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Review on Soldering In Prosthodontics

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Abstract: *The fabrication of a multiunit fixed partial denture may include a soldering step to assemble the individual components. The decision to solder is based on the accumulated inaccuracies found in the various materials and techniques used through the casting stage. Soldering has been defined as the joining of metals by the medium of a filler metal that has a lower fusion temperature than that of the metal parts to be joined. This article mainly focuses on the principles of soldering, the parameters affecting the outcomes of this technique, and the obtained dimensional accuracy of soldering. A comprehensive chancery of principles, the background, theory, working terminologies is being elaborately included in the article*

Key Words*: soldering, soldering techniques, flux, antiflux*

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I. Introduction

Soldering continues to have an important role in dentistry, evidenced by the large selection of solders and fluxes still currently available from alloy suppliers .All dentists and technicians are somewhat familiar with the skill involved in joining the components of a fixed multiunit prosthesis or fixed partial denture (FPD)[1].Soldering is the process of joining metal using an intermediate metal alloy whose melting temperatureis lower than that of the solidus temperature of the metal to be joined.Metal to be joined is parent metal and metal used for joining parent metal is solder or filler metal.The parts to be joined are not melted during soldering,but must be thoroughly wetted by liquefied solder.

II. Material Science

The standard soldering techniques are called freehand and investment soldering. Upon melting, the solder alloy flows by capillary action between and around the adjacent heated but unmelted parts to be joined .Numerous processes, which are conventionally called soldering in dentistry, actually use brazing or welding alloys[2]. Soldering is similar to brazing. Solder melt at temperature below 840 degree F(450 degree C) and in brazing filler materials melt at temperature above this point.

Soldering operation at or above 450 degree C is generally termed brazing.Most dental soldering procedures are actually brazing but the names are used interchangeably in dentistry.Brazing is defined as a joining by the fusion of filler metals between them at a temperature below the solidus temperature of metals being joined and above 450 degree C.

Welding is the process of joining two pieces of similar metals without addition of another metal.Welding has a very limited use in prosthodontics. It is usually used to join flat surfaces like bands and brackets, in pedodontics to weld bands and other appliances, in prosthodontics to join wrought wire clasps and repair of broken metal partial dentures[3].

APPLICATION OF SOLDERING IN PROSTHODONTICS:

1. Assemble long span fixed partial dentures.
2. Joining wrought wire clasps arms to cast partial dentures framework.
3. Joining precision attachments.
4. Joining sections of metal superstructure for implant supported restorations etc.
5. To overcome distortion in multiunit cast fixed prostheses,.
6. Repair of perforated crown and bridges.
7. Develop contacts points in crown.
8. Cutting and rejoining of ill fitted distorted bridge.

FLUX

A flux is a powerful reducing agent. Its purpose is to facilitate "wetting" of the parent metal by the molten solder by preventing oxidation and by dissolving and removing surface oxides that form during the soldering operation.

ANTIFLUX

An antiflux acts to limit the flow of solder on clean metal surfaces. A layer of graphite (C), whitening ($ZnO2$), or rouge ($Fe2O3$) can be applied over the parent metal/alloy, where appropriate, for this purpose.

III. Review Of Literature

Pioneering research Prior to 1970, some of the luminaries in the art and science of soldering were Coleman,Taylor and Teamer, Steinman,Ryge, Smyd,Hollenback and Shell and Johnston et al

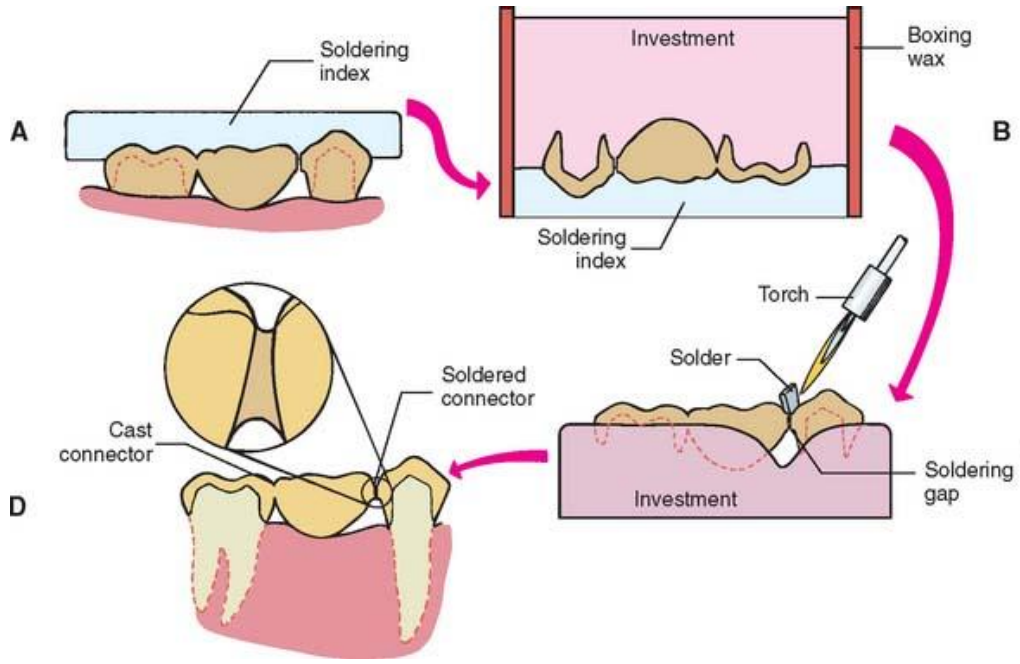
Coleman5 classified dental gold casting alloys and solders on the basis of their composition and melting characteristics. Taylor and Teamer25 studied the desirable properties of dental gold solders (melting temperatures and flow characteristics) in relation to their basic Au–Cu–Ag content, and suggested a fineness range of 0.435 to 0.800[4]. They designed tests (specifications) to determine practical working characteristics of gold solders.

Steinman studied the reasons for warpage/distortion in soldering, and although he used wires (Au–Pt–Pd wire), his findings still relate closely to current soldering practices. He showed that factors such as parallel approximating surfaces in close contact, investment soldering, and the use of a minimum of solder by The American College of Prosthodontists Byrne Soldering in Prosthodontics reduced distortion[5]. He also showed that the practice of immediate quenching and heat treatment increased distortion. Ryge1 studied the influence of soldering gap distance on distortion in the investment soldering technique for dental bridges. He outlined basic technique principles such as cleanliness, use of fluxes and antifluxes, use of investment, and heat application. His recommendations include: (1) a minimum gap distance of 0.005 inches, (2) preheating in a furnace, (3) applying the solder at the soldering temperature, and (4) bench cooling for 5 minutes followed by quenching to minimize grain growth and joint brittleness. He demonstrated that overheating or prolonged heating caused undesirable diffusion of solder at the solder/parent alloy interface, and "contrary to common belief a strong solder junction can be obtained without noticeable diffusion between the solder and the parent alloy.

Hollenback and colleagues studied soldering distortion as a function of investment, and noted the importance of investment expansion. They reported that the shape of the joint had no appreciable effect on soldering distortion. Smyd discussed the various expansion and contraction factors involved in soldering, with emphasis on soldering investment. Johnston et al reported post-soldering as many as ten metal ceramic units at one time in a porcelain furnace "without any clinical evidence of warpage." These authors set the stage for more recent work in the field

SOLDERING TECHNIQUES

1. Indexing/connecting
2. Investment
3. Joint configuration
4. Gap width
5. Assembly heating/cooling

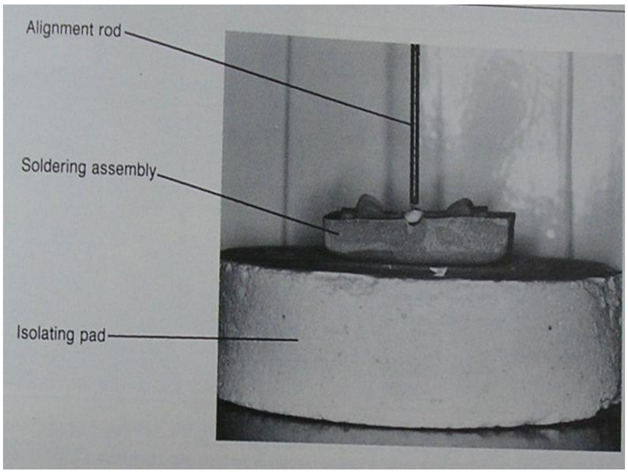


INDEXING

Harper and Nicholls compared the 3D distortion caused by various indexing media. They concluded that ZOE bite registration paste was the most accurate indexing method, plaster and Duralay resin were less accurate, and sticky wax least accurate. Moon et al found the least distortion with a plaster nonremoval technique, followed by Duralay resin

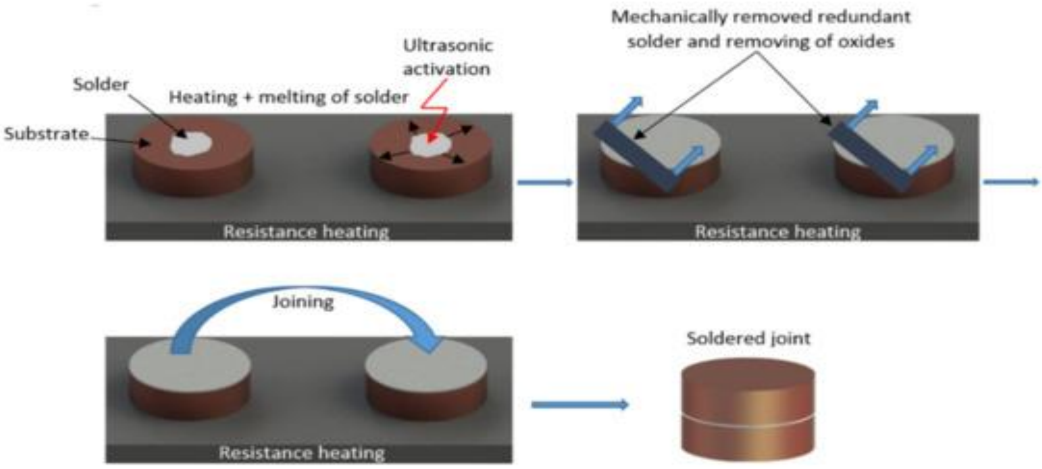
INVESTMENT

The composition of a soldering investment is much like that of conventional investments for gold casting, with quartz preferred to cristobalite as a refractory to minimize thermal change. As the contraction of gold during casting is compensated for by investment expansion, so the shrinkage of solder must be compensated for by the setting and thermal expansion of the investment



JOINT CONFIGURATION

Steinman16 noted the adverse effect of wedge-shaped joints and solder shrinkage on wire joints. Shillingburget al[6] continued to recommend the use of flat opposing joint surfaces, rather than wedge-shaped approximating axial surfaces, to minimize distortion. Using curved joint configuration have noted FPD retainer misfit without being able to attribute the distortion to joint shape, or other specific variables.



GAP WIDTH

Gap width is considered an important soldering parameter from both accuracy and strength perspectives. Many gap widths have been used in research, including 0.005 inches,1 0.3 mm,22 0.5 mm,23 0.15 mm,26 0.4 mm,35 0.15 mm,52 and 0.012 inches68 (calling card), 0.2 mm (business card), 0.13 mm,10 0.15 to 0.2 mm, 0.25 mm. Once a gap has been created, several factors influence its size during the soldering operation. Willis and Nicholls65 studied the influence of gap distance (0.0 mm, 0.15 mm, 0.3 mm, 0.45 mm) on distortion. They concluded that a minimum gap distance between metal parts, without contact, was desirable[6].

HEATING / COOLING

Steinman cautioned against quenching or heat treatment lest they contribute to distortion. Ryge1 later recommended a compromise of bench cooling followed by quenching as a means of optimizing joint strength without causing distortion

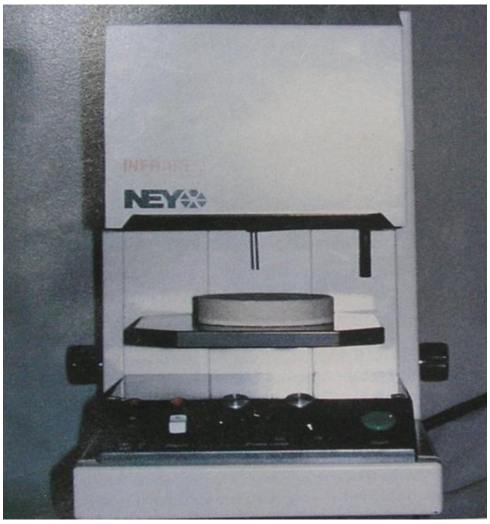
The invested units were removed from the oven and soldered in one of three ways.

1. Torch soldering.

Flux (J. M. Ney Co.) was applied to the solder joint area and the solder (SMGB, J.M. Ney Co.) was inserted. A gas and oxygen torch was used in a back-and-forth motion to heat the joint site until the solder flowed into the gap[7]. The temperature of the flame was monitored with an infrared optical thermometer (Optitherm infrared thermometer, model 12-8723, Barnes Engineering, Stamford, Conn.) to avoid heating the parent alloy to its melting range.

2. Infrared soldering.

Flux was applied to the joint area and the specimens were soldered with an infrared instrument



3. OVEN SOLDERING

Oven soldering has helped to standardize technique as compared with flame soldering. A vacuum is not needed for oven soldering of noble metal alloys.

IV. Discussion

For soldering to be a useful everyday procedure, it must be predictable for the average operator and produce consistent results. Researchers must build on existing knowledge and desist from haphazard, isolated experimentation. In particular, fluxes, investments, and solder-parent alloy compatibility must be studied and guidelines clarified.

V. Conclusions

Soldering is a useful and technique-sensitive procedure. It may improve the dimensional accuracy of multiunit fixed prostheses. Many variables in soldering technique affect the outcome. Research science has developed some helpful guidelines. Research projects are disconnected and limited in scope. New technologies such as CAD/CAM and laser welding may replace soldering in dentistry, although such technologies are likely to remain beyond the resources of many populations for some time.

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