

RECYCLING AND REUSE OF DENTAL MATERIALS: A OVERVIEW

¹Dr. Ravikiran Asabe, ²Dr. Manali Bhansali

¹MDS, ²BDS(Intern)

¹Prosthodontics and Crown & Bridge,

^{1,2}Bharati Vidyapeeth Dental College and Hospital, Pune, India.

Abstract: Dentistry is a profession that promotes and enhances oral health and well-being by providing various dental treatments which uses a variety of materials and instruments. Thus, large amount of waste is generated like dental amalgam, lead, silver, waxes, gypsum, biomedical waste that has detrimental effect on environment and may be hazardous to the human life. Recycling and reusing of these dental materials may help reduce waste and its harmful effects on the environment.

Keywords: Recycling, Dental Gypsum, Dental Amalgam.

INTRODUCTION

Dentistry is defined as the “evaluation, diagnosis, prevention and/or treatment (non-surgical, surgical or related procedures) of diseases, disorders and/or conditions of the oral cavity, maxillofacial area and/or the adjacent and associated structures and their impact on the human body”[1]. The dental treatments require a variety of materials and equipment usually fabricated from metallic and non-metallic materials obtained from natural resources presenting potential challenges to the environment. The natural resources are getting depleted due to its extensive use in different fields of science, which may be due to increase in the population, new inventions and technologies [2]. Dentistry, among other fields in the medical industry contributes large amount of environmentally “unfriendly waste” that have significant environmental impact.

Recycling and reusing of dental materials is one of the attempts to reduce the detrimental impact on the environment and promote environmental awareness. The four R’s include **reduce, reuse, recycle, and rethink**.

- **Reduce:** To reduce the amount of waste generated and usage of materials should be only when necessary. Purchase of products with minimal packaging can help reduce 30% of the garbage.
- **Reuse:** To reuse the materials which can be reused and single use items should be replaced by reusable items.
- **Recycle:** To recycle paper, metal, waxes, gypsum and every material that can be recycled to keep the environment cleaner and greener. Identification of existing recycling programs is necessary.
- **Rethink:** Before buying any material, think of environmentally better options. While using any material during a procedure, use the material judiciously and dispose it off following proper protocols or prefer recycling.

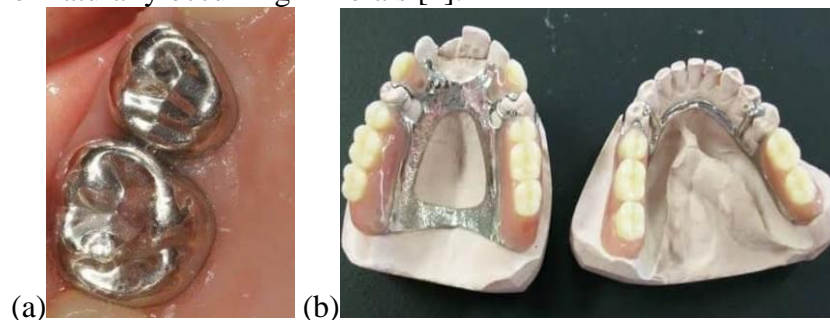
This review discusses about some of the dental materials that can be recycled and reused.

MATERIALS AND METHODS

(1) CASTING ALLOYS (CR – CO AND NI – CR ALLOYS):

Base metal alloys are used in fabrication of metal copings, crowns and bridges, cast partial denture frameworks, metal denture bases and implant-supported frameworks and crowns. Casting technique generates about 50%–60% of the alloy that remains as waste in the form of buttons and sprues. The remaining wasted materials can be effectively reused for fabricating new restorations or appliances by proper cleaning techniques like sand blasting, electropolishing. The mechanical properties of this material reduces only by 5%–10% even after 20th recast. The only concern for reusing this material is its biocompatibility which can be checked after each recast. Even if there is a biocompatibility failure these materials can be redirected to other engineering areas for the fabrication of 1) Cutting tools 2) Oil well drilling bits, dredging cutters, hot trimming dies, internal combustion engine valves 3) Gas turbine vanes,

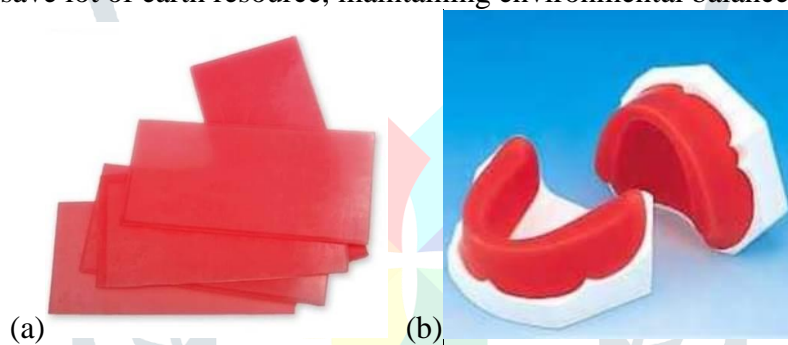
buckets and so on. These alloys are termed as super alloys in engineering fields due to their high strength and high corrosion resistance [4]. Thus, by setting up recycling units, tones of metals/alloys can be conserved and environment can protected from getting polluted due to extensive mining work required to extract huge amounts of naturally occurring minerals [2].



(a) Full coverage metal crown, (b) Cast partial denture

(2) DENTAL WAXES:

Different types of waxes such as modeling wax inlay wax, utility wax, casting wax, beading and boxing wax, baseplate wax, sticky wax, and bite registration wax are used in dentistry. These waxes are made out of natural waxes, synthetic waxes, plant wax, animal wax, and natural resins. In most of the procedures, wax is not consumed but used and rejected. Around 80 – 90 % of wax can be recycled using simple laboratory technique by removing adhering impurities without any deterioration of their original properties. Since this is in-vitro procedure, there is no biocompatibility issue. Recycling and reusing dental waxes extracted from natural resources, will save lot of earth resource, maintaining environmental balance [2].

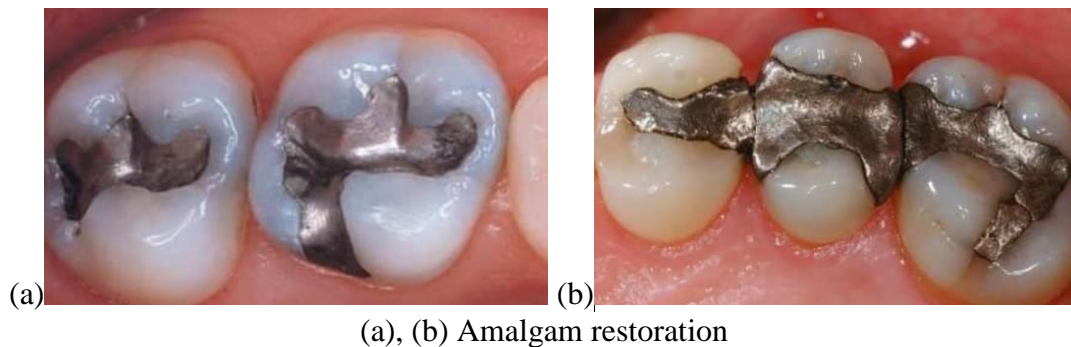


(a) Modelling wax, (b) Occlusal rims made using wax

(3) SILVER AMALGAM:

Dental amalgam has been extensively used as a tooth filling material for many decades and now its use has been reduced to some extent due to development of composite and other tooth colored restorative materials. It is most widely used in all the dental colleges for demonstration work, training students in filling artificial cavities prepared in typodont and mainly as permanent posterior restorative material in dental clinics. Almost 100% of silver amalgam is discarded in dental teaching institutes, and 25% is discarded in dental clinics. Both the placement and the replacement of dental amalgam restorations produce amalgam waste [5]. This waste consists of 50 to 60 % silver, 20 -30 % tin and 10 – 15 % as silver-mercury, copper-tin and tin-mercury phases. From this amalgam scrap, it is possible to separate mercury and silver by simple laboratory procedures, and thus, they can be redirected for use. From this amalgam waste, mercury can be recovered by heating the waste amalgam at temperature higher than 450°C. Eventually, the evaporated mercury condenses and comes out of the mix which can be purified and reused. The remaining mix is dissolved in concentrated HNO₃ forming soluble nitrates of silver and copper. If pure copper or any other metal having lower electrode potential is added to this silver nitrate solution, silver gets displaced and easily recovered [2].

Ag & Hg can be reused in many areas of industries & dentistry leading to conservation of earth resources. Since mercury cannot be easily disposed, recycling and reusing will reduce mercury health hazards [2].



(a), (b) Amalgam restoration

(4) GYPSUM AND PLASTER:

Large amount of gypsum waste is generated in the field of dentistry. This gypsum waste is discarded onto the landfills whose reduction causes production of hydrogen sulfide, having a characteristic rotten egg smell. The respiratory tract and nervous system are the most sensitive targets of hydrogen sulfide toxicity. This has few symptoms like irritation to the eyes, nose, or throat causing difficulty in breathing for some asthmatics. Other symptoms include headaches, poor memory, tiredness, and balance problems. Permanent or long-term effects include headaches, poor attention span, poor memory, and poor motor function [3]. Currently, gypsum and plaster waste—harbouring biomedical material is disposed by incineration which is very critical and environmentally unfriendly as it produces toxic gases and heavy metals.

The eco-friendly and rapid disintegration of such waste can be done by treatment with ammonium bicarbonate solution with a concentration of 20%. The 20% ammonium bicarbonate solution exhibits antibacterial and antifungal property that kills 99.9% microbes in waste samples within 3 hours. This solution disintegrates the waste into high value and non-toxic chemicals such as ammonium sulphate and calcium bicarbonate in the form of sludge in 24 hours to 36 hours at room temperature. [6].

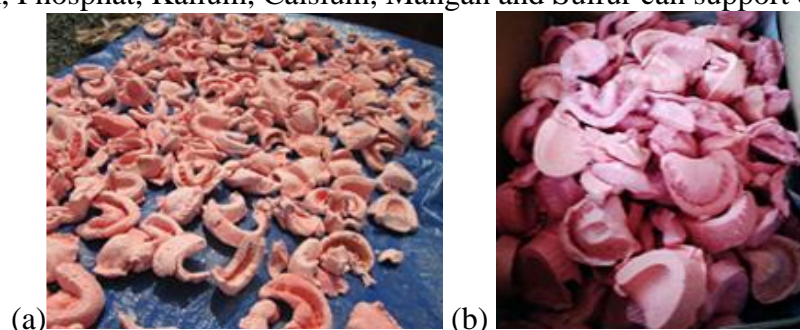
Ammonium sulphate can be utilized as nitrogen fertilizer, fire-extinguishing powder, and in industries like pharmaceutical, textile and wood pulp. Calcium carbonate can be used in metallurgy industry, mainly in steel manufacturing [6].



(a), (b) Gypsum casts

(5) DENTAL IMPRESSIONS:

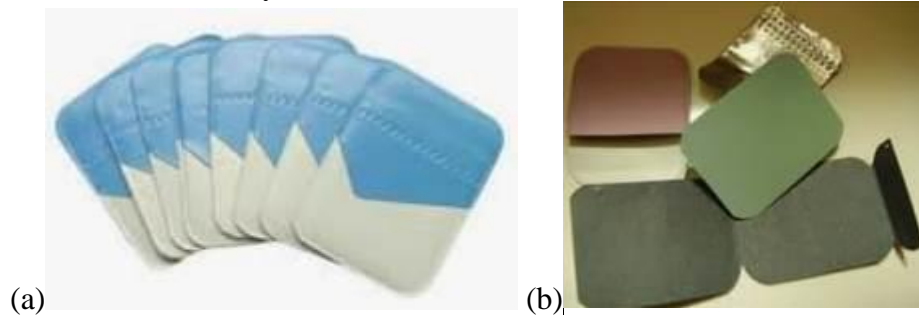
Dental alginate is an impression material that is widely used in dentistry because of the ease of stirring and manipulation, the necessary equipment is simple, the flexibility of the mold, accuracy, and the relatively economist. This dental alginate molds are disposed of in the garbage along with other infectious waste and further disposal united with domestic waste. This alginate impression waste can be recycled by the process of washing, drying and meshing until the size approximately 2-3 mm. This recycled alginate showed sufficient quantity to add nutrients associated with soil fertility and crops. The high calcium content can be used as calcification material to improve soil quality and other nutrients derived from dental alginate waste were Nitrogen, Natrium, Phosphat, Kalium, Calsium, Mangan and Sulfur can support crop yields well [7].



(a), (b) Disposed alginate impressions

(6) DENTAL X-RAYS:

Another common waste product in the dentistry is unused film which should not be disposed in the general waste. Unused films contain unreacted silver that can be toxic in the environment [8]. Thus, recycling of X-rays is a good idea. In recycling process, the films are washed in a chemical solution that separates out the silver. The silver is melted and turned into bars. After the silver has been removed, a piece of PET plastic is left which can be recycled. This silver can be reused in different fields [9].



(a) X-ray film packets, (b) Contents of x-ray film packet

DISCUSSION

It is identified that humans are the biggest threat to their own race. Our own attitude toward our environment is affecting our health and well-being on a large scale. We must recognize that some of the materials and procedures used to provide dental health services present challenges to the environment. Realizing this, we must begin to take measures to minimize the production of these wastes and their potential environmental effects [8].

Base metal alloys are largely used in dentistry for fabrication of many oral appliances but majority of dentists did not know what to do with left over casting alloys and discarded it. Thus, these casting alloys can be recycled and reused in different fields reducing the amount of natural resources from getting depleted. The engineering field considers these base metal alloys as super alloys and uses in the fabrication of many cutting tools and devices, hence after certain amount of reusing in dentistry it can be utilized in engineering fields, since there is a very little loss of their mechanical properties [4].

Waxes are used in dental field for various purposes as well as an accessory aid in fabrication of dental appliances. After preparing the occlusal rims or any other pattern from this wax, the left over carved out or excess wax is just discarded in the dust bin. Hence this wax can be collected back, purified and new wax sheets can be prepared and reused. This will save lot of earth resource, maintaining environmental balance.

Dental amalgam has been extensively used as a tooth filling material because of its durability, strength and low cost. Silver is used in many areas and its careless disposal may affect humans as well as environment. Hence, recycling of silver becomes very important in the field of dentistry.

Gypsum waste is produced on large scale in dentistry and its disposal on landfills produces toxic gases that affect human health and environment. Thus, recycling of gypsum will reduce the burden of waste generation and its toxic effects harming the environment. Ammonium sulphate and calcium carbonate generated after recycling of gypsum is beneficiary and is used in different fields.

Dental alginate impression material is the most common material used in dentistry. However, dental alginate waste (DAW) is one of the causes of the increasing number of dentistry and medicinal wastes. To maintain the environmental balance and preserve its resources, recycling and reusing of alginate waste is important. Recycled alginate is used as fertilizer increasing the yield of certain crops.

Unused X-ray films and lead foils constitute a part of dental waste having harmful effects. Thus recycling of X-ray films becomes important. Thus, the use of digital radiographs not only reduces the radiation exposure but also eliminates the use of biohazardous materials.

CONCLUSION

Dental practitioners are becoming increasingly concerned about the potential impact of dentistry on the environment and often take voluntary measures to reduce the production and release of environmentally unfriendly wastes and our efforts should always aim toward the betterment of the society. Large quantity of natural resources can be saved from getting depleted by conserving natural resources. Recycling and reusing of the dental materials may help reduce waste and its deteriorating effects on the environment.

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