Systematic review on alternative methods for caries removal in permanent teeth

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Abstract

Introduction: Dental caries is the most common chronic dental disease in the world. It is defined as a multifactorial infectious disease characterized by demineralization of the inorganic and destruction of the organic substance of the tooth. The host, flora, and the substrate should be there for the formation of dental caries. There are various microorganisms responsible for caries. The treatment for caries is essential to prevent teeth from involving pulp, leading to further damage. There are various methods in removing caries such as minimally invasive technique, rotary method with different types of burs, chemomechanical caries removal, and lasers. There are no data in literature for various methods of removing caries in permanent teeth.

Materials and Methods: Research question was formulated based on the PICO strategy. A comprehensive electronic literature search was conducted, independently by two reviewers. Based on the specified inclusion and exclusion criteria’s, the selected articles were subjected to quality assessment and the risk of bias was evaluated.

Objective: The objective of this study was to evaluate the efficiency of caries removal by various methods in permanent teeth.

Search Strategy: A search was performed in electronic database (i.e. PubMed and Medline) using search terms alone and in combination by means of PubMed search builder from January 1985 to January 2018.

Selection Criteria: Studies were selected if they met the following criteria: in vivo studies comparing various methods of caries removal in permanent teeth.

Results: The search identified 338 publications, out of which 328 were excluded after examination of the title and 2 were excluded after examination of the abstract. Through the hand search, three articles were included. Eight articles were retrieved for more detailed evaluation from the search. A total of 11 publications fulfilled all the criteria for inclusion.

Conclusion: With the available evidence, this review concludes that the studies included in this review have a high risk of quality evidence.

Keywords: Caries; chemomechanical; infected dentin; permanent teeth; type of burs

INTRODUCTION

Dental caries is one of the most prevalent chronic diseases, which may lead to pulpal infection if left untreated. Caries may lead to infection of the dental pulp. Most of the clinicians’ objective is to remove only the infected layer, leaving the unaffected dentin intact.[1] It is important to remove the infected layer to prevent the unnecessary removal of tooth structure.[1,2]

The affected dentin is left unremoved so that remineralization may take place.[3] Previously conventional
rotary method was used for tooth preparation and the cavities were designed in specific dimension for the restorative material employed. But, the current concept is to preserve as much of tooth structure as possible. Hence, the concept of minimally invasive dentistry came in.

The rotary or conventional method is not much preferred as it removes a lot of tooth structure, noise, discomfort, fear, excessive cutting of uninfected dentin, and pain. Hence, the removal of caries with minimal pain given rise to various alternative methods such as air abrasion, sono-abrasion, chemomechanical caries removal, lasers, and atraumatic restorative method fluorescence aided caries excavation.[4-10]

In the conventional method or rotary method, the high-speed handpiece is used to gain access to cavity lesion and low-speed handpiece is used to remove carious dentine.[11] Steel bur and conventional rotary methods remove a large amount of sound tissue, over preparation. It may cause pressure or heat on the pulp, noise, and pain stimulus and may need local anesthesia in many patients.[12]

In the year 2003, Boston developed new polymer prototype burs as an alternative to conventional burs. It is the self-limiting polymer bur, which is the new version of SmartPrep, now called SmartBurs. It can be used with slow speed handpiece. It removes only infected dentin, and it does not remove healthy dentin. It is claimed to be disposable once the cutting portion of the bur wears off. Hence, these cannot be used repeatedly for tooth preparations.[13,14]

The chemomechanical system was developed 30 years back. But it was gained into attention only in the late 1990s by the introduction of Carisolv in the market.[15,16] It can able to dissolve collagen fibers, so that caries is easy to remove with hand instruments.[15,16] Chemomechanical caries removal (CMCR) method is a noninvasive technique, avoids pulp irritation and patient discomfort, eliminates infected tissues, and preserves healthy structures. It has antibacterial, anti-inflammatory effects. Chemomechanical method is a minimally invasive method.

In Brazil 2003, it was the first time they introduced papain gel commercially known as Papacarie for CMCR agent.[17-19] Papain is a proteolytic enzyme. It has bactericide, anti-inflammatory, and bacteriostatic characteristics.[20] It is extracted from the latex of leaves and fruits of adult green papaya. It acts only in infected tissue because infected tissue lacks a plasmatic antiprotease called antitrypsin.[20]

Structured question
Does efficiency of removing caries in permanent teeth with conventional method and other alternative methods have any difference?

PICO analysis

- Population – Caries in permanent teeth
- Intervention – Alternative methods for caries removal
- Comparison – Conventional method
- Outcome – Efficiency of caries removal.

Null hypothesis
There is no significant difference in removing caries by alternative methods when compared to conventional method in permanent teeth.
Table 1: Search methodology

| Search Query                                                                 | Items found | Time              |
|------------------------------------------------------------------------------|-------------|-------------------|
| #81 Search ((((((((((((caries) OR tooth decay) OR tooth decay in adult teeth) OR tooth decay in permanent teeth) OR dental caries) OR dental caries in adult teeth) OR dental caries in permanent teeth) OR permanent tooth) OR permanent tooth or secondary tooth) OR secondary tooth) OR adult tooth) OR adult tooth or adolescence) OR cavities) OR tooth cavity) OR cavity) OR decay) OR mature teeth) OR tooth demineralisation in adult teeth) OR tooth demineralisation in permanent teeth) OR carious lesions in permanent teeth) OR carious lesions in adult teeth) OR dental decay in adult teeth) OR dental decay in permanent teeth) AND (((((((((((chickochemical) OR polymer bur) OR air abrasion) OR air abrasion) OR laser) OR ART) OR atraumatic restorative treatment) OR fluorescence aided caries excavation) OR FACE) OR MID) OR minimal invasive dentistry OR carisolv OR caridex OR CMCR OR carica papaya) OR chemomechanical caries removal OR micro invasive treatment) OR nonrotary) OR air polishing) OR ultra sonication) OR enzymes) OR photo ablation) OR ultra sonic)) AND (((((((((((conventional method) OR airrotor) OR burs) OR bur) OR rotary) OR mechanical) OR drilling) OR rotary drill) OR rotary instruments) OR dental handpiece) OR dental burs) OR dental bur) OR drill) OR conventional drill) OR traditional drill) OR conventional drilling) OR conventional rotary method) OR traditional treatment of removing decay) AND ((((((efficiency of caries removal) OR assessment of caries removal) OR evaluation of caries removal) OR remaining decay) OR absence of soft caries) OR removal of decay) OR removal of caries) OR effectiveness of caries removal) OR removal of infected caries) | 338 | 0:16:23 |
| #80 Search (((((((((efficiency of caries removal) OR assessment of caries removal) OR evaluation of caries removal) OR remaining decay) OR absence of soft caries) OR removal of decay) OR removal of caries) OR effectiveness of caries removal) OR removal of infected caries) | 4044 | 0:15:18 |
| #79 Search removal of infected caries                                           | 94          | 0:14:15 |
| #78 Search effectiveness of caries removal                                      | 111         | 0:13:47 |
| #77 Search removal of caries                                                   | 1427        | 0:13:19 |
| #76 Search removal of decay                                                    | 1854        | 0:13:05 |
| #75 Search absence of soft caries                                              | 24          | 0:12:52 |
| #74 Search remaining decay                                                     | 836         | 0:12:36 |
| #73 Search evaluation of caries removal                                         | 226         | 0:12:22 |
| #72 Search assessment of caries removal                                        | 127         | 0:12:02 |
| #71 Search efficiency of caries removal                                        | 56          | 0:11:45 |
| #70 Search ((((((((((conventional method) OR airrotor) OR burs) OR bur) OR rotary) OR mechanical) OR drilling) OR rotary drill) OR rotary instruments) OR dental handpiece) OR dental burs) OR dental bur) OR drill) OR conventional drill) OR traditional drill) OR conventional drilling) OR conventional rotary method) OR traditional treatment of removing decay) AND ((((((efficiency of caries removal) OR assessment of caries removal) OR evaluation of caries removal) OR remaining decay) OR absence of soft caries) OR removal of decay) OR removal of caries) OR effectiveness of caries removal) OR removal of infected caries) | 662749 | 0:11:16 |
| #69 Search traditional treatment of removing decay                            | 2           | 0:07:02 |
| #68 Search conventional rotary method                                          | 500         | 0:06:38 |
| #67 Search traditional drilling                                                | 226         | 0:06:18 |
| #66 Search conventional drilling                                               | 467         | 0:06:05 |
| #65 Search traditional drill                                                  | 189         | 0:05:45 |
| #64 Search conventional drill                                                  | 378         | 0:05:31 |
| #63 Search drill                                                              | 6418        | 0:05:17 |
| #62 Search dental bur                                                         | 1655        | 0:05:02 |
| #61 Search dental burs                                                        | 923         | 0:04:45 |
| #60 Search dental handpiece                                                   | 862         | 0:04:35 |
| #59 Search rotary instruments                                                  | 3138        | 0:04:11 |
| #58 Search rotary drill                                                       | 63          | 0:03:55 |
| #57 Search drilling                                                           | 6861        | 0:03:42 |
| #56 Search mechanical                                                         | 392034      | 0:03:34 |
| #55 Search rotary                                                             | 9978        | 0:03:23 |
| #54 Search bur                                                               | 3057        | 0:03:10 |
| #53 Search burs                                                              | 1112        | 0:03:03 |
| #52 Search airtor                                                            | 13          | 0:02:55 |
| #51 Search conventional method                                                 | 258403     | 0:02:43 |
| #50 Search (((((((((((((((((((chemomechanical) OR polymer bur) OR air abrasion) OR sono abrasion) OR laser) OR ART) OR atraumatic restorative treatment) OR fluorescence aided caries excavation) OR FACE) OR MID) OR minimal invasive dentistry OR carisolv OR caridex OR CMCR OR carica papaya) OR chemomechanical caries removal OR micro invasive treatment) OR nonrotary) OR air polishing) OR ultra sonication) OR enzymes) OR photo ablation) OR ultra sonic | 3725353 | 0:02:22 |
| #49 Search ultra sonic                                                        | 107         | 23:59:56 |
| #48 Search photo ablation                                                     | 194         | 23:59:45 |
| #47 Search enzymes                                                           | 2951421     | 23:59:26 |
| #46 Search ultra sonication                                                   | 255         | 23:59:13 |
| #45 Search air polishing                                                      | 528         | 23:58:55 |
| #44 Search nonrotary                                                         | 3660        | 23:58:41 |
| #43 Search micro invasive treatment                                           | 1542        | 23:58:29 |

Contd...
Table 1: Contd...

| Search | Query | Items found | Time   |
|--------|-------|-------------|--------|
| #42    | Search chemomechanical caries removal | 67 | 23:58:10 |
| #41    | Search cariica papaya | 1492 | 23:57:50 |
| #40    | Search CMCR | 82 | 23:57:31 |
| #39    | Search caridex | 78 | 23:57:16 |
| #38    | Search carisolv | 167 | 23:57:08 |
| #37    | Search minimal invasive dentistry | 413 | 23:56:53 |
| #36    | Search MID | 116063 | 23:56:30 |
| #35    | Search FACE | 299027 | 23:56:20 |
| #34    | Search fluorescence aided caries excavation | 12 | 23:56:11 |
| #33    | Search atraumatic restorative treatment | 466 | 23:55:36 |
| #32    | Search ART | 119201 | 23:55:16 |
| #31    | Search laser | 294059 | 23:55:06 |
| #30    | Search sono abrasion | 13 | 23:54:48 |
| #29    | Search air abrasion | 1229 | 23:54:34 |
| #28    | Search polymer bur | 666 | 23:54:22 |
| #27    | Search chemomechanical | 701 | 23:54:08 |
| #26    | Search ((((((((((((caries) OR tooth decay) OR tooth decay in adult teeth) OR tooth decay in permanent teeth) OR dental caries) OR dental caries in adult teeth) OR dental caries in permanent teeth) OR permanent teeth) OR permanent tooth) OR secondary teeth) OR secondary tooth) OR adult teeth) OR adult tooth) OR adolescence) OR cavities) OR tooth cavity) OR cavity) OR decay) OR mature teeth) OR tooth demineralisation in adult teeth) OR tooth demineralisation in permanent teeth) OR carious lesions in permanent teeth) OR carious lesions in adult teeth) OR dental decay in adult teeth) OR dental decay in permanent teeth) | 2279061 | 23:53:50 |
| #25    | Search dental decay in permanent teeth | 4703 | 23:49:02 |
| #24    | Search dental decay in adult teeth | 6461 | 23:48:41 |
| #23    | Search carious lesions in adult teeth | 648 | 23:48:25 |
| #22    | Search carious lesions in permanent teeth | 532 | 23:48:01 |
| #21    | Search tooth demineralisation in permanent teeth | 16 | 23:47:23 |
| #20    | Search tooth demineralisation in adult teeth | 52 | 23:46:55 |
| #19    | Search mature teeth | 1479 | 23:46:29 |
| #18    | Search decay | 67453 | 23:46:16 |
| #17    | Search cavity | 227046 | 23:46:06 |
| #16    | Search tooth cavity | 68953 | 23:45:54 |
| #15    | Search cavities | 82421 | 23:45:41 |
| #14    | Search adolescence | 1942154 | 23:45:28 |
| #13    | Search adult tooth | 50664 | 23:45:14 |
| #12    | Search adult teeth | 61851 | 23:45:05 |
| #11    | Search secondary tooth | 9629 | 23:44:46 |
| #10    | Search secondary teeth | 5942 | 23:44:27 |
| #9     | Search permanent tooth | 19882 | 23:44:11 |
| #8     | Search permanent teeth | 17916 | 23:43:55 |
| #7     | Search dental caries in permanent teeth | 4665 | 23:43:42 |
| #6     | Search dental caries in adult teeth | 6334 | 23:43:22 |
| #5     | Search dental caries | 54758 | 23:43:01 |
| #4     | Search tooth decay in permanent teeth | 4700 | 23:42:48 |
| #3     | Search tooth decay in adult teeth | 4690 | 23:42:25 |
| #2     | Search tooth decay | 55351 | 23:42:08 |
| #1     | Search caries | 56870 | 23:41:42 |

Alternate hypothesis

There is a significant difference in removing caries by alternative method when compared to conventional method in permanent teeth.

MATERIALS AND METHODS

Sources used

For identification of studies included or considered for this review, detailed search strategies were developed for the database searched. The Medline search used the combination of controlled vocabulary and free text terms [Table 1].

Searched databases

- PubMed
- PubMed advanced search
- Cochrane database of systematic review
- Science direct.

Language

There were no language restrictions.

Hand search

The following journals were hand searched:

- International Endodontic Journal
- Journal of Endodontics
### Table 2: General information - results

| Author                | Years | Country  | Study design | Sample size | Type of teeth                                                                 | Follow up period | Caries removal methods used                                      | Factors analyzed                                                                                          | Method of evaluation                          | Outcome measures                                                                                     |
|-----------------------|-------|----------|--------------|-------------|--------------------------------------------------------------------------------|------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------------------------------------------------------------|
| A.H. Ali et al.       | 2018  | London   | In vivo study| 101         | Permanent posterior teeth with symptoms of reversible pulpitis                 | 12 months        | Group 1: Rotary burs without magnification Group 2: Carisolv with operating microscope | 1. Bacterial reduction 2. Periapical health of teeth after restoration                                    | 1. Polymerase chain reaction 2. Periapical radiograph | 1. Periapical radiograph was taken in month 0 and month 12. At the end of month 12, periapical radiograph showed 92% (Group 1) and 98.6% (Group 2) as healthy. 2. Bacterial tissue reduction after excavation of caries is about 96.5% in total |
| AR Yazici et al.      | 2010  | Turkey   | In vivo study| 108         | Occlusal noncavitated superficial carious lesions, first and second permanent molars | 24 months        | Group 1: Diamond bur Group 2: Er, Cr: YSGG laser               | 1. Retention of restoration 2. Marginal discoloration 3. Marginal adaptation                             | Restorations evaluated according to Cva/r/Rye criteria | Clinically evaluated at baseline, 6, 12, 18, and 24 months using modified Cva/r/Rye criteria |
| Prabhakar et al.      | 2009  | India    | In vivo study| 40          | Bilateral occlusal carious lesions on mandibular permanent molars              | 6 months         | Group 1: Polymer bur Group 2: Carbon steel round bur (conventional) | 1. Time required for caries removal 2. Patient comfortness 3. Evaluation of restoration 4. Visual and tactile | Radiographic evaluation of restoration |                                                                                                     |
| Hosein and Hasan      | 2008  | Pakistan | In vivo study| 60          | Permanent mandibular molar, Class 1 caries                                    | -                | Group 1: Steel bur Group 2: Carisolv                         | 1. Time required 2. Completeness of caries removal                                                     | Visual and tactile method                        |                                                                                                     |
| Henrik Dommisch et al.| 2008  | Germany  | In vivo study| 102         | Caries in permanent teeth                                                     | -                | Group 1: Fluorescence-Controlled Er: YAG laser Group 2: Rotary carbide bur | 1. Microbiological analysis 2. Treatment time 3. Pain 4. Vibration and sound intensity Anxiety level | 1. CFU Of Streptococcus Mutans and lactobacilli 2. Visual Analog Scale 1. MDAS 2. Visual Analog Scale |                                                                                                     |
| S Rafique et al.      | 2003  | London   | In vivo study| 22          | Class 1/5 cavities on premolar and molar teeth and Class 3 carries on incisors, contralateral teeth | -                | Group 1: Tungsten carbide bur Group 2: Air-abrasion and Carisolv gel |                                                                                                        |                                                                                                        | 1. 86% of participants showed some level of anxiety, 59% are moderately anxious during LA or drill 2. Time taken for cavity preparation with Group 1 was 6.3 min and 5.4 min for Group 2 |
### Table 2: Contd...

| Author | Years | Country                  | Study design                                                                 | Sample size | Type of teeth                                             | Follow up period | Caries removal methods used                                                                 | Factors analyzed                                                                 | Method of evaluation | Outcome measures                                                                 |
|--------|-------|--------------------------|------------------------------------------------------------------------------|-------------|----------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------|----------------------|----------------------------------------------------------------------------------|
| Hadley et al. | 2000  | San Francisco           | In vivo study                                                                | 66          | Class 1, Class 3, or Class 5 in permanent teeth          | 6 months         | Group 1: Conventional air turbine/bur dental surgery                                    | 1. Pulp vitality                               | 1. Vitalometer                   | 1. Both groups remained vital at the evaluation at the 6th months of restoration |
|         |       |                          |                                                                              |             |                                                          |                  | Group 2: Er, Cr: YSGG laser-powered system                                               | 2. Recurrent caries                             | 2. Restoration retention          | 2. There was no discomfort in 87.9% in Group 1 and 98.5% in Group 2 during the  |
|         |       |                          |                                                                              |             |                                                          |                  | Group 1: Chemomechanical treatment (Carisolv)                                              | 3. Pain and discomfort                          | 3. Discomfort scale               | day 1 of procedure                                                             |
|         |       |                          |                                                                              |             |                                                          |                  | Group 2: Conventional drill                                                               | 4. Restoration retention                       | 4. Evaluation of restoration       | 1. One-year follow up showed 29 intact restorations in Group 1, out of which 2  |
|         |       |                          |                                                                              |             |                                                          |                  |                                                                                             |                                                   |                                    | were lost during follow up visits and one reported secondary caries           |
|         |       |                          |                                                                              |             |                                                          |                  |                                                                                             |                                                   |                                    | 2. 31 teeth in Group 1 were sensitive and 24 were found to be sensitive in    |
|         |       |                          |                                                                              |             |                                                          |                  |                                                                                             |                                                   |                                    | Group 2 3. Anesthesia was not preferred by patients in Group 1 and 12 out of 20 |
|         |       |                          |                                                                              |             |                                                          |                  |                                                                                             |                                                   |                                    | preferred anesthesia in Group 2                                               |
| S Fure et al. | 2000  | Sweden                  | In vivo study                                                                | 60          | Primary root carious lesions                             | 1 year           | Group 1: Chemomechanical treatment (Carisolv)                                              | 1. Pain during treatment                        | Three-score evaluation scheme     | The mean preparation time by laser was 7.3 min. The mean preparation time by   |
|         |       |                          |                                                                              |             |                                                          |                  | Group 2: Conventional drill                                                               | 2. Treatment time                               |                                     | mechanical means was 3 min                                                  |
| Keller et al. | 1998  | Cross-over study (5 German universities) | In vivo study                                                               | 206         | Any type of permanent teeth                              | 1 year           | Group 1: Conventional mechanical preparation                                              | 3. Evaluation of restoration                    | Questionnaire                    | 21% of patients requested for LA during caridex treatment and 37% during      |
|         |       |                          |                                                                              |             |                                                          |                  | Group 2: Er: YAG laser preparation                                                          |                                                   |                                     | conventional treatment            |
|         |       |                          |                                                                              |             |                                                          |                  |                                                                                             |                                                   |                                    | 85.3% of patients responded that they did not require LA for CRS procedure    |
|         |       |                          |                                                                              |             |                                                          |                  |                                                                                             |                                                   |                                    | in future. 29.4% would allow the                                         |
|         |       |                          |                                                                              |             |                                                          |                  |                                                                                             |                                                   |                                    | conventional treatment without anesthetic                                     |
| JH Zinck et al. | 1988  | New Orleans             | In vivo study                                                                | 60          | Vital permanent teeth either previously restored or unrestored | -                | Group 1: Caridex                                                                           | 1. Patient preference                          |                                     |                                                                                  |
|         |       |                          |                                                                              |             |                                                          |                  | Group 2: Conventional rotary bur                                                           | 2. Time required for treatment                  |                                     |                                                                                  |
|         |       |                          |                                                                              |             |                                                          |                  |                                                                                             |                                                   |                                    |                                                                                  |
| KJ Anusavice and JE Kincheloe | 1987 | Florida             | In vivo study                                                                | 47          | Carious lesions in vital teeth                           | 3 months         | Group 1: Chemomechanical caries removal system (GK-101E Solution)                          | 1. Preference for local anesthetic             |                                     |                                                                                  |
|         |       |                          |                                                                              |             |                                                          |                  | Group 2: Conventional method                                                               | 2. Evaluation of pain                           |                                     |                                                                                  |

LA for CRS: Cytoreductive surgery, MDAS: Modified dental anxiety scale, CFU: Colony forming unit, Er: YAG: Erbium: yttrium-aluminum-garnet, Er, Cr: YSGG: Erbium, chromium-doped yttrium, scandium, gallium, and garnet


Inclusion criteria
Criteria for considering studies for this review

Types of studies
1. Randomized controlled trials, clinical trials, retrospective clinical trials, or observational studies
2. *In vivo* studies assessing the efficiency of caries removal in permanent teeth.

Types of participants
• Studies having patients with permanent teeth
• Teeth with caries.

Types of interventions
Studies in which caries removal is done by alternative methods other than conventional method.

Types of outcome measure
Efficiency of caries removal.

Exclusion criteria
The following studies were excluded:
• Case reports or series
• Animal studies
• *In vitro* studies
• Studies not meeting inclusion criteria.

RESULTS

Description of studies
The search identified 338 publications, out of which 330 publications were excluded after removing the duplicates, reviewing the title or abstract, and for the reason of being retracted by the journal. Three articles were obtained after hand searching specified journals. A total of 11 publications fulfilled all criteria for inclusion [Flow Chart 1].

DISCUSSION

The purpose of this review was to determine the efficacy of alternative methods of caries removal in permanent teeth. Eleven *in vivo* studies fulfilled the criteria for being included in this review (A. H. Ali et al., 2018; AR Yazici et al., 2010; Prabhakar et al., 2009; Hosein and Hasan, 2008; Henrik Dommisch et al., 2008; S. Rafique et al., 2003; Hadley et al., 2000; S. Fure et al., 2000; Keller et al., 1998; J. H. Zinck et al., 1988; and K. J. Anusavice and J. E. Kincheloe, 1987) [Table 2]. The sample size distribution of included studies is presented in Figure 1.

Interpretation of the results
Of these 11 studies, all were clinical trials (A. H. Ali et al., 2018; AR Yazici et al., 2010; Prabhakar et al., 2009; Hosein and Hasan, 2008; Henrik Dommisch et al., 2008; S. Rafique et al., 2003; Hadley et al., 2000; S. Fure et al., 2000; Keller et al., 1998; J. H. Zinck et al., 1988; and K. J. Anusavice and J. E. Kincheloe, 1987), and they evaluated the alternative method of caries removal in permanent teeth.

According to A. H. Ali et al., at the end of month 12, periapical radiograph showed 92% (rotary burs) and 98.6% (Carisolv) showed as healthy, and bacterial tissue reduction after excavation of cavities is about 96.5% in total.

According to AR Yazici et al., both diamond bur and erbium, chromium-doped yttrium, scandium, gallium, and garnet (Er: Cr: YSGG) laser performed equally in all the parameters such as marginal discoloration and marginal adaptation.

According to Prabhakar et al., polymer group showed complete caries removal in 76% of the cases analyzed and partial removal in 24%. Among these 30% of the patients reported no discomfort and 70% of them showed mild discomfort. Whereas, carbon steel round bur group showed complete caries removal in 46.6% of cases and partial removal in 53.4%. Among these 47.5% of the patients reported no discomfort and 52.5% of them showed mild discomfort.

According to Hosein and Hasan, the mean time for caries removal with Carisolv was 12.19 min in 27 cases. The mean time for caries removal was 7.4 min with steel bur group.

According to Henrik Dommisch et al., colony-forming unit (CFU) for lactobacilli after laser treatment was 0.00–2.11 and after bur treatment was 0.00–1.68. CFU for *Streptococcus mutans* was around 0.00-0.70 after laser treatment and ranged from 0.00-1.52, when the rotary bur was used for preparation.

According to S. Rafique et al., 86% of participants showed some level of anxiety, 59% are moderately anxious during Local Anesthesia (LA) or drill. Time taken for cavity preparation with tungsten carbide bur was 6.3 min and 5.4 min for air-abrasion and Carisolv groups, respectively.

According to Hadley et al., both conventional bur and Er: Cr: YSGG laser groups remained vital at the evaluation at the 6th month of restoration. There was no discomfort in 87.9% in conventional bur group and 98.5% in Er: Cr: YSGG laser group during day 1 of procedure.
According to S. Fure et al., 21% of patients responded that they did not require LA for CRS procedure in the future. 29.4% would allow the conventional treatment without anesthetic.

Conclusion

With the available evidences, this review concludes that alternative methods for caries removal are not as effective as other commercially available conventional burs.

However, a good number of clinical trials are needed to establish their potency as an effective caries removal agent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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