Bridging The Gap -A Focus Group Study OnNeed For Transformation In DentalAmalgam Usage AsA Part Of Dental Curriculum

Abstract:

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, non-teaching 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

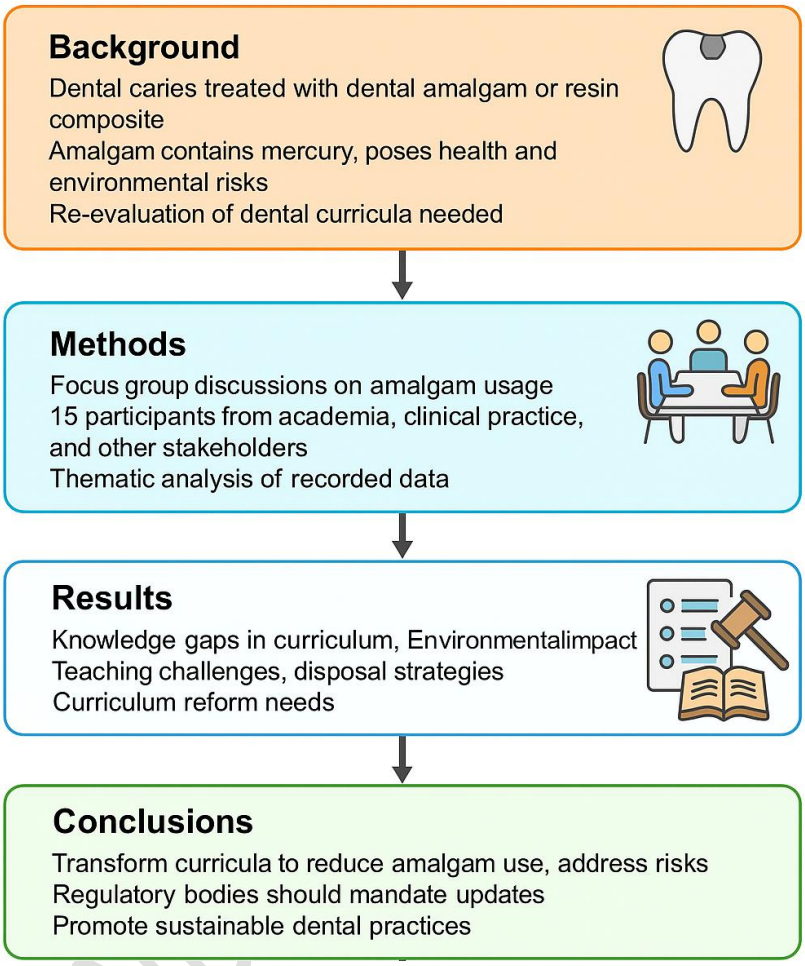
Key Findings

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.

Keywords: Dental amalgam, Dental curriculum, Dental education, Focus group discussion, Mercury toxicity.

GRAPHICAL ABSTRACT:



1. Introduction

Dental caries, commonly known as tooth decay or dental cavities, are one of the most common non-communicable diseases worldwide[1]. Dental caries pivot 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.

2. 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.

2.1 Intervention:

2.1.1 Preparation phase:

Dental professionals were invited via mail which included a consent form and demographic 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.

2.1.2 Scientificreviewandsuggestions:

Thetopic of researchwaspresentedintheScientificReviewCommitteeoftheinstitution which lso included an external member. According to the scientificcommittee's suggestion, 'qualitative' word was added in the title. The ScientificReviewCommitteeacceptedandgaveapprovalfortheresearch study.

2.1.3 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.

2.1.4 Focusgroupdiscussion:

On the day of discussion participants seating arrangements were made as per the givenrole of the participant (Picture-1).The groups were divided into faculty, privatepractitioners,management, non-teaching staff and students. Each participant wasprovided with an instruction list, consent form and writing pad. Discussion wasinitiated by the organizers with a set of questions addressing a particular category.Eachquestionwasgiven1minuteforthediscussionamongthegroupofsimilarrolesand3minutesforanswering.Participantswerefreetoanswerinanylanguagecomfortably. Also, participants were not allowed to debate over apoint with othermembers.Iftheyhadanydisagreementitwasdiscussedintheopendiscussionattheendofthesession.Organizerswerenotallowedtoputtheirpointsforwardtoremovethe chances of bias. Thesessionwasaudio and video recorded.

Picture-1:Focusgroupdiscussion

2.1.5 DataAnalysis:

Each group discussion's qualitative data underwent an inductive analysis usingqualitativecontentanalysis,andthemesassociatedwiththediscussedquestionsweregiven codes. Thestudy'sgoals werethenanalyzedusingthemes that surfaced often.

3. Results and Discussion

3.1 Demographicdata: Thedemographicdataisasfollows(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:Demographicdataoftheparticipantsforfocusgroupdiscussion

3.2 Themesidentifiedasperthecoding:

Knowledgeaboutcurriculumandsyllabus

EffectofAmalgam'susageonenvironment

Challengesexperiencedteachingwithamalgam

Amalgamusageindentalpractice.

Disposalstrategiesforusedamalgam.

Curricularreformsrequired.

3.3Results of Thematic analysis:

3.3.1 CurriculumimplementationbytheDentalcolleges:

Asuccessfulformalteachingandlearningprocessinvolvesappropriatechoiceandorganization of instructional resources. The curriculum, syllabus, scheme of work, andlesson plan stages involve the selection and sequencing of learning content and approaches.According to an early, unofficial conversation with participants, most professors and theirstudentsareconfusedaboutthedifferencebetweencurriculum and syllabus.

As per DCI (Dental Council of India) recommendations, the syllabus for undergraduate BDScourseswasgivenunder2007regulations.Itwasmentionedasthe minimumobjectivesoflearningin the syllabus. However, the curriculum is not mentioned by the regulating body of DCI. It ismandatoryforeveryhighereducationalinstitute(HEI)toframethecurriculumwithminimumcriteriaofDCIsyllabusinclusion.HEI'sshouldmakeregularamendmentstothecurriculumtomeettheneeds of undergraduate learningoutcomes forundergraduatestudents.

3.3.2 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 thecontroversy.Thisledtoadiscussionbythemembersthattherearedividedopinions about amalgam usage.

Mercuryexposureindentaloffices:

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.

Harmfulsideeffectsofdentalamalgamonhumanhealthandenvironment:

The side effects of dental amalgam on human health depend on the amount of mercury levelpresent.Itmaydevelopskinrashesandleadtoa comawhichcanalsobefatalifthemercurylevel 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.

3.3.3 DoesthecurrentDCIcurriculumfocusonthehazardsof mercuryexposureand theenvironmentaldegradation duetoit?

Yes,thecurrentdentalcurriculumofBDScoursesfocusesonthehazardsofmercuryexposureand it is systematically divided according to the years. As in the first year it focuses ontheoretical knowledge about the hazards of mercury exposure and environmental degradation.Second year during preclinical practical demonstration for proper disposal of mercury andamalgamwaste.Similarlyinthe3rdand4thyeartrainingofproperhandlingdispensationanddispose ofalloyandmercuryis followed.

3.3.4 Teachingwithamalgam:

Whenaskedwhytheusageofamalgamisstillrecommendedinteaching,theparticipantshaddifferentvie wsonthestatement.Theseinclude,(i)usageofamalgamshouldbestillrecommendedbutexclusiveuseof amalgamshouldbereduced,(ii)Amalgamrestorationsgivebetter learning experience to the students as carving helps them learn the anatomy of teeth. Itiseconomical material,so morebeingpracticedinrural areas.

AdvantagesofteachingcompositesoveramalgaminaBDScourse:

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.Studentsagreedthatmoreexposuretopracticingwithcompositetoothfi llings 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.

TeachingilleffectsofAmalgamusage:

Whiletheparticipantsinmanagementandacademicsmentionedilleffectsofamalgam,itsriskfactorsand itsenvironmentaldegradationduemercuryemissionreleasearesensitizedwiththestudents,theywereno treallyemphasizedwithpriority.Mostlythefocusoffacultyismoreondeveloping the skills of the

students, discussion regarding mercury emission and release takesback seat and is done just once a year. The faculty also opinionated that explaining thematerial's ill effect of wrong handling and management is difficult because there are noimmediatechanges whichcan beshown to thestudents.

Amalgamusageindentalpractice:

The professionals with clinical practice mentioned that most of the time, Amalgam is shiftedtoResincomposites.WhiletheusageofAmalgamisnotcompletelydiscarded,thematerialhasbeen used in encapsulated forms in certain patients. The participants opinionated that moretooth-colored restorations are done as the patients want more esthetic restorations. If doneproperly, these restorations also last long, indicating that Amalgam has higher durability incomparisonwithcomposites.Incertainsituations,likethepostendodonticrestorationsorcusp build up, amalgam is used where it will be superior. But 90 - 95% of the time tooth-coloredrestorations are used. In certain areas, the participants mentioned that clinics advertise to be"metalfree."

Patients who took part in the discussion acknowledged having heard of amalgam, a substancethat includes mercury. They said no when asked if they would replace the amalgam filling inyourmouthbecauseitwouldneedseveraldentalconsultations.Intheirperspective,replacement is necessary if there is a significant problem with the amalgam and potentialnegativeeffects.Theyalsostatethattheywouldprefertohavetooth-coloredmaterialused forfronttooth restoration.

Respondentswhoareclinicansstatedthatifapatientrequestsanamalgamfillingreplacementevenwhen theconditionisgood,theyattempttopersuadethemagainstreplacingtherestorationforcosmeticpurposesalone.Ifthepatientstillpersuades,theclinicianswillproceedwiththerestoration. While few voted for amalgam ban in dental practice stating that few countries have alreadytakenastandforamalgambantostopmercurytoxicity,othersdidnotcompletelyagreethat the material should befullybanned.

3.3.5 Disposalandhandlingamalgam:

Institutionaltraininginproperamalgamhandlingandusage:

Themanagementexpectsthattheeducationsystemprovidesadequateinstructionforamalgamhandling 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 dominoeffect,whileaccordingtoadifferent participant,itis still insufficient.

Managementofleftoversorthescrapamalgamoftheinstitution:

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.

Protectivemeasurestakenincaseofmercuryspill:

Students are not particularly cautious when using amalgam. The material is used 2-3 times foronecavity,resultinginwaste.Inaddition,whileutilizingthematerial,pupilsdropmercuryandalloy powder, exposing non-teaching staff. The Institute's readiness to provide any equipmenttoprotectthestudentsfrommercuryvaporsisstilllacking.Theparticipantsshowedthatthere's a need to sensitize the students, faculty and technicians about the ill effects of the mercury spill,its proper handling and disposal. Kits for containing spills of mercury are now available. As aprecaution,masks andgloves arerequired forstudents to wear.

Curricularreformsrequired:

Participants answered that there is a need for transformation of the BDS syllabus. The use ofamalgam for teaching should not be ceased but it can be reduced. The three main things to betakenintoconsiderationshouldbethematerialaspect,theoperatorskillandcariesmanagement. The participants stated that there is a need for early introduction of rubber damisolation placement procedure in the undergraduate curriculum. The faculty opinionated thattheamalgamrestorationquotacanbepartiallyreducedbutnotcompletelyreplacedascurriculum focuses on amalgam restoration as a part of evaluation process. The participantsvotedfortheintroductionoftoothcoloredmaterialforrestorationduringclinical postingsandassessments for the students. As good decision making and clinical skills are required formakingoperativedentistrymoresustainableandfinerpractice,aparticipantsuggestedintroducingru bberdamusageasapartofclinicalskillwithinthecurriculumandincorporationofcomposites in secondyear.

3.4 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.

3.4.2 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].

3.4.3 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].

3.4.4 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].

3.4.5 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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5. Funding/Conflicts of interests if any

Nil.

6. Author contribution:

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.

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