A systematic review of randomized controlled trials on sterilization methods of extracted human teeth

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Abstract

Aim of this Study:
The aim was to evaluate the efficiency of different sterilization methods on extracted human teeth (EHT) by a systematic review of in vitro randomized controlled trials.

Methodology:
An extensive electronic database literature search concerning the sterilization of EHT was conducted. The search terms used were “human teeth, sterilization, disinfection, randomized controlled trials, and infection control.” Randomized controlled trials which aim at comparing the efficiency of different methods of sterilization of EHT were all included in this systematic review.

Results:
Out of 1618 articles obtained, eight articles were selected for this systematic review. The sterilization methods reviewed were autoclaving, 10% formalin, 5.25% sodium hypochlorite, 3% hydrogen peroxide, 2% glutaraldehyde, 0.1% thymol, and boiling to 100°C. Data were extracted from the selected individual studies and their findings were summarized.

Conclusion:
Autoclaving and 10% formalin can be considered as 100% efficient and reliable methods. While the use of 5.25% sodium hypochlorite, 3% hydrogen peroxide, 2% glutaraldehyde, 0.1% thymol, and boiling to 100°C was inefficient and unreliable methods of sterilization of EHT.

Keywords: Autoclaving, extracted human teeth, formalin, sterilization methods, systematic review

INTRODUCTION
Extracted human teeth (EHT) are routinely used by students for performing preclinical exercises, for preparing ground sections, and for research.[1] Since they harbor bloodborne pathogens and are a potential source of infection, they must be sterilized before use.[2] The efficiency of several sterilization methods is comparatively evaluated in a number of randomized controlled trials. There exists a need to systematically summarize the current knowledge regarding this issue.

The objective of this study was to systematically organize all the studies evaluating the efficiency of different sterilization methods of human teeth and to determine efficient methods by summarizing the findings from individual studies.

**METHODOLOGY**

This systematic review was conducted following the preferred reporting items for systematic reviews and meta-analyses guidelines to ensure optimum quality.[3,4] An extensive literature search concerning the sterilization of EHT was conducted in electronic databases of PubMed, LILACS, Scopus, Google Scholar, and hand searching reference lists from relevant journals. The keywords used were “Human Teeth, Sterilization, Disinfection, Randomized Controlled Trials, and Infection Control.” The search resulted in a total of 1618 articles. After removal of irrelevant articles and duplicates, the abstracts of the selected 43 articles were screened. Studies evaluating the effect of different sterilization methods on the physical and chemical composition of tooth structure were all eliminated. For the remaining twenty articles, full text was retrieved and they were screened based on the following predetermined study eligibility criteria.

**Inclusion criteria**

Studies that were (1) done from 1990 to 2015, (2) in English, (3) randomized controlled trials, (4) done in EHT, (5) in vitro studies, (6) comparing the efficacy of at least one method of sterilization of EHT with that of a control group.

**Exclusion criteria**

studies that were (1) in vivo studies, letters, comments, editorials, questionnaire surveys, case reports, proceedings, personal communications, and any type of literature reviews, (2) done in nonhuman teeth, (3) with no control group, (4) with outcome measures not defined clearly.

A flowchart diagram of the study selection process is given in Figure 1. List of studies with references and their reasons for exclusion as numbered in the study exclusion criteria is given in Table 1.
The sterilization method used in the primary studies could not be standardized. Disinfectant solutions used were all standardized while summarizing this systematic review, the time limit of each sterilization method used in the primary studies could not be standardized.

Table 2 summarizes the method of data collection, synthesis, and extraction from the eight selected primary studies. In this systematic review, percentile efficiency of each sterilization method is calculated from the total number of samples tested and the total number of samples which had no microbial growth after being subjected to the particular sterilization method.

Table 2

The method of data synthesis and data extraction from the selected primary studies

Extracted teeth are prone to colonization by potentially pathogenic bacteria and need to be sterilized properly[23] before use in teaching laboratory and research. Scientific literature has documented various randomized controlled trials comparing various methods of sterilization of EHT. Although several narrative literature reviews[8,9,24] were done in the past, there are no systematic reviews done in this field. The objective of this systematic review was to identify all randomized controlled trials evaluating the efficiency of different sterilization methods of EHT, to determine the total number of trials done to date, to assess the quality of those trials, to determine whether a particular sterilization method works better than the others based on the findings from the primary individual studies, and to identify gaps in knowledge where new trials are still needed.

The present systematic review concluded that autoclaving and 10% formalin are very efficient and reliable methods of sterilization of EHT; 5.25% sodium hypochlorite, 3% hydrogen peroxide, 2% glutaraldehyde, 0.1% thymol, and boiling to 100°C are all inefficient and unreliable methods of sterilization of EHT.

While the data obtained from this review are valuable, its application to practice may be limited because these methods of sterilization reviewed have their own set of advantages and disadvantages. Autoclaving and 10% formalin do not alter the feel and cutting characteristics; therefore, they do not compromise the learning experience when used for preclinical exercises.[22] Autoclaving causes disruption of collagen[25] and denature the organic component in dentin,[26] which can alter the hybrid layer after resin penetration. Therefore, autoclaving makes the teeth not suitable for use in in vitro studies testing the microhardness,[26] bond strength, and microleakage.[25] The tooth containing dental amalgam restorations should not be autoclaved because the vaporized mercury[22] can be inhaled subjecting the patients and dental personnel to health risk.[27] Formalin causes stabilization of the collagen preventing their collapse, which allows increased mechanical interlocking of the restorative material to the dentin. This makes it unsuitable for use in in vitro microleakage and bond strength research.[24,25] Formalin is a skin and eyes irritant,[10] cytotoxic, genotoxic,[28] and carcinogenic.[29] Therefore, although being an efficient sterilization method, its use is discontinued as it poses a major health hazard.

Limitations of this systematic review are (1) preferable inclusion of articles in English, (2) restricted time frame from 1990 to 2015, (3) other methods of sterilization including gamma radiations, chemiclave, dry heat, microwave, benzalkonium chloride, 0.5% chloramine, 2% sodium azide, iodophor, phenol, alcohol, and antibiotics could not be included because of lack of sufficient number of studies carried out using these methods for effective comparison, (4) perceived weakness of such disinfection efficiency evaluation studies may be due to inherent variations in the microbial composition, microbial load, and biofilm matrix composition[18] between individual tooth used in different studies, (5) it is not coupled with a meta-analysis because there is a mix of comparisons of different sterilization methods with diverse outcomes in the primary studies, (6) although the concentration of disinfectant solutions used were all standardized while summarizing this systematic review, the time limit of each sterilization method used in the primary studies could not be standardized.
Excluding gamma radiations, all the other sterilization methods tested so far resulted in changes in properties of tooth structure.[14] Therefore, there exists a need to find out a feasible and efficient sterilization method suitable for use in teeth to be used for in vitro studies. Further, this review brings into light the need for new ideas and methods for sterilization of root canal space of extracted teeth to be used in preclinical endodontics.

CONCLUSION

This systematic review concluded that autoclaving and 10% formalin were 100% efficient and reliable methods of sterilization of EHT; autoclaving method may be the definitive method for sterilizing teeth used for preclinical conservative exercises. Usage of 10% formalin, although effective, is discouraged due to associated health risks. 5.25% sodium hypochlorite, 3% hydrogen peroxide, 2% glutaraldehyde, 0.1% thymol, and boiling to 100°C are all inefficient and unreliable methods of sterilization of EHT. This systematic review also brings into light the need for sterilization methods and protocol needed for sterilization of extracted teeth to be used for preclinical endodontics and in in vitro studies.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES


