with organic components then no prominent transformation was found after seven years [17]. Another prominent ingredient was chitosan which has a wide range of microorganism properties which is effectively utilized to enhance the ability of TC. It enhances the inhibition quality because of nanoparticles and acts as an antifungal agent [18]. Several studies indicate that the use of chitosan and related ingredients intensify the physical and mechanical characteristics of TC because it improves the concentration of hardness, adsorption, and solubility of the material. However, the result did not provide any significance toward improving the characteristics. The in vitro finding shows that incorporation with chitosan strengthens the denture base material and surface roughness of material [22].

Nanoparticles incorporated into TC

TC incorporated with nanoparticles provide antimicrobial and antibacterial functioning which provide other benefits such as low toxicity, appropriate biocompatibility, as well as long term antibacterial properties that develop no bacterial resistance against them. Furthermore when the silver nano component is mixed with other nano-based elements it demonstrates improved anti-microbial characteristics. When silver nano molecules are amalgamated with 15 WT percentages of zinc oxide nanoparticles to formulate TC, it evaluates antifungal impact without any adverse influence on the penetration depth and tensile bond strength. The inhibition of candidal development relies on the percentage of concentration of silver nanoparticles which involve denture acrylic and denture liner. The study illustrated the higher the percentage of silver nano-based elements declining the growth of candida.

Conclusion

Removing dentures is one of the most common practices which need replacement of missing teeth. The advantage of wearing dentures involves proper mastication working, talk, appearance, and dental health which are associated with quality of life. Although, denture stomatitis is one of the most normal inflammatory reactions that adversely impact mucosa. The etiology of this disorder is multifactorial which comprises several aftereffects like ill-fitted denture, poor denture hygiene, microbial colonization on the denture surface, and intensify the risk of denture induced stomatitis.

TC allows direct precise and sustained availability of antifungal, antimicrobial medicament at the affected side without requiring patient compliance. Supplementary with its resilient nature that assists to observe mechanical stress generated while mastication and allow healing of traumatized tissue. The review indicates that antifungal agents combined to formulation of TC are effective for the prevention and the treatment of denture stomatitis. This affects the functional significance and clinical longlasting of the material. To resolve the challenges the research analyzes several components that pose antifungal anti microbial quality along with certain nanoparticles which are also identified which are incorporated with TC and enhance its hardness, absorption quality, and solubility in different conditions. Such as organum oil, neem, silver nanoparticles, chitosan, lemongrass oil and others.

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