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*RESEARCH ARTICLE*

# BRIDGING THE GAP -A FOCUS GROUP STUDY ONNEED FOR TRANSFORMATION IN DENTALAMALGAM USAGE ASA PART OF DENTAL CURRICULUM

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## *Abstract*

**Background:**Dental caries, a widespread non-communicable disease, is often treated using dental amalgam or resin composite. Amalgam, used for over 150 years,contains about 50% mercury,posing health risks such as neuropsychological and renal toxicity, hypersensitivity reactions, and environmental hazards. This raises concerns about its continued use in dental education, necessitating a re-evaluation of dental curricula.

**Methods:**This qualitative study used focus group discussions to explore perceptions of amalgam usage. Fifteen participants, including academic staff, clinical practitioners,management,students,nonteaching staff,and patients,were selected via mixed purposeful sampling. Participants discussed challenges in teaching amalgam use, disposal practices, and the need for curriculum reform. Data were recorded, thematically analysed, and validated by participants.

**Results:**Key themes identified were knowledge gaps in the curriculum, environmental impact of amalgam,teaching challenges,clinical use of amalgam,disposal strategies, and curriculum reform needs. Participants acknowledged mercury toxicity,and the extensive cavity preparation required for amalgam.Some supported amalgam for its durability and cost-effectiveness, while others preferred aesthetic composite restorations. Training on amalgam handling and disposal was deemed inadequate, highlighting the need for curricular updates to reduce amalgam use and incorporate alternative materials.

**Conclusions:**The study emphasizes the need to transform dental curricula to address health and environmental risks of amalgam. Regulatory bodies like the Dental Council of India should mandate regular curriculum updates, ensuring safer and more sustainable dental practices.The findings highlight the importance of aligning dental education with contemporary clinical practices and environmental safety standards

**Key Findings:**The study found a significant gap between theoretical knowledge and clinical practice in dental amalgam usage,with students observing a shift toward alternative materials like composites. Participants raised concerns about mercury toxicity and environmental risks, aligning with global efforts to phase out amalgam. The findings highlight the urgent need to modernize the dental curriculum by integrating sustainable and evidence-based restorative practices.



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## Introduction: -

Dental caries, commonly known as tooth decay or dental cavities, are one of the most common non-communicable diseases worldwide[1]. Dental caries pivots successive demineralization of enamel and dentine which needs to be restored by dental professionals. The direct restorative material repeatedly used is either dental amalgam or resin composite. The dentist has used dental amalgam for more than 150 years which is used as a filling material for restoring posterior teeth. Dental amalgam adds up to 50% of mercury which is highly hazardous to the operator, patient as well as environment.

Mercury present in dental amalgam has the potential to be toxic to the neuropsychological and renal function in humans. Dental amalgam can produce delayed hypersensitivity reactions in some individuals which are usually dermatological and oral symptoms. The constant exposure to mercury in amalgam restoration may sensitize some individuals, making them more susceptible to oral lichenoid lesion[2].

Mercury emitted into the air eventually settles into water or onto land where it can be washed into water. Once deposited, certain microorganisms can change it into methylmercury, a highly toxic form that builds up in fish, shellfish and animals that eat fish[3].

Use of liquid mercury for dental amalgam by the students at dental teaching institutions is considered as the main reason for extremely high mercury vapor levels in the air at some of the monitored dental sites[4].
In view of all the perilous effects of dental amalgam on the occupation and environment, it is mandatory to remould the usage of dental amalgam in dental curriculum.

## Materials and Methods: -

For Focus Group discussion was used as the method of investigation. The study was conducted as per institutional ethical standards after review from the institutional board for ethics and research. A study population of 15 participants selected based on mixed purposeful sampling strategy, including academic staff, clinical practitioners, management personnel, students including undergraduate and postgraduate, non-teaching staff and patients.
All participants were invited via mail for the study after appropriate consent and Ethical approval (for names and affiliations, see acknowledgement section).

The participants were given an outline and purpose for the study in advance along with the date and time for the event. The demographic data of the participants was collected before the study. The participant's permission was taken before recording the discussion and was granted the choice to withdraw from the discussion if the need arises. The study was done by conducting the discussion within the focused group. The discussion emphasized the challenges experienced with teaching amalgam and its disposal in dental curriculum and the need for curriculum development. The discussion topics also included insight of academic staff on dental amalgam teaching, alternatives for dental amalgam and recommendations for improvement in current curriculum on dental amalgam. The recorded data was examined carefully by the researchers and thematic analysis was done. The data analyzed was sent to one of the participants to check for the correct interpretation and provide feedback to draw final conclusions.

**Intervention:**
**Preparation phase:**Dental professionals were invited via mail which included a consent form andemographic data collection form. This also consisted of the outline and purpose of the study. The participants were informed prior that the session will be audio and video recorded. For the focus group discussion, a set of questions was prepared which was validated by 4 staff members (Annexure-1). These questions were not disclosed until the time of discussion to any of the participants.

**Scientific review and suggestions:**
The topic of research was presented in the Scientific Review Committee of the institution, which also included an external member. According to the Scientific Committee's suggestion, the word "qualitative" was added to the title. The Scientific Review Committee accepted and gave approval for the research study.

**Pre discussion preparation:**
Before the focus group discussion, the set of questions were divided into categoriesaccording to the participant's group. Each question was discussed by the members.Audio and video facilitywas checked before the discussion.

**Focusgroupdiscussion:**
On the day of discussion, participants' seating arrangements were made as per the given role of the participant (Picture-1). The groups were divided into faculty, private practitioners, management, non-teaching staff, and students.

Each participant was provided with an instruction list, consent form, and writing pad. The discussion was initiated by the organizers with a set of questions addressing a particular category. Each question was given 1 minute for discussion among the group of similar roles and 3 minutes for answering. Participants were free to answer in any language they were comfortable with.

Participants were not allowed to debate or argue a point with other members. If they had any disagreement, it was discussed in the open discussion at the end of the session. Organizers were not allowed to put their points forward to remove the chances of bias.
**The session was audio and video recorded.**

**Picture-1:Focus group discussion**

## Data Analysis:

Each group discussion's qualitative data underwent an inductive analysis using qualitative content analysis, and themes associated with the discussed questions were given codes. The study's goals were then analyzed using themes that surfaced frequently.

## Results and Discussion:-

**Demographicdata:Thedemographic data is as follows (Table-1).**

| Participant | Affiliation | Role Designated | Gender | Years of clinical experience |
|---|---|---|---|---|
| Participant A | Principal at Bharati Vidyapeeth Dental College and Hospital | Management | Male | |
| Participant B | Professor at Saraswati Dhanwantari Dental college | External | Male | 8 yrs |
| Participant C | HOD at Bharati Vidyapeeth Dental College and Hospital | Faculty | Male | 23 yrs |

| | | | | |
|---|---|---|---|---|
| Participant D | Vice principal at Bharati Vidyapeeth Dental College and Hospital | Management | Male | 20 yrs |
| Participant E | Vice principal at Bharati Vidyapeeth Dental College and Hospital | Management | Male | 16 yrs |
| Participant F | HOD at Bharati Vidyapeeth Dental College and Hospital | Private practitioner | Female | 23 yrs |
| Participant G | Professor at Bharati Vidyapeeth Dental College and Hospital | Faculty | Male | 8 yrs |
| Participant H | Assistant professor at Bharati Vidyapeeth Dental College and Hospital | Faculty | Female | 10 yrs |
| Participant I | Student at Bharati Vidyapeeth Dental College and Hospital | Intern | Female | - |
| Participant J | Student at Bharati Vidyapeeth Dental College and Hospital | PG | Male | - |
| Participant K | Student at Bharati Vidyapeeth Dental College and Hospital | UG | Female | - |
| Participant L | Staff nurse at Bharati Vidyapeeth Dental College and Hospital | Non-teaching staff | Female | - |
| Participant M | Peon at Bharati Vidyapeeth Dental College and Hospital | Non-teaching staff | Male | - |
| Participant N | Clerk | Patient | Male | - |
| Participant O | Professor at Bharati Vidyapeeth Dental College and Hospital | Observer | Male | 16 yrs |
| Participant P | Assistant professor at Bharati Vidyapeeth Dental College and Hospital | Observer | Female | 4 yrs |
| Participant Q | Professor at Bharati Vidyapeeth Dental College and Hospital | Observer | Female | 4 yrs |
| Participant R | Student at Bharati Vidyapeeth Dental College and Hospital | Observer | Female | - |

**Table-1: Demographic data of the participants for focus group discussion**

**Themes identified as per the coding:**
Knowledge about curriculum and syllabus.
Effect of amalgam's usage on environment.
Challenges experienced teaching with amalgam.
Amalgam usage in dental practice.
Disposal strategies for used amalgam.
Curricular reforms required.

## Results of Thematic analysis:

**Curriculum implementation by the Dental colleges:**

A successful formal teaching and learning process involves appropriate choice and organization of instructional resources. The curriculum, syllabus, scheme of work, and lesson plan stages involve the selection and sequencing of learning content and approaches. According to an early, unofficial conversation with participants, most professors and their students are confused about the difference between curriculum and syllabus.

As per DCI (Dental Council of India) recommendations, the syllabus for undergraduate BDS courses was given under 2007 regulations. It was mentioned as the minimum objectives of learning in the syllabus. However, the curriculum is not mentioned by the regulating body of DCI. It is mandatory for every higher educational institute

(HEI) to frame the curriculum with minimum criteria of DCI syllabus inclusion. HEIs should make regular amendments to the curriculum to meet the needs of undergraduate learning outcomes for undergraduate students.

**Amalgam'seffectonthe environment:**
**Amalgamcontroversy:**
The participants answered that there are two key issues concerning amalgam controversy. 1)Mercury related toxicity 2) Amalgam requires extensive cavity preparation. Most of theparticipants in the capacity of management feel that the controversy started when compositescame into existence. Also, the mercury toxicity of amalgam is said to be associated withspecificsystemicillnesseswhich led to the controversy.
This led to discussion by them embers that there are divided with opinions about amalgam usage.

**Mercury exposure indenta loffices:**
The various sources of mercury are mercury vapor via the leftover amalgam and duringtriturating and condensation process. Use of amalgam in capsulated form should be preferredtoprevent exposure.

**Harmful side effects of dental amalgam on human health and environment:**
The side effects of dental amalgam on human health depend on the amount of mercury levelpresent. Itmay develops kinrashes and lead toa coma which canalsobefatalif themercury level at present increases. E.g., Minamata disease which is caused by increased mercury levels foundin fishes. Patients are getting exposed to mercury when amalgam filling is done so theamountof mercurylevelis increased in their blood and bodytissues.

**Does the current DCI curriculum focus on the hazards of mercury exposure and the environmental degradation due to it?**
Yes, the current dental curriculum of BDS courses focuses on the hazards of mercury exposure and it is systematically divided according to the years. As in the first year it focuses on theoretical knowledge about the hazards of mercury exposure and environmental degradation. Second year during preclinical practical demonstration for proper disposal of mercury and amalgam waste. Similarly, in the 3rd and 4th year training of proper handling, dispensation and disposal of alloy and mercury is followed.

**Teaching with amalgam**:
When asked why the usage of amalgam is still recommended in teaching, the participants had different views on the statement. These include: (i) usage of amalgam should be still recommended but exclusive use of amalgam should be reduced, (ii) amalgam restorations give better learning experience to the students as carving helps them learn the anatomy of teeth. It is economical material, so more being practiced in rural areas.

**Advantages of teaching composites over amalgam in a BDS course:**
A participant answered that 90% of the patients will be asking for the esthetic restorations inpresent day practice. But a 4th year student may not have much experience using composites,so he/she won't be proficient in using it post completion of a BDS course. While the BDS quotacompletion for the student requires amalgam fillings for a patient,finding patients for silverfilling is not an easy task as the patients are aware of the color differences between amalgamandcompositefillings.Studentsagreedthatmoreexposuretopracticingcompositetoothfillings is needed because patients choose composite filling as it is tooth colored and there isnot much cost difference between the two. The participants mentioned that in undergraduatedental courses only knowledge aboutcomposite material has been introduced but is not givenfor handling by the students. But in postgraduate training the students get trained to use bothcompositeaswellasamalgamrestorationas apartofthecurriculum.

**Teaching ill effects of amalgam usage**:-
While the participants in management and academics mentioned ill effects of amalgam, its risk factors and its environmental degradation due to mercury emission release are sensitized with the students, they were not really emphasized with priority. Mostly the focus of faculty is more on developing the skills of the students, discussion regarding mercury emission and release takes back seat and is done just once a year. The faculty also opinionated that explaining the material's ill effect of wrong handling and management is difficult because there are no immediate changes which can be shown to the students.

**Amalgam usage in dental practice:**
The professionals with clinical practice mentioned that most of the time, amalgam is shifted to resin composites. While the usage of amalgam is not completely discarded, the material has been used in encapsulated forms in certain patients. The participants opined that more tooth-colored restorations are done as the patients want more esthetic restorations. If done properly, these restorations also last long, indicating that amalgam has higher durability in comparison with composites.

In certain situations, like post-endodontic restorations or cusp build-up, amalgam is used where it will be superior. But 90–95% of the time, tooth-colored restorations are used. In certain areas, the participants mentioned that clinics advertise to be "metal-free."

Patients who took part in the discussion acknowledged having heard of amalgam, a substance that includes mercury. They said "no" when asked if they would replace the amalgam filling in their mouth because it would need several dental consultations. In their perspective, replacement is necessary only if there is a significant problem with the amalgam or potential negative effects. They also stated that they would prefer to have tooth-colored material used for front tooth restoration.

Respondents who are clinicians stated that if a patient requests an amalgam filling replacement even when the condition is good, they attempt to persuade them against replacing the restoration for cosmetic purposes alone. If the patient still insists, the clinicians will proceed with the restoration.

While a few voted for an amalgam ban in dental practice, stating that some countries have already taken a stand for amalgam ban to stop mercury toxicity, others did not completely agree that the material should be fully banned.

**Disposal and handling of amalgam:**
**Institutional training in proper amalgam handling and usage:**
The management expects that the education system provides adequate instruction for amalgam handling and usage. In response, the faculty said that adequate training is prioritized more. Additionally, the training is reliant on the test pattern being asked; hence, there is a domino effect, while according to a different participant, it is still insufficient.

**Management of leftovers or the scrap amalgam of the institution:**
Use of Proper gloves for handling the leftover mercury and is usually disposed of in the bottlecontaining the fixer solution. One of the participants informed that the dropped amalgam isswept and disposed of in fixer solution bottles, and later the fixer solution bottles are given tobiomedicalwaste.

**Protective measures taken in case of mercury spill:**
Students are not particularly cautious when using amalgam. The material is used 2–3 times for one cavity, resulting in waste. In addition, while utilizing the material, students drop mercury and alloy powder, exposing non-teaching staff. The institute's readiness to provide any equipment to protect the students from mercury vapors is still lacking. The participants indicated that there is a need to sensitize the students, faculty, and technicians about the ill effects of mercury spills, as well as its proper handling and disposal. Kits for containing spills of mercury are now available. As a precaution, masks and gloves are required for students to wear.

**Curricular reforms required:**
Participants answered that there is a need for transformation of the BDS syllabus. The use of amalgam for teaching should not be ceased but can be reduced. The three main considerations should be the material aspect, operator skill, and caries management.

The participants stated that there is a need for early introduction of rubber dam isolation placement procedures in the undergraduate curriculum. The faculty opined that the amalgam restoration quota can be partially reduced but not completely replaced, as the curriculum focuses on amalgam restoration as part of the evaluation process.

The participants voted for the introduction of tooth-colored materials for restoration during clinical postings and assessments for the students. As good decision-making and clinical skills are required for making operative dentistry

more sustainable and refined, a participant suggested introducing rubber dam usage as a part of clinical skill within the curriculum and incorporating composites in the second year.

## Discussion:-

### 3.4.1 Needs of the curriculum and changes required:

As per DCI (Dental Council of India) guidelines, undergraduate BDS course syllabus was given under 2007 regulations. It was named the minimum learning objectives in the syllabus. The curriculum is not named by the regulating authority of DCI. It is mandatory for all higher educational institutions to frame the curriculum with minimum standards of DCI syllabus inclusion. HEI's should update the curriculum from time to time to meet the requirements of undergraduate learning outcomes for undergraduate students[5].

Preclinical education of the students according to DCI regulations 2007 such as cavity preparation, application of varnish and base, matrix and wedge placement followed by dental amalgam restoration on phantom head models are categorized as - 5 - Class I, 2 - Class I with extension, 10 - Class II, 2 - Class II MOD, 2 - Class V[5]. While amalgam remains in use as a first choice of restorative material in clinical teaching of undergraduate courses, there seems to be a lacuna which lies between instruction and practice.

The metallic color of amalgam does not blend with the natural tooth color so patients and professionals preferred tooth-colored restorative material for cavity filling in carious teeth for better aesthetics[2]. The patients when asked about the type of restorations they preferred, 70% stated that they wanted tooth colored restorations or as they said white fillings in comparison with black ones[6].The reasons for the patients' choice of either type of restoration, 70% stated that they were concerned with the esthetic, 27% were concerned about the strength and longevity of lifetime of restoration, while only 3% stated that the lower cost of amalgam restorations influenced their choice[6].

Composites restorations are more expensive than amalgam and, therefore, dental amalgam remains a common usage, other developed nations with greater incomes have embraced a ban on dental amalgam usage as a restorative material, considering the added availability and accessibility of other tooth-colored dental material6.

**Amalgam controversy:**

In 1843, the American Society of Dental Surgeons (ASDS), established in New York City, made use of amalgam malpractice due to the fear of mercury poisoning among patients and dentists and compelled all its members to sign an oath not to use it[7]. Due to its opposition to the use of amalgam, membership in the American Society of Dental Surgeons decreased, and because of the loss of members, the society was dissolved in 1856. In 1859, the American Dental Association (ADA) was established, and it did not prohibit use of amalgam[8].

**Ban on amalgam:**

Although amalgam is the most widely used restorative material around the globe considering its health hazards it has been banned in many Scandinavian countries. Norway in 2008, Denmark came into place on 1 April 2008 banning the use of amalgam and Sweden in 2009 have already banned dental amalgam. Countries like Ireland, Slovakia, Czech Republic and Finland have also announced phase wise plans to eradicate amalgam use[9].

In India, amalgam consumption has been decreasing year after year, not so much because of public sentiment over mercury toxicity or because of regulation but because of increasing popularity of esthetic restoratives[10].

Already, there has been a workshop co-sponsored by the "United Nations Environment-World Alliance" on Mercury-Free Dentistry. The co-op was specially arranged and devoted to talking about the discontinuation of the use of amalgam in "women, children, and for future generations."

The "Consumers for Dental Choice" organization continually make an international effort to prevent the use of amalgam in all children. Starting a ban on the use of amalgam in children worldwide would be the first step in preventing the use of amalgam in all dental patients worldwide.

More than 50 groups have supported "The Chicago Declaration to End Dental Industry Mercury Use". The Declaration calls on the United States to, among other acts of measures, emulate the European Union ban by stopping the use of amalgam among pregnant women, lactating women, and children in 2018[11].

The Minamata Convention on Mercury (2013) is an international legally binding instrument that is aimed at facilitating the protection of human health and the environment from anthropogenic releases and emissions of mercury and mercury compounds. The convention focuses on mercury products like dental amalgam with an approximate content of 50% elemental mercury by weight and recommends nine steps towards phasing down dental amalgam usage[12].

**Process of amalgam disposal:**
Some of the suggestions made by ADA are to be implemented by all the professionals who handle it. Use encapsulated alloys and have a range of capsule sizes available. Recycle capsules used for disposal amalgam, utilize chairside traps, vacuum pump filters and amalgam separators to catch and recycle their contents. Recycle teeth containing amalgam restorations that are being removed, utilize line cleaners that minimize dissolution of amalgam and do not utilize bleach or chlorine-based cleaners for wastewater line cleaning[13].

All amalgam waste, like spent amalgam capsules, unwrapped amalgam, amalgam in chairside filters, vacuum pump filters and amalgam separators should be gathered and stored in a safe manner pending onward transmission to a licensed mercury recycling company[14].

**Poor handling and management of dental amalgam:**
Mercury waste and amalgam material that are removed by dental offices are unregulated. It is generally discharged down the drain, generally to a municipal sewer system or septic systems or dental office, put into biomedical waste containers to be shipped for waste incineration or into trash that is discarded in a municipal waste landfill or incinerator[15].

Research shows that dental students who are trained to remove amalgams without water spray and suction are exposed to very high concentrations of mercury vapour beyond safety limits. University laboratory dental students remove plastic teeth amalgams without the utilization of protection devices like water spray or evacuation to increase visibility of the amalgam and drill. Dental students expose their arms to amalgam particles (roll up sleeves or take off long sleeve outerwear) on a daily basis while operating in the dental school labs. Latex gloves, which are widely used by dental students, have been depicted as less protective of mercury exposure compared to non-latex nitrile gloves[16].

## Conclusions:-

The present study gives an understanding that a gap exists in application-oriented teaching forthe undergraduate dental students to fulfil outcome-based competencies. While amalgam stillcan be used to teach restorative dentistry, inclusion of composites for restoration in clinicalpostings can enhance the student's skill as well as confidence in future clinical practice. Theinvestigators propose the need for curricular reforms within the undergraduate dental coursesandencouragetheDentalinstitutes toimplementapplicationaswellasoutcomebasedcurricularchanges forthestudents.

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All authors have approved the manuscript and agree with its submission. It is also to confirm that all authors have contributed to planning, execution and writing the manuscript for publication equally without any conflict.

## References:-


1. World Health Organization. Sugars and dental caries: Technical information note. [Internet]. [cited 2025 Apr 2]. Available from: https://www.who.int/publications/i/item/WHO-NMH-NHD-14.1
2. Rathore M, Singh A, Pant VA. The dental amalgam toxicity fear: A myth or actuality. Toxicol Int. 2012 May;19(2):81–8. doi: 10.4103/0971-6580.97191. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3388771/
3. United States Environmental Protection Agency. Mercury emissions: The global context. [Internet]. [cited 2025 Apr 2]. Available from: https://www.epa.gov/international-cooperation/mercury-emissions-global-context
4. Khwaja MA, Abbasi MS. Mercury poisoning in dentistry: High-level indoor air mercury contamination at selected dental sites. Rev Environ Health. 2014;29(1-2):29–31. doi: 10.1515/reveh-2014-0010. Available from: https://pubmed.ncbi.nlm.nih.gov/24552960/
5. Dental Council of India. BDS course regulation. 2007;54. [Internet]. [cited 2025 Apr 2]. Available from: https://dciindia.gov.in/Rule_Regulation/BDS_Course_Regulations_2007.pdf
6. Nahel H, Mohammed A, Al-Naimi R. Choice between composite and amalgam restorations according to dentists and patients perception. Al-Rafidain Dent J. 2020;20(1):1–17. doi: 10.33899/rden.2020.164891. Available from: https://www.researchgate.net/publication/339768303_Choice_Between_Composite_and_Amalgam_Restorations_According_to_Dentists_and_Patients_Perception
7. American Society of Dental Surgeons. American Journal of Dental Science. Massachusetts, U.S: Harvard University; 1845. p. 170.https://archive.org/search.php?query=external-identifier%3A%22urn%3Aoclc%3Arecord%3A609333292%22
8. Bremner MDK. Story of dentistry from the dawn of civilization to the present. Brooklyn, NY: Dental Items of Interest Pub. Co.; 1939. p. 86–7.https://archive.org/search.php?query=external-identifier%3A%22urn%3Alcp%3Astoryofdentistry0007mdkb%3Alcpdf%3A6e397b34-02c0-4158-af1d-59461ed0eb8f%22
9. Kopperud SE, Staxrud F, Espelid I, Tveit AB. The post-amalgam era: Norwegian dentists' experiences with composite resins and repair of defective amalgam restorations. Int J Environ Res Public Health. 2016;13(4):441. doi: 10.3390/ijerph13040441. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4847084/
10. Shenoy A. Is it the end of the road for dental amalgam? A critical review. J Conserv Dent. 2008;11(3):99–107. doi: 10.4103/0972-0707.45245. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2813106/
11. Jones R. European ban on mercury amalgam fillings. Nashville Restorative Dentistry; July 19. [Internet]. [cited 2025 Apr 2]. Available from: https://www.nashvillerestorativedentistry.com/european-ban-on-mercury-amalgam-fillings/
12. Minamata Convention on Mercury. Geneva: United Nations Environment Programme; 2013. [Internet]. [cited 2025 Apr 2]. Available from: http://www.mercuryconvention.org/Convention/tabid/3426/language/en-US/Default.aspx
13. American Dental Association. Best management practices for amalgam waste. October 2007. [Internet]. [cited 2025 Apr 2]. Available from: https://www.ada.org/~/media/ADA/Member%20Center/FIles/topics_amalgamwaste_brochure.pdf
14. FDI General Assembly. Amalgam: Safe management of waste and mercury. September 2021. [Internet]. [cited 2025 Apr 2]. Available from: https://www.fdiworlddental.org/amalgam-part-1-safe-management-waste-and-mercury
15. Indian Dental Association. Biomedical waste management protocol. [Internet]. [cited 2025 Apr 2]. Available from: https://www.ida.org.in/Membership/Details/BiomedicalWasteManagementProtocol
16. Warwick R, O'Connor A, Lamey B. Mercury vapour exposure during dental student training in amalgam removal. J Occup Med Toxicol. 2013;8:27. doi: 10.1186/1745-6673-8-27. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3850894/