REVIEW ARTICLE

DENTAL WAXES – A REVIEW

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ABSTRACT
Waxes used in dentistry are combinations of two or more natural waxes plus small amounts of additives, such as oils, natural resins, synthetic waxes, and coloring agents. There are different waxes used specifically for clinical and laboratory procedures. The ultimate goal of the combination of waxes and additives is to produce dental waxes that possess a set of given physical properties over a specified range of temperature. Therefore, the successful use of waxes must be with a full understanding of waxes' characteristics.
Keywords: Paraffin, Oils, Resins, Beeswax.

INTRODUCTION

The accuracy of fit of dental castings is imperative for the success of any prosthodontic treatment. Various methods and procedures have been advocated to improve the accuracy of fixed partial denture (FPD) and removable partial denture (RPD) castings and these attempts are still ongoing. One of the main causes of dental casting inaccuracies is the wax pattern for crowns, inlays and onlays, and posts and cores as well as overdenture copings, and the wax/plastic pattern on the refractory cast for RPD frameworks.

Distortion of wax patterns used for these dental restorations is detrimental to the accuracy of fit of the completed casting in the patient's mouth and may cause a major problem in the overall success of the prosthodontic or restorative treatment for the patient.[1]

Dentistry has evolved by leaps and bounds over the last century. Numerous materials are used in dentistry for a wide number of clinical and laboratory procedures. Waxes are used in dentistry for many clinical and laboratory procedures. There are different forms of waxes that are available but the most important property is that waxes are thermoplastic in nature which are hard at room temperature but melt without decomposition to form fluids. Clinically, they can be used to fabricate direct wax patterns for cast restorations, alterations and adaptations of impression trays and wax bite registrations.[2]

In the laboratory scenario, their uses range from as simple as boxing an impression before pouring any gypsum product to provide indirect patterns for casting procedures. The dental waxes are used in many dental procedures such as wax patterns for inlays, crowns, pontics complete dentures and partial dentures. They are also very useful in recording bite impressions and edentulous areas of the oral cavity. [3]

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CLASSIFICATION OF WAXES ACCORDING TO ORIGIN[4]

MINERALS

Paraffin wax - Refined from crude oil, has relatively low melting point (50-70°C) and relatively brittle.
Ceresin wax - Refined from petroleum, has medium melting range (60°C).

PLANTS

Carnauba-Obtained from palm trees, it is hard, tough, and has high melting point (80-85°C).
Candelilla -It is hard, tough, and has high melting point (80-85°C), used to increase the melting point and reduce flow at mouth temperature.

ANIMALS

Stearin Obtained from beef fat, has low melting point.
Bees wax -Obtained from honey-comb, consist of partially crystalline natural polyester. It is brittle, has medium melting temperature (60-70°C).

SYNTHETIC WAXES

They are used to modify some properties of natural waxes like polyethylene.

CLASSIFICATION OF DENTAL WAX ACCORDING TO ITS USE

Pattern: Inlay, Casting: sheet, ready shapes, wax-up, Baseplate.
Processing: Boxing, Utility, Sticky.
Impression: Corrective, Bite wax.
Uses:
Inlay Pattern Wax:
Such restorations as inlays, crowns and bridge units are formed in a gold casting process that uses the lost wax pattern technique.
Boxing wax:
To form a wax box around the edentulous functional impression before casting model.
Base Plate wax:
Red or pink color is normally supplied in sheets 1-2 mm thick. three types of wax according to the climate: soft (I), medium (II) or hard (III)
Casting wax:
The pattern for the metallic framework of removable partial dentures is fabricated from the casting waxes.
Utility wax:
Used to stabilize a bridge pontic with crowns, when denture is constructing and soldering
Sticky wax:
Sticky when melted, adheres well to the surfaces on which it is applied.
Corrective impression wax:
Waxes with the lower softening points are used to register functional impressions.
Bite registration wax:
For bite registration.

DENTAL WAX PROPERTIES

Of all dental materials, waxes have the highest coefficient of thermal expansion, which may be a major contributing factor to the inaccuracy of the final restoration when it is not controlled. Dental waxes, including pattern waxes, are characterized by several properties that result in their dimensional instability.

1. On cooling, wax contracts. Inlay wax can have a linear thermal expansion of up to 0.6% when heated from 25 ° to 37 ° C. This constitutes solidification shrinkage plus contraction on cooling to room temperature.[5]
2. Wax has a tendency to flow. The plastic deformation or percentage of flow increases with the temperature and under stresses even at room temperature. Flow results from the slippage of wax molecules over each other.
3. Regardless of the method used to prepare a wax pattern, residual or internal stresses are induced in the completed pattern from factors such as occluded gas bubbles, changes during molding, and other manipulative variables.
   Studies have also shown that when inlay casting wax is used to make crowns, inlays, and post and core restorations, the amount of induced stresses and the subsequent distortions of the wax patterns are influenced by the shape and bulk of the pattern, storage time, and temperature of the pattern while it is on or off its die. [6,16]
4. Wax is affected by exposure. Inlay casting patterns, allowed to stand unrestrained, exhibited tendencies to distort as the temperature and time of storage increased.These findings were emphasized in the study by Campagni et al.[7,17]which reported marked deterioration in the fit of post and core patterns stored for 3 months as compared with only 2 weeks before casting. Residual or internal stresses released by the action of time and temperature can result in a nonuniform dimensional change or distortion of the cast restoration.[1]
5. Wax manifests recovery (memory). The phenomenon of wax recovery (memory) commonly observed in wax sheets and shapes is a process by which the wax attempts to return to its original molded shape and the adapted wax pattern attempts to straighten out as it is cooled to room temperature. This same phenomenon is even more evident in plastic sheets and forms and these will attempt to recover even at room temperature. This can be readily observed on patterns of inlays as they cool after the wax is flowed into the die. The wax must be readapted as it cools and approaches room temperature.[1]

MELTING RANGE OF DENTAL WAXES

With complicated components, waxes have a melting range rather than a single, sharp melting point. Generally the mixture has a wider melting range than one component of mixture of dental wax.[8,18]It is of primary importance in designing a commercial wax product because this, and particularly the lower limit, controls the applicability of a given wax formulation in a particular function.[1] But it is difficult to obtain precise values for the top and bottom of the melting range merely by studying ordinary cooling curves, because of the strong chemical similarities of components. There are several methods for the determination of the melting point of waxes. The two commonly used are Ring and Ball Softening Point and U belohde Drop Melt Point. These two methods yield different results, with the Ring and Ball method generally yielding slightly lower value.[9,19]

Waxes which are mainly composed of hydrocarbons soften at low temperatures and over large temperature ranges.[10,20] The rate of temperature change during solidification and the presence of discontinuities in the cooling curves below solidification indicate the extent of crystallinity present in a wax. The more crystalline the wax, the greater is the internal stress in a wax when manipulated below these temperatures. For beeswax, the rate of temperature change during solidification is much greater than that of paraffin during solidification.[10,20] Like other materials, waxes expand when subjected to a rise in temperature and contract as the temperature is decreased. In general, dental waxes and their components have the largest coefficient of thermal expansion of any material used in restorative dentistry, particularly around the melting range.[11,21] Waxes are somewhat elastic in nature and tend to return to their original shape after deformation.

STRENGTH PROPERTIES

Each component of the wax has different strength properties in dental and commercial casting waxes that are of most important, since these dental waxes undergo forces that are developed during the setting of investments and to various temperature changes that are developed during the setting reactions.[12,22] Strength properties are particularly important when considerable expansion takes place in the investment, such as when the hygroscopic procedure is used with calcium sulphate-bonded investments or when silica sols are used with the phosphate bonded investments. The silicate-bonded investment shrinks during setting, also applying stress to the wax pattern.

Shell[13,23]reported the force necessary to restrict the longitudinal hygroscopic expansion of a calcium sulfate-bonded investment to be approximately 1,000 Gm./cm.2 and concluded that the hygroscopic expansion had adequate strength to move invested wax patterns. Shell also observed in his study that the normal setting expansion has a higher strength compared to the hygroscopic expansion.

RECENT ADVANCES

Dental waxes have many functions and are used for various procedures in the laboratory for high precision work. One such most important procedure done in the laboratory is the production of wax patterns for inlays, onlays, crowns and fixed partial dentures. conventionally the wax patterns are prepared manually and then casted, but there are newer advancements in the preparation of wax patterns using CAD CAM machines. The wax pattern is produced using the milling technique based on a virtual model created from the digital data that are obtained from the oral cavity. Similarly, rapid prototyping technique known as the 3D-printing [14], is being used now a days to design and print a wax pattern for a restoration. Later the wax pattern is cast in the same conventional manner. The advantages of these technologies include high precision of the patterns fabricated and also aids in reduced laboratory time and turnover of the restorations fabricated[15,].

CONCLUSION

Waxes in dentistry have applications in a large number of clinical and laboratory procedures. The alteration of its properties by modifying the compositions make it versatile and useful for most applications. The more recent advancements such as CAD CAM and 3D printing of patterns have led to increased accuracy which has decreased human errors drastically.

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