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REVIEW ARTICLE

The Museum Maze in Oral Pathology Demystified: Part II

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ABSTRACT

Museum technology is perpetually changing due to current requirements and added inventions for our comfort and furbished display of specimens. Hence numerous methods of specimen preservation have been put on trial by diverse people in the medical field as are the inventions. But only few have caught people's interest and are popularized today. This part provides unique insights into specialized custom-made techniques, evolution of recent advances like plastination and virtual museum that have popularized as visual delights. Plastination gives handy, perennial life-like acrylic specimens, whereas virtual museum takes museum field to the electronic era making use of computers and virtual environment.

Keywords: Calculi, Injection methods, Maceration, Mounting media, Plastination, Transparent specimens, Virtual museum, Whole organ mounting.

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SPECIALIZED MUSEUM TECHNIQUES

The technique of specimen mounting is specimen specific. Apart from the routine soft tissue mounting procedures explained in part-I, specialized techniques for different specimens like bone, calculi, transparent specimens, whole organs, blood vessels and ducts are briefed in this part (Table 1).

MACERATION OF BONES

Maceration is a bone preparation technique whereby parts of maxillofacial skeleton are allowed to putrefy at a stable temperature in a container devoid of oxygen to acquire a spotless skeleton.[3]

Maceration can be achieved by various methods which employ either heat or suitable chemicals. Various maceration techniques have been collated in Table 2. The end point of maceration is when the bones would be devoid of soft tissue.[4]

APPLICATION

1. Maceration of skeleton contributes to real or mistaken identity in traumatized conditions with a noticeable role in forensic anthropology.[5]
2. Long-term preservation of maxillofacial skeleton (e.g.: mandible for teaching osteology) (Fig. 1).
3. To demonstrate bony lesions, such as osteogenic sarcomas, osteomas and the effects of chronic osteomyelitis and tuberculosis.[1]

CALCULI

When a calculus is mounted, both surfaces of the calculus and laminations should be visible clearly. Calculi are cut into two halves, with a fine fretsaw, or coping saw, and the cut surfaces polished with sandpaper. One-half is polished and mounted and the other is labelled with Indian ink, the latter being kept for students to handle and study more closely at lectures. The polished specimens are cemented halfway through a sheet of Perspex which in turn is cemented into the box, thus ensuring a minimal disturbance. Then stencilling is done on a sandpapered rectangle.[1]

Fig. 1: Macerated mandible depicting fracture at various levels (A and B)

Calculi are often presented by either: dry mounting in boxes with removable glass lids or mounting in gelatine to which formalin has been added.[1]

For example: salivary calculi, phleboliths.

TRANSPARENT SPECIMENS

The techniques used in the preparation of transparent specimens are dependent on the replacement of the tissue fluids, by fluids of a higher refractive index. Such techniques are usually employed to demonstrate either the bones of embryo or circulatory system. Commonly used are Spalteholz technique, Dawson's technique and modified Dawson's method for staining fetal skeleton (Richmond and Bennett) (Table 3).[1,2]

Table 1: List of specialized museum techniques[1,2]

Type of specimen	*Technique employed*
Bone	*Maceration*
Calculi	• Dry mounting in boxes • Mounting in gelatine • Mounting in Perspex
Transparent specimens e.g.: embryos, circulatory systems	• Spalteholz technique • Dawson's technique • Modified Dawson's method
Whole organs	Gough and Wentworth paper mounted sections
Blood vessels, lymphatics, bronchi, bile ducts	Injection methods • Polyester resins • Neoprene latex • Radiopaque materials • Gelatine

WHOLE ORGAN MOUNTING

Whole organs may be sectioned and mounted on paper by methods of Gough and Wentworth (1948, 1949; Gough, James and Wentworth 1949). These preparations provide valuable information on the structure of the whole organ and serve as intermediate links between the mounted museum specimen and the histological section of a small piece of organ.[2]

For example: salivary glands.

INJECTION METHODS

Blood vessels, lymphatics, bronchi, bile ducts and many other anatomical structures can be better visualized by injection of colored insoluble substances. Casts are produced which may be examined in the intact specimen if it is sufficiently translucent. When a radiopaque injection medium is used, the specimen can be X-rayed and details of small blood vessels are seen on naked-eye examination.

Table 2: Maceration techniques[4]

Method	*Protocol*
Hot-water bath	Water bath (10.5 L) maintained at or just below 90°C
Boiling	Water bath (10.5 L) maintained around 100°C
Microwave	Specimens are placed in microwave-safe dish and covered with plastic wrap; samples are heated in a 1300-watt, 2450 MHz microwave oven (Sears, Hoffman Estates, IL) on high power for 1-min intervals until all flesh easily slipped from the bones
Bleach (Sodium hypochlorite)	10% bleach (Clorox, Oakland, CA) solution (1.05 L liquid bleach and 9.45 L water) kept at room temperature (22°C)
	Hydrogen peroxide (H_2O_2) 1.0 L 3% hydrogen peroxide
EDTA/Papain	Two teaspoon (11.25 gm) EDTA (Fisher Scientific, Fair Lawn, NJ) and 2 teaspoon
	(13.6 gm) papain (Sigma, St. Louis, MO) per 10.5 L water maintained below 45°C
Meat Tenderizer /Palmolive	Six teaspoons (39.4 gm) Adolph's (Lipton, Englewood Cliffs, NJ) nonseasoned meat tenderizer and six teaspoons (29.6 ml) Palmolive (Colgate/Palmolive, New York, NY) per 10.5 L water maintained at or below 90°C
Detergent/Sodium carbonate (Biz /Na_2CO_3)	Seven tablespoons (100 cc) powdered Biz (Redox Brands, Inc., West Chester, OH) and seven tablespoons (100 cc) powdered sodium carbonate (Arm and Hammer Super Washing Soda, Church and Dwight Co., Inc., Princeton, NJ) per 10.5 L water maintained at or below 90°C
Detergent/Sodium carbonate + degreaser	Biz/Na_2CO_3 followed as mentioned earlier, then rinsed and placed in 300 ml liquid sudsy ammonia and 4 L water

Table 3: Commonly used techniques for the preparation of transparent specimens[1]

Technique	*Principle*	*Application*
Spalteholz technique (1911):	Specimens are completely dehydrated in graded alcohols followed by removal of tissue fluids with benzyl benzoate and oil of wintergreen.	Demonstrates the circulatory system
Dawson's technique (1926)	Soft tissues are cleared in potassium hydroxide followed by attaining of bone with alizarin and the replacement of body fluids with glycerine.	Demonstrates bone in embryos and small animals.

Routinely used materials for injection are polyester resins, neoprene latex radiopaque materials and gelatin.[2]

For example: salivary ductal systems.

RECENT ADVANCES IN MUSEUM TECHNOLOGY

Recent developments in museum field have led to the emergence of newer innovative methods of preservation and demonstration of specimens. The most interesting are:

- Plastination
- Virtual museum
- Newer mounting media.

Table 4: Different polymers used for Plastination[6]

Polymer	*Special features*	*Specific application*
Silicone	• Exists with different degrees of viscosity • Produces three-dimensional resilient and semi-flexible specimens	• Teaching purposes
Epoxy resin	Produces thin transparent slices of body parts	• Teaching sectional anatomy • Training in CT, MRI and USG.
Polyester resin	Enhances the color of the specimen	Exclusively used for the preparation of opaque brain slices

CT: Computed tomography; MRI: Magnetic resonance imaging; USG: Ultrasonography

PLASTINATION

Plastination is an exclusive way of preservation of biological material with its varied application in numerous schools and research institutes across the globe. It was invented in 1978 at the University of Heidelberg by Doctor Gunther von Hagens.[6]

Principle

The principle of plastination involves the substitution of water and lipids in the specimen by a curable polymer.[7]

Application in Oral Pathology

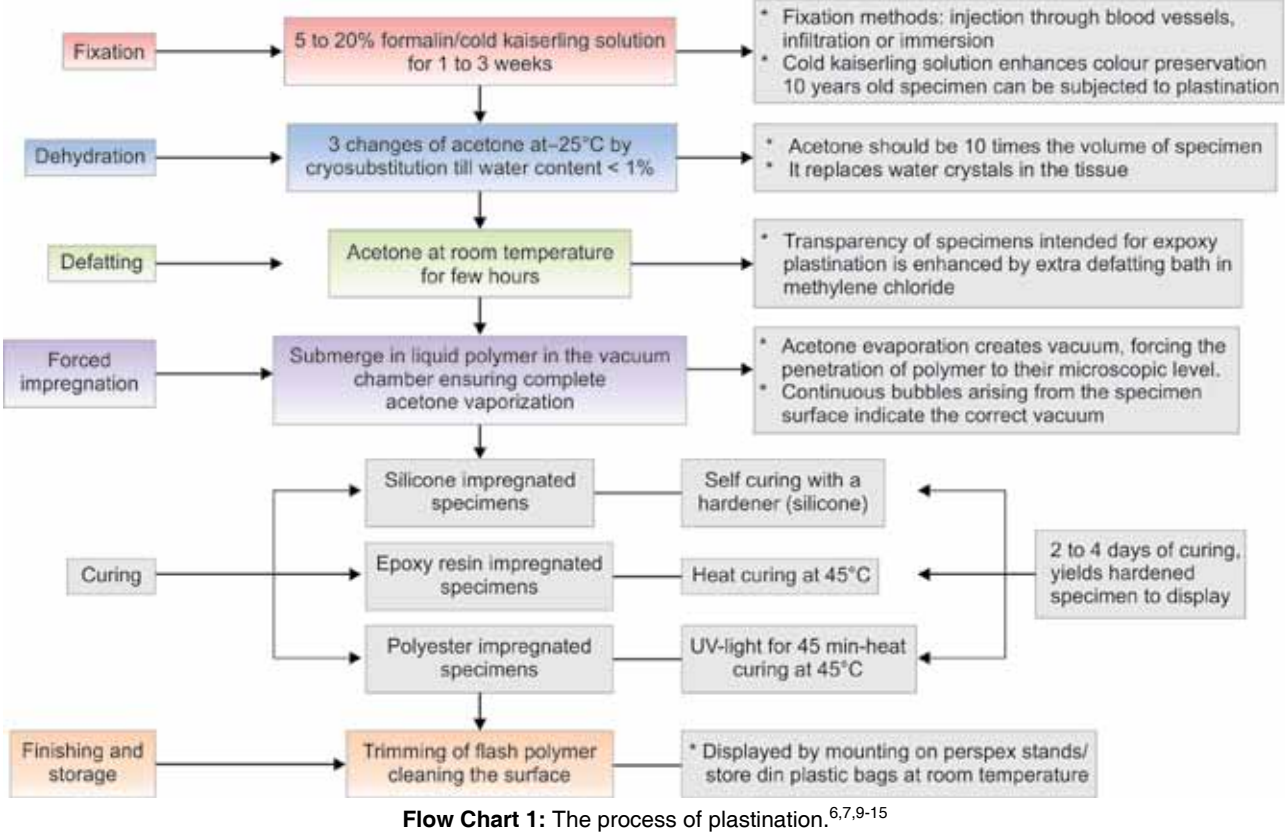
Cysts and tumors can be plastinated especially for teaching purposes.

Polymers used for Plastination

Plastination has been performed using array of polymers: epoxy, silicone rubber, and polyester being the most preferred. Each will produce specimens with appropriate physical characteristics (Table 4).[6]

Desirable Properties of Polymers

a. Polymer should be easy to handle, economical and freely flowing in the unseasoned state.[7,8]
b. Its refractive index should not match that of the tissue. (Unless the requirement is transparent specimen).[7]
c. Mixture of resin and activator should provide flexible timing for manipulation.[7]



Flow Chart 1: The process of plastination.[6,7,9-15]
*Denotes alerts during the plastination procedure

d. The polymer should be curable even when present in the tissue.[7]
e. Mechanical properties should impart a natural appearance to the specimen as well as make it firm to allow grinding.[7]

Having taken the above mentioned credentials, silicone rubber has been the preference of choice.[9]

Plastination Procedure

The process of plastination involves 6 basic steps, represented in the Flow Chart 1.

Histologic Examination of Silicone-Impregnated Specimens

Interestingly, the silicone plastination is considered superior for longer preservation of tissue microscopy.[9] Plastinated tissue can be made suitable for histological examination by 'deplastination'. It uses sodium ion to depolymerize silicone rubber. Silicone plastinated tissues are subjected to a solution of sodium methylate in anhydrous methanol until free of polymerizedsilicone rubber and further proceeded for standardized histological procedures. The outcome of this method merely equates that of conventional methods.[7]

The merits and demerits of plastination are summarized in Table 5.

VIRTUAL MUSEUM

A virtual museum is an online museum. It's also called as electronic museum, hypermuseum, digital museum, cybermuseum or web museum.[17]

A famous definition of 'virtual museum' by Geoffrey Lewis is – a collection of digitally recorded images, sound files, text documents and other data of historical, scientific, or cultural interest that are accessed through electronic media. A virtual museum does not house actual objects and therefore lacks the permanence and unique qualities of a museum in the institutional setup. The internet navigates the visitors into a visual world which is incomparable to a real museum experience.[18]

The concept of a museum without walls was firstly introduced by Malraux, as a new kind of environment for viewing and presenting art.[19] The term 'Virtual Museum' was coined by Tsichritzis and Gibbs.[20]

AN INSIGHT OF VIRTUAL MUSEUM

Virtual museum consists of roughly two parts as followos:
1. A museum server: conveys the museum services based on databases.
2. Interface orbit: a conceptual term to represent user's applicability according to devices.[21]

Table 5: Merits and demerits of plastination[6,7,16]

Merits	*Demerits*
• Technique is simple, inexpensive and produces maintenance-free permanent specimens.	• Process is time consuming and technique sensitive.
• Prepares 'real' dry, odorless, durable and nontoxic specimen with its dual application in classroom and laboratory.	• Initial trials to achieve the desired outcome may lead to wastage of rare and unusual specimens.
• Plastination is reversible and deplastination permits the use of tissue for routine histological techniques, special stains and IHC procedures.	• Expensive and needs more equipments than the conventional laboratory methods.
	• Process needs intense post curing work such as trimming, polishing, coloring, and mounting to obtain a good display specimen.
	• Limitations in terms of tactile and emotional experience that is provided by wet cadavers.
	• Deplastination is not possible with all types of resins.

Table 6: Merits and demerits of virtual museums over real museums[20]

Merits	*Demerits*
1. Provides unlimited space for innumerable specimens and also allows for display of fragile specimens.	1. Development of virtual museum is time consuming and requires special expertise as well as high expenditure.
2. Affords a more vivid and realistic experience as exhibits can be interactively observed from different viewpoints or even manipulated.	2. It can not be accessed by laymen who are not aware of usage of electronic media.
3. Provides multisensory experience to the museum visitor.	3. Virtual museum fails in terms of tactile and emotional experience that is provided by wet cadavers.
4. Virtual museum can be accessed at any exhibition site or remote location.	

DEVELOPMENT OF THE VIRTUAL MUSEUM

Consists of four main tasks:

1. Digitization of exhibits to be presented.
2. Development of the virtual museum environmental elements, within which the exhibits would be spatially arranged and presented.
3. Actual integration of exhibits within the virtual space.
4. The manner in which participants navigate within the VE and interact with its elements is implemented.[20]

Merits and demerits of virtual museum over real museum are briefed in Table 6.

NEWER SAFER MOUNTING MEDIAS

Although alcohol and formalin have multifaceted use in tissue preservation, they have lost their sheen due to their known toxicity. While, alcohol can result in tissue discoloration on a long run.

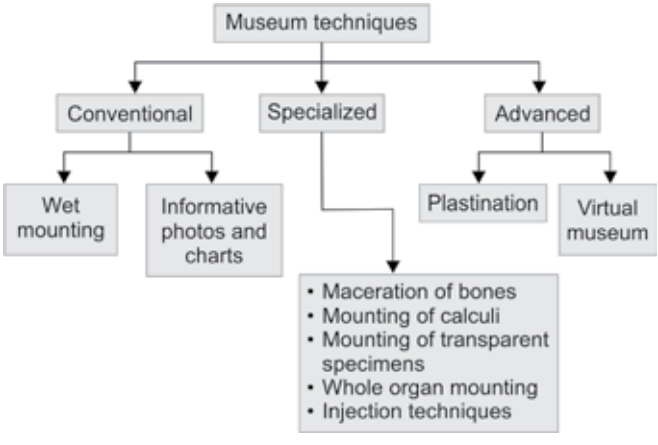
A safer mounting media should be nonflammable, colorless; non-yellowing, preserve specimen's natural color, chemically and thermally stable, nonvolatile organic compound (VOC), odorless, least toxic, ozone friendly and cause low global warming.[22] Commercial products which meet some of these requirements are available and can be adopted in the museum.

SUMMARY

Summary of various museum techniques are depicted in the Flow Chart 2.

CONCLUSION

New methods of specimen mounting and preservation are at rise since every specimen is unique. Intelligent usage of space for exhibits in dentistry is much required in current scenario due to lack of space. Also, technologies like virtual museum are most desired as they take museum to the present electronic era. Every histologist must have a watch on the newer and better museum technologies and adopt in his museum to make it simpler, accessible and attractive.



Flow Chart 2: Summary of museum techniques

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