

Influence of Biological Dentin Post on Fracture Resistance of Endodontically Treated Anterior Teeth: A Systematic Review

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ABSTRACT

Introduction: A biological dentin post is recommended when more support for the restoration is needed and there is a severe loss of tooth structure. However, whether the use of biological dentin post affects the fracture resistance of the restored anterior teeth is not impervious.

Aim: This systematic review aimed to evaluate the fracture resistance of endodontically treated and restored anterior teeth and to answer the research question, “Does the use of biological dentin post influence fracture resistance of endodontically treated anterior teeth?”

Materials and Methods: In the present systematic review, the initial search was performed on PubMed, Scopus, Web of Science, EBSCO, and Cochrane. According to inclusion criteria, additional records from all other resources like the citation database of related articles were also performed. The articles were searched between January 2000 to December 2021. The risk of bias was evaluated by using the Cochrane

risk of bias assessment tool. The keywords for search strategy were “Biological Dentin Post” OR “Dentin Post” OR “Biological Post” OR “Experimental Dentin Post” AND “Fracture Resistance” OR “Dentin Post Failure” OR “Biological Post Failure.”

Results: After removal of duplicates and title and abstract screening, five studies met the inclusion criteria. Three studies were considered having/showing high-risk of bias and two studies were considered having/showing medium risk. The data concluded that the biological dentin post exhibited higher fracture resistance in three studies. However, one study concluded that both dentin post and glass fibre post may be preferred for additional reinforcement of immature teeth. Another study disclosed that human dentin, bovine dentin and prefabricated glass fibre posts presented similar values of fracture resistance.

Conclusion: The use of biological dentin post increases the fracture resistance of endodontically treated and restored teeth. Also, future studies should follow a standardised approach to implementation and reporting of data.

Keywords: Bovine dentin, Non vital, Post and core technique, Tooth, Tooth fractures

INTRODUCTION

Endodontically treated teeth often endure multiple alterations as a result of blood supply loss, dehydration, and changes in physical and mechanical qualities, let alone the loss of substantial dental tissues. Empirical data is used to support the clinical choice to repair endodontically treated teeth utilising intracoronal and extracoronal restorative methods. Depending on the remaining tooth structure, bone support, ferrule presence, related disease, and occlusal as well as other biomechanical pressures, several treatments are routinely performed based on scientific evidence and the clinician's judgement. When a tooth with little supraosseous tissues is remaining, a post may be considered to offer a platform for retention, either for an intra coronal or extra coronal restoration [1].

The primary function of a post is to keep a coronal restoration in place in an endodontically treated tooth that has lost a significant amount of crown structure [2]. In anterior teeth, numerous types of customised and prefabricated posts are used, of which, metal and cast posts have been used for decades. In response to a desire for tooth-coloured posts, many non metallic posts have lately been introduced. Some of the examples of non metallic posts are fibre posts, polyethylene posts, glass fibre posts etc. All these posts have shown varying success rates over a period of six months to three years. The advantages of these posts are elasticity, high tensile strength, low electrical conductivity, resistance to solubility and resistance to biochemical degradation [3]. Failure of fibre and metal posts due to endodontic failure, root fracture, post and core separation, post and core fracture and also modulus of elasticity not equivalent to dentin and poor bonding property resulted in the emergence of biological dentin posts [4].

Santos J and Bianchi J coined the phrase “biological restoration” to describe a procedure that combines the adhesive properties of

materials with the strategic implantation of extracted human tooth components [5]. Ramires-Romito AC et al., utilised teeth from human tooth bank as natural posts and crowns to fit into the roots and replace the crowns [6]. The presence of the biological dentin post might avoid the stress concentration and distribute the stress better to other areas of the tooth. Biological dentin post is economical, easy to perform and natural tooth can easily be obtained from the patient or tooth bank [7]. Biological dentin posts have been reported to perform well when compared to other posts because of their lower elastic modulus (similar to dentin) and may be associated with fewer root fractures in the long-term [8]. Though certain studies [7,8] and case reports [6,9] are available in the literature claiming the better clinical success of these posts in permanent teeth, a consensus on the use of biological dentin post to reinforce weakened teeth is lacking. Also, the available literature is lacking in standardised evidence for the use of biological dentin post in endodontically treated teeth.

So, this systematic review aimed to critically evaluate the fracture resistance of endodontically treated anterior teeth restored using biological dentin posts. The research hypothesis was that the use of biological dentin post improves the fracture resistance of endodontically treated and restored anterior teeth compared with other posts. Probably, this is the first systematic review evaluating success of treatment of endodontically treated anterior teeth with the use of biological dentin post.

MATERIALS AND METHODS

The systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO) database (December 08, 2021; www.crd.york.ac.uk/PROSPERO-CRD42021297140) and

reported in accordance with the recommendations of the Preferred Reporting Items for Systematic Review (PRISMA) statement (www.prisma-statement.org). The research question of this systematic review was “Does the use of biological dentin post influence fracture resistance of endodontically treated permanent anterior teeth?”

Study design: In-vitro studies that included groups consisting of intraradicular biological dentin post in endodontically treated and restored teeth as an experimental group and control groups, consisting of posts other than biologic dentin post to compare fracture strength were included as per the PICOS strategy: Population (P) permanent anterior teeth; Intervention (I) biological dentin post; Comparison (C) other posts; Outcome (O) fracture resistance and Study Design (S) in-vitro studies.

Inclusion criteria:

1. Studies on permanent anterior teeth
2. In-vitro studies done in human extracted teeth
3. Studies using biological dentin post
4. Studies evaluating fracture resistance of biological dentin post
5. Studies in the English language
6. Studies between 1st January 2000- 31st December 2021

Exclusion criteria:

1. Reviews, case reports, in-vivo studies
2. Animal studies
3. Studies evaluating other parameters
4. Studies published in languages other than English

Study Procedure

Search strategy: The search strategy was based on the controlled vocabulary (MeSH terms) of the PubMed database along with the free keyword using the following search terms and keywords alone or in combination with the Boolean operator “AND” and “OR.” The search was performed first on PubMed, Scopus, Web of Science, EBSCO, and Cochrane databases. According to inclusion criteria, additional records from all other resources like the citation database of related articles were also performed. The articles were searched between 1st January 2000- 31st December 2021. The initial search was done to segregate all the studies using biological dentin post. Also, many times which tooth is used in the study is not mentioned in the title. So, initial search was done without using anterior teeth keyword, and used at the stage of full article assessment. The keywords for search strategy were “Biological Dentin Post” OR “Dentin Post” OR “Biological Post” OR “Experimental Dentin Post” AND “Fracture Resistance” OR “Dentin Post Failure” OR “Biological Post Failure”

Study selection: Titles and abstracts of each of the articles were reviewed for the study selection after removing the duplicate studies. Full-text of articles was retrieved for study selection. Two reviewers identified the studies that met the eligibility criteria. Subsequently, each eligible study was given a code combining the first author’s name and year of publication. Custom extraction forms were used by the two reviewers to independently extract the relevant data from the included studies.

Data collection: Data like author, year, country, type of specimen, root length, remaining crown structure, type of post used, angle of load application and fracture mode or fracture resistance were extracted and tabulated separately for all the articles.

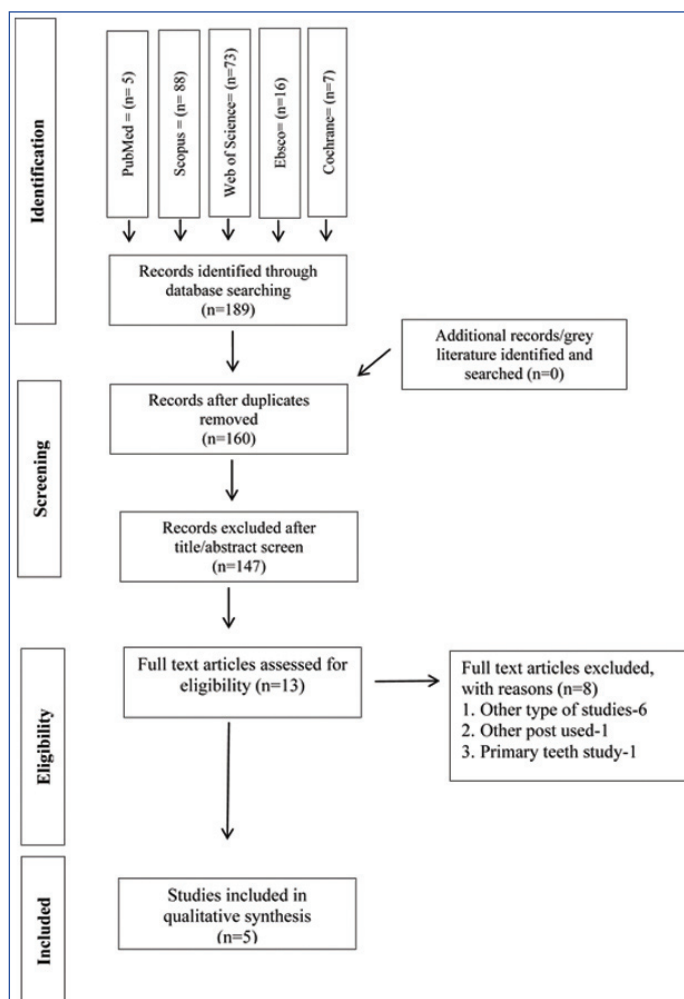
Risk of bias assessment: The assessment of Risk of Bias (RoB) and methodological qualities of retrieved studies were carried out according to the guidelines provided by Cochrane RoB assessment tool following the criteria; tooth randomisation, teeth with no caries, teeth with similar dimension, performed by a single operator,

blinding of outcome assessed. Yes (Y) and No (N) were assigned to all the criteria in each study. When a criterion was reported by a study, a “Y” was assigned; if the criteria were not reported, the study received a “N”. The study was considered at low RoB if total 4 or 5 criteria were reported Y. If 3 criteria’s reported Y, the study was judged as having a medium RoB. Those reporting 1 or 2 criteria with Y were considered at high RoB. Disagreements between the reviewers during this process were discussed until an agreement was reached. A third reviewer was consulted when necessary.

Risk of bias of included studies was evaluated by two independent reviewers (YJK and SJG) using a specific study design-related RoB developed by Cochrane Collaboration (Cochrane Handbook for Systematic Reviews of Interventions 5.1.0). The criteria include tooth randomisation, teeth with no caries, teeth with similar dimension, performed by a single operator, and blinding of outcome assessed. The bias risk was assessed by rating each of the study criteria as low RoB, medium RoB and high-RoB. Any disagreement between the reviewers was resolved by discussion and mutual agreement [10].

RESULTS

Study selection: Two authors (YJK and SJG) independently performed search of studies. During the first phase of study selection, 189 results were found, distributed in five electronic databases, including the grey literature. After removing the repeated/duplicate results, 160 studies remained for the analysis of titles and abstracts. After the detailed analysis, only 13 studies were eligible for the full text analysis. And after reading the full texts, eight studies were excluded and the reason for exclusion is described in [Table/Fig-1] which represents the process of search, identification, inclusion, and exclusion of articles [Table/Fig-1].



[Table/Fig-1]: Flowchart depicting search, identification, inclusion and exclusion processes of the studies, adapted from Preferred Reporting Items for Systematic Reviews (PRISMA).

Characteristics of eligible studies: The studies conducted by Kathuria A et al., Ambica K et al., Nikhil V et al., Kurthukoti AJ et al., Tavano KTA et al., were included in this review [11-15]. The main characteristics of five selected in-vitro studies are presented in [Table/Fig-2]. Human teeth were used in all the studies. Biological dentin posts were tested with other groups of posts in all studies. Fibre Reinforced Composite (FRC) post was used in studies conducted by Kathuria A et al., Ambica K et al., and Kurthukoti AJ et al., glass fibre post was used in studies conducted by Nikhil V et al., Tavano KTA et al., carbon fibre composite post was used in the study conducted by Ambica K et al., zirconia post was used in the study conducted by Kurthukoti AJ et al., [11-15]. The remaining tooth structure was considered for all the studies where 2 mm of ferrule was present in three studies, 3 mm of ferrule was present in one study and 1 mm of ferrule was present in one study. Teeth with root length 13 to 17 mm were included in all the studies. The angle of load application was 135° for all studies. Failure mode or fracture resistance was considered for all studies.

reported medium RoB as tooth randomisation, teeth with no caries and teeth with similar dimensions were taken for study. [Table/Fig-2] explains the number of studies that reported Y for the specific parameters. Tooth randomisation was reported Y for two studies, teeth with no caries was reported Y for four studies and teeth with similar dimensions were reported Y for all five studies [11-15].

DISCUSSION

Posts are required for supporting the core foundation when insufficient clinical crown is remaining. Endodontically treated teeth restoration with metal-free, physiochemically homogeneous material with physical qualities similar to dentin has become a main goal in dentistry. A few reported cases using dentin as a post material have shown successful outcomes [12,16]. Hence, the probability of human dentin serving as a post material needs to be investigated.

The current study sought to address the following question: "Does the use of biological dentin post influence fracture resistance of endodontically treated permanent anterior teeth?" It is feasible to

Author, year, country	Type of specimen	Root length	Remaining crown structure	Type of post, sample size (n)	Angle of load application	Fracture resistance
Kathuria A et al., 2011, India [11]	Human permanent maxillary central incisor	13±1 mm	2 mm of ferrule	1. Control, n=10 2. FRC post, n=10; 3. Dentin post, n=10	135° (Palatal aspect)	Dentin post exhibited better fracture resistance than FRC posts.
Ambica K et al., 2013, India [12]	Human permanent maxillary central incisor	13 mm	2 mm of ferrule	1. Control, n=10 2. Carbon fibre composite post, n=20 3. Prefabricated glass FRC post, n=20 4. Dentin post, n=20	135° (Palatal aspect)	Experimental dentin posts exhibited higher fracture resistance than those restored with glass fibre or carbon fibre posts under static and cycling loading. Most of the specimens of all groups showed restorable fractures.
Nikhil V et al., 2015, India [13]	Human permanent maxillary canine	17 mm	3 mm of ferrule	1. AH Plus+Gutta percha, n=10 2. GFP and Paracore, n=10 3. DP and Paracore, n=10 4. Paracore, n=10; 5. Control, n=10	135° (Lingual surface)	GFP and DP may be preferred for additional reinforcement of immature teeth.
Kurthukoti AJ et al., 2015, India [14]	Human permanent maxillary central incisor	13±2 mm	2 mm of ferrule	1. Control, n=10 2. Zirconia post, n=10 3. FRC post, n=10 4. Biological dentin post, n=10	135° (Palatal aspect)	Biological dentin post demonstrated highest fracture resistance, closely followed by FRC post system. Biologic dentin post system and FRC system demonstrated more favourable fractures.
Tavano KTA et al., 2020, Brazil [15]	Human maxillary canine	15 mm	Endodontic access	1. Control group (glass fibre post), n=10 2. Human biological cylindrical post, n=10 3. Bovine biological dentin post with self-adhesive cement resin, n=10 4. Bovine biological dentin post with RMGIC, n=10	135° (Palatal aspect)	Human dentin, bovine dentin and prefabricated glass fibre posts presented similar values of fracture resistance.

[Table/Fig-2]: Characteristics of included studies [11-15].

FRC: Fibre reinforced composite post; GFP: Glass fibre post; GIC: Glass ionomer cement; DP: Dentin post

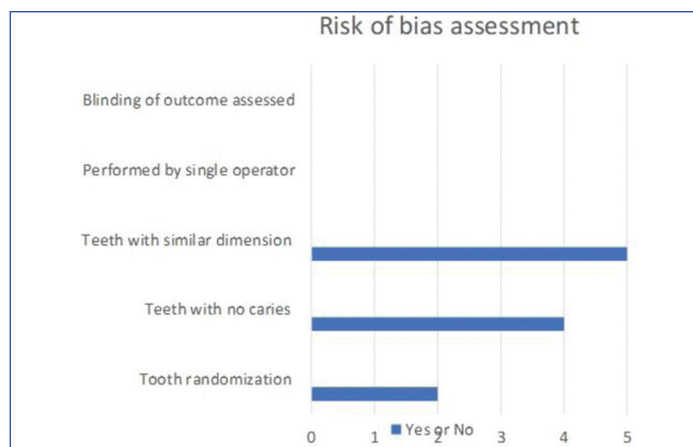
Synthesis of results: The data concluded that in out of five studies, the biological dentin post exhibited higher fracture resistance in three studies i.e., the studies conducted by Kathuria A et al., Ambica K et al., Kurthukoti AJ et al., concluded that anterior teeth restored with dentin posts exhibited better fracture resistance than those restored with FRC posts [11,12,14]. Ambica K et al., concluded that human dentin can serve as post material under static and fatigue loading. Kurthukoti AJ et al., concluded that teeth restored with permanent anterior teeth with the biologic dentin post system demonstrated the highest fracture resistance and repairable fractures, closely followed by FRC post system. However, study conducted by Tavano KTA et al., concluded that human dentin post, prefabricated glass fibre post and bovine dentin post showed similar values of fracture resistance in cases of endodontically treated human teeth [15]. Studies conducted by Nikhil V et al., on permanent anterior teeth concluded that glass fibre post show better fracture resistance than biological dentin post.

Quality analysis [Table/Fig-3,4]: The assessment of risk of bias for the eligible articles served as an important parameter for quality analysis. Out of five articles, three articles resulted in high-RoB mainly because of the variability of the operator in performing the study and no blinding present for the outcome assessed. Also, tooth randomisation was not performed in these studies. Two articles

Article author and year	Tooth randomisation	Teeth with no caries	Teeth with similar dimension	Performed by single operator	Blinding of outcome assessed	RoB
2011, Kathuria A et al., [11]	N	Y	Y	N	N	HR
2013, Ambica K et al., [12]	N	Y	Y	N	N	HR
2015, Nikhil V et al., [13]	Y	Y	Y	N	N	MR
2015, Kurthukoti AJ et al., [14]	Y	Y	Y	N	N	MR
2020, Tavano KTA et al., [15]	N	N	Y	N	N	HR

[Table/Fig-3]: Assessment of risk of bias for included studies.

Y: Yes; N: No; RoB: Risk of Bias; HR: High-risk; MR: Medium risk



[Table/Fig-4]: Graphical representation of risk of bias assessment for included studies.

standardise the technique and reporting for some research designs by following a guideline, such as the consolidated standards of reporting trials for clinical trials and the PRISMA. However, guidelines for in-vitro research are inadequate, as evidenced by the analysis of the risk of bias in the current investigation, where blinding of the results or single operator execution of the study was not undertaken or reported by any study [11-15].

This review was designed to assess if there is any increase in fracture resistance of the endodontically treated anterior teeth if restored with biological dentin post than with other posts. Both primary as well as permanent anterior teeth were to be assessed as evidence of use of posts in restoring endodontically treated primary anterior teeth is consistently increasing. However, the review had to be limited to permanent anterior teeth due to lack of studies on primary anterior teeth.

In the studies, included in this review, the biological dentin posts were formed from the roots of extracted teeth with a specifically developed and constructed drill, which standardised the specimens in a cylindrical form. The coronal section of each tooth was cut by a cylindrically-shaped diamond tip bur at high rotation while cooling, and this tooth piece was then discarded. The root segment of the tooth was cut into four pieces along the long axis with carborundum disc under cooling. All biological dentin posts utilised in the trials were created using a standard technique. After obtaining straight line access using a round bur into the pulp chamber, the canals were thoroughly irrigated with saline and sodium hypochlorite to remove all debris. Biomechanical preparation was done followed by obturation with gutta percha. The post space was prepared leaving 4 mm apical filling intact. Cementation of post in root canal was done using luting agent [11-15].

Sterilisation is an important aspect while using biological dentin post. It provides teeth disinfection with all biosafety and biosecurity standards and also helps to prevent chances of cross-infection [15]. In this systematic review, three studies i.e., the study by Nikhil V et al., Kurthukoti AJ et al., Tavano KTA et al., were found to have performed sterilisation of the samples [13-15] maintaining the biosafety standards.

Teeth with no caries is directly relatable to fracture resistance of teeth, as the teeth with caries have weak strength, also, the availability of limited tooth structure in teeth indicated for posts may influence the results. In the present systematic review, the studies by Kathuria A et al., Ambica K et al., Nikhil V et al., Kurthukoti AJ et al., performed the methodology using teeth without caries [11-14]. The length of root is one of the important factors for evaluation of fracture resistance of teeth. More the length, more the strength of teeth. Ideally coordination between with post length and remaining crown structure should exist. Studies in the literature have shown increasing the length of post increases the retention of post and core and more favourable stress distribution along the teeth. However, study by Chuang SF et al., has shown contradictory results that increasing the post length might decrease the root strength [17].

The angle of load application for all studies in this review [11-15] was 135° as it simulates the maxillary/mandibular occlusal relationship of Angle Class-I in the anterior region. It is important to note that more precise the simulation of the clinical situation, the better will be the result, where all structures are analysed [18,19]. Kathuria A et al., compared dentin posts with FRC posts with the angle of load application of 135° and found that dentin posts exhibited better fracture resistance than FRC posts [11]. The same interpretation was done by Ambica K et al., which reported that, experimental dentin posts exhibited higher fracture resistance than those restored with glass fibre posts and carbon fibre posts [12]. Kurthukoti AJ et al., also concluded that biological dentin posts exhibited higher fracture resistance with the same angle of load application i.e., 135° than FRC posts [Table/Fig-2] [14].

Nikhil V et al., found that glass fibre post exhibited higher fracture resistance than dentin post [13]. Tavano KTA et al., found that prefabricated glass fibre posts, bovine dentin posts and human dentin posts presented similar values of fracture resistance [15].

Teeth restored with dentin posts exhibited higher fracture resistance and more favourable fracture patterns than those restored with other posts in three studies which were conducted by Kathuria A et al., Ambica K et al., Kurthukoti AJ et al., [11,12,14]. This might be explained on the basis of physio mechanical properties, uniform stress distribution, shock-absorbing potential of dentin posts [20]. Dentin has a complex microstructure with a range of mechanical properties. It possesses a modulus of elasticity of 13-18 GPa, which varies in different locations and orientations, suggesting that it may provide a mechanism that prevents fracture development in dentin [21]. The dentin post might resemble root dentin in all the physical properties such as modulus of elasticity, viscoelastic behaviour, compressive strength, thermal expansion, etc., [22-24] Furthermore, the fracture toughness of dentin has been found to be better than most of the current restorative materials [25].

In addition to enhanced fracture resistance, several studies have found that the biologic dentin post fracture pattern correlates to a better prognosis following a fracture [26]. The majority of fracture modes were repairable, according to a qualitative review of research that analysed them. This avoids the loss of tooth structure and allows the tooth to be treated. The present study evaluated relevant questions about the necessity of the biologic dentin post and highlighted it as an important alternative for weakened teeth even without data from clinical studies. The review also emphasises the presence of high heterogeneity in in-vitro study data in available literature. Many studies in the present systematic review did not present important parameters such as specimen randomisation, use of teeth of similar dimensions, if conducted by a single operator and blinding of outcome assessment, which may have happened but not addressed in the research design or not reported, have added to RoB values in the present study. Improved reporting of in-vitro studies would promote better methodological quality and transparency [27]. The findings of this review reinforce the need for well reported randomised clinical trials to provide clinical evidence to answer this question. The present systematic review could be used to guide such clinical studies.

Limitation(s)

The present systematic review was initially designed to analyse clinical trials, providing the highest level of evidence. However, as very few clinical studies have studied this question, a systematic review of in-vitro studies was carried out to reach a consensus among laboratory studies that reached different conclusions. The outcomes of the present systematic review should be taken with caution due to the heterogeneity of the available data, presence of uncontrolled confounding factors and a variable risk of bias in the studies.

CONCLUSION(S)

This systematic review indicates that, there is a difference in fracture resistance of teeth treated with biological dentin post and other posts. The data concluded that the biological dentin post exhibited higher fracture resistance in permanent anterior teeth. Further in-vitro studies with standardised methodology are needed regarding the fracture resistance of biologic dentin posts which may explain other relevant variables, such as the load values and load angles of application for the mechanical tests, the adhesive strategy, the dimensions of intra radicular posts and the variable remaining tooth structures such as in primary and permanent teeth.

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PLAGIARISM CHECKING METHODS: [\[Jain H et al.\]](#)

- Plagiarism X-checker: Mar 24, 2023
- Manual Googling: May 24, 2023
- iThenticate Software: Jun 13, 2023 (16%)

ETYMOLOGY: Author Origin

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