THE POST TRANSFIXED IN THE CORONAL CAVITY INCREASES THE FRACTURE RESISTANCE OF WEAKENED AND DIRECTLY RESTORED TEETH? A SYSTEMATIC REVIEW.

Bruna Neves Portugal[1], Vanessa Mallmann Weschenfelder[1], Luiz Henrique Burnett Junior[2], Tiago André Fontoura de Melo[1]

1 Restorative Dentistry Division, Department of Conservative Dentistry, Federal University of Rio Grande do Sul – Porto Alegre, RS, Brazil.
2 Clinical Department, Post-Graduate Program, Dental School, Pontifical Catholic University of Rio Grande do Sul (PUCRS), Porto Alegre, RS, Brazil.

CORRESPONDING AUTHOR: tiago.melo@ufrgs.br

ABSTRACT

Introduction: The objective of this systematic review was to answer the question: Does the intraradicular post transfixed in the dental crown increases the fracture resistance of weakened and directly restored teeth? Methods: Electronic databases (MEDLINE/PubMed, LILACS, SCOPUS, EMBASE, Scientific Electronic Library Online - SCIELO, and Central Register of Controlled Trials - CENTRAL) were searched until March 2021, without language or year restriction. Grey literature was also searched through Google scholar and OpenGrey repository. Only in vitro stud-ies were included that evaluated the influence of the use of intraradicular post trans-fixed in the crown in the buccopalatal/lingual direction in the fracture resistance of the dental crown. Relevant results were summarized and evaluated. The risk of bias was also assessed in the studies. Results: Initial screening of databases resulted in 249 studies, of which 109 were excluded for being duplicates. Of 140 eligible pa-pers, fourteen studies met the inclusion criteria and were selected for full-text read-ing. Of these, two studies were excluded for not having access to the full article. All selected articles were classified as low risk of bias. Conclusion: Based on the studies, it is possible to conclude that the use of a transfixed post in the crown increases the fracture resistance of weakened and directly restored teeth.

KEYWORDS: Dental stress analysis. Operative dentistry. Systematic review. Tooth crown.

INTRODUCTION

Restoration of endodontically treated teeth is a very complex procedure, since in most cases these elements present major coronary impairments. According to Santos-Filho et al.[1], the resistance to fracture of endodontically treated teeth is directly related to the quantity and quality of the remaining dental structure, thus being a determining factor for the longevity of the restorative procedure.

Usually, when tooth fracture occurs, it is associated with fracture of the cusps. This fact deserves special attention, as there is a risk of the fracture line extending below the bone crest, which may cause the loss of the tooth piece or hinder its restoration[2].

Direct restorations with composite resin, when properly executed, can be a viable form of treatment because, in addition to the low operating cost, it does not require additional wear on healthy dental tissue. Plotino et al.[3] found no statistical difference in the fracture resistance of molars, with extensive loss of tooth structure and treated

with composite resin restorations by the direct or indirect technique.

A fact that is already known and established in the scientific literature is that the use of intraradicular posts for restoration of endodontically treated posterior teeth does not increase the strength of the remaining tooth. The intraradicular post only has the function of promoting the retention of the restorative material[4].

A treatment alternative that is being tested in order to increase the fracture resistance of fragile and endodontically treated teeth is the use of posts transfixed horizontally on the buccal and palatal/lingual walls. Studies by Beltrão et al.[5], and Fávero et al.[6] observed that groups that received transfixation of posts and restoration with composite resin showed a significant increase in fracture resistance when compared to groups restored with resin alone. In addition, there was a lower degree of impairment of the tooth structure due to the fracture.

(1) To date, no systematic review has been performed evaluating such information. Therefore, the objective of this systematic review is to answer the following question: "The intraradicular post transfixed in the dental crown increases the fracture resistance of weakened and directly restored teeth?".

MATERIALS AND METHODS

This systematic review was conducted in accordance with the recommendations provided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines[7] and was registered in the International Prospective Register of Systematic Review (Registration number CRD42021262954).

Search strategy

The search was performed independently by two examiners (B.N.P and V.M.W) in the following electronic databases: MEDLINE/PubMed, LILACS, SCOPUS, EMBASE, *Scientific Eletronic Library Online* (SCIELO), and *Central Register of Controolled Trials* (CENTRAL). The search was conducted for articles published until March 2021, without language or year restriction. Grey literature was also searched through Google scholar and OpenGrey repository.

The electronic search strategy was developed using the most cited descriptors in previous publications on this theme combining Medical Subject Heading (MeSH) terms and text words (tw.). For each database, the following terms were combined: *((Restorations) OR (Direct restoration)) AND ((Resistance) OR (Fracture) OR (Failure) OR (Fracture strength)) AND (Horizontal post).*

Additional screening on the selected studies' references was performed, and the related articles were searched in the PubMed database. All articles selected were imported into the Mendeley© (Mendeley Ltd, London, United Kingdom) reference manager to catalogue the references and facilitate the exclusion of duplicates.

Eligibility criteria

The eligibility criteria were based on the PICOS strategy (PRISMA-P 2015)[8,9], as follows:

* Population (P): posterior permanente human teeth;
* Intervention (I): use of intraradicular post transfixed in the dental crown in the buccopalatine/lingual direction;
* Comparison (C): direct composite restoration without transfixed intraradicular post;
* Outcome (O): fracture resistance of the dental crown;
* Study design (S): in vitro studies.

Selection of the studies

The first stage consisted of excluding the duplicated studies, considering only once, and examining the selected studies' retrieved titles and abstracts by two independent authors (B.N.P. and V.M.W.). When it was not possible to judge the studies by title and abstract, the full text was accessed and read for the final decision. The second stage consisted of reading the potentially eligible studies' full texts based on the PICOS strategy's eligibility criteria. Disagreements on study inclusion were solved by a consensus with a third author (T.A.F.M.).

Data extraction

Two authors (B.N.P. and V.M.W.) independently collected the data from the included studies. Disagreements were solved by a third author (T.A.F.M.). The following data were extracted from the included studies: publication data (authors, year, and country of origin), study characteristics (teeth evaluated, type of control, groups tested, type of restorative cavity, restorative material, type of intraradicular post, type of resistance test, applied force in the test, and outcome information). In cases of missing data, the authors were contacted three times by e-mail.

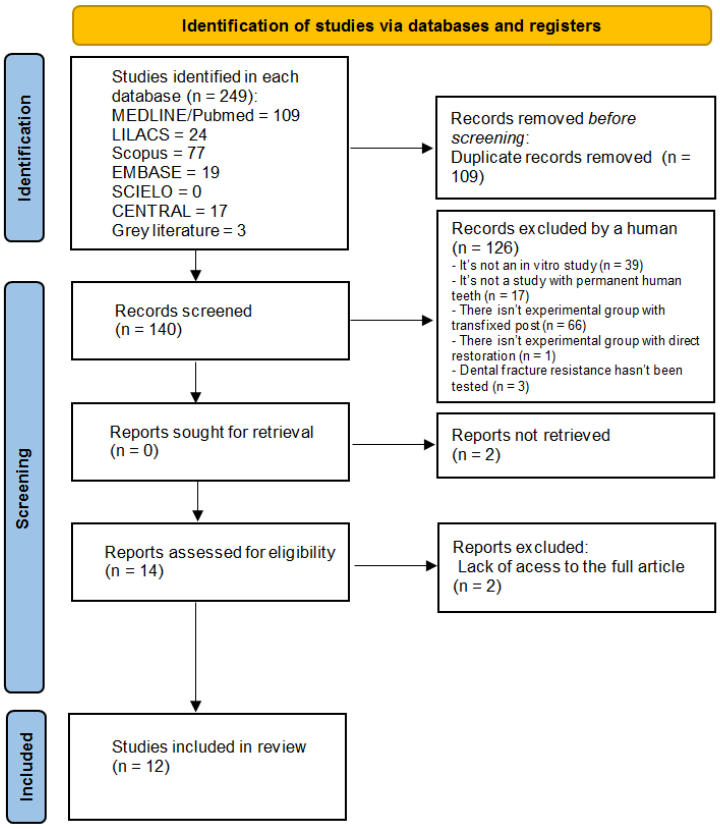
Risk of bias assessment

The methodological risk assessment of bias for each study was performed by two independent authors (B.N.P. and V.M.W.), and, in case of disagreement, it was resolved by a third author (T.A.F.M.).

As this review only included in vitro studies, the criteria were adapted to allow for a critical analysis of the studies. The risk of bias between six domains (description of the sample size calculation, randomization of teeth, presence of a control group, description of restorative methods, description of the fracture resistance test used, and statistical method) was evaluated. The studies were classified into: low risk, moderate risk, and high risk.

A "yes" was assigned where the parameters were found, and a "no" in the absence of them. Articles in which none or two of these parameters were not found were classified as low risk of bias; those with three or four parameters were considered to be at moderate risk of bias; with five or six parameters, high risk of bias.

Figure 1 - PRISMA flow diagram representing the systematic review



RESULTS

Study Selection

Initial screening of databases resulted in 249 studies. Of these articles, 109 were excluded as they were duplicates. From the analysis of the titles and abstracts, 126 studies were exclude and fourteen studies met the inclusion criteria and were selected for full-text reading. Two studies[10,11] were not found for the analysis of the full text and were excluded. Thus, twelve papers were included in this systematic review. Figure 1 presente the flow diagram of the search strategy.

Data Extraction

Table 1 presents the characteristics and main findings of the included studies. Authors of studies with insufficient data were contacted by e-mail, but no additional information was received.

The SEM evaluation of the Regarding the dental group in which the in vitro study was performed, most used maxillary premolars[13,17,19,21] and maxillary third molars[5,6,14,15] followed by maxillary or mandibular premolars[16,18], only mandibular premolars[12] and mandibular first molars[20].

Regarding the type of restorative cavity, practically all studies were carried out in class II – MOD cavities[5,6,12,13,15-21], with except for the study by Bainy et al.[14] which was in a class II – MO cavity.

The fiberglass post was the retainer that predominated in the selected transfixation studies, with a variety of commercial brands: RelyXTM posts[12], Reforpost® posts[5,6,13-16], Whitepost DC® posts[17,18], GranTEC posts[20], and EvenStick NET posts[21]. Only the study by Mesquita et al.[18] used zirconia post instead of fiberglass.

As for the type of resistance test performed, most studies applied vertical compressive load[5,6,13-19]. The studies by Aslan et al.[12], and Scotti et al.[20] applied oblique compressive load (45°) and Scotti et al.[21] oblique compressive load (30°).

Regarding the results found, practically all studies analyzed observed that the use of transfixed post horizontally in a class II restorative cavity significantly increased tooth fracture resistance. Only in the study by Scotti et al.[21] it can be observed that the insertion of glass fibers in direct composite restorations was not able to guarantee a significant increase in fracture strength or a significant change in the fracture pattern.

Risk of bias assessment

Table 2 summarizes the risk of bias of the selected in vitro studies. According to the evaluated parameters, all studies included in this review were qualified with low risk of bias. The parameter that was not found in most studies was the description of the sample size calculation.

Table 1 - Data extracted from the included studies.

Author (s) (Year of publication)	Country of origin of the study	Dental Group	Experimental groups	Type of restorative cavity	Restorative material	Type of post used	Type of resistance test (Applied force)	Main findings
Aslan *et al.* [12]	Turkey	Mandibular premolars	Group 1: intact teeth (positive control); Group 2: unfilled MOD cavity (negative control); Group 3: MOD + composite resin; Group 4: 10-mm-long fiber post + composite resin; Group 5: 5-mm-long fiber post + composite resin; Group 6: Ribbond in the occlusal surface + composite resin; Group 7: horizontal fiber post + composite resin.	MOD cavity	Flowable composite resin (Filtek Flow; 3M ESPE, St. Paul, MN, USA) + resin composite (Filtek Ultimate; 3M ESPE, St. Paul, MN, USA)	Glass fiber posts (RelyX™ Fiber Post, 3M ESPE, Deutschland GmbH, Germany)	Oblique compressive load (45°). 0.5mm/min	Usage of horizontal post or occlusal Ribbond usage increased the fracture resistance of root canal-treated premolars with MOD cavities.
Bahari *et al.* [13]	Iran	Maxillary premolars	Group 1: intact teeth (positive control); Group 2: endodontically treated teeth without restoration (negative control); Group 3: composite resin restoration; Group 4: placement of fibers at occlusal position; Group 5: splinting the buccal and palatal walls with horizontal fiber posts; Group 6: placement of fibers at the occlusal position after splinting the buccal and palatal walls with horizontal fiber posts.	MOD cavity	Valux Plus composite resin (3M Dental Products, St. Paul, MN, USA)	Reforpost® (Angelus, Londrina, PR, Brazil) glass fiber posts	Vertical compressive load. 0.5mm/min	Fiber insertion had no additional reinforcing effect on the fracture strength following composite resin restoration.
Bainy *et al.* [14]	Brazil	Maxillary third molars	Group 1: intact teeth (positive control); Group 2: endodontically treated teeth without restoration (negative control); Group 3: restoration with SonicFill 2® system; Group 4: restoration with braided glass fiber and SonicFill 2® system; Group 5: restoration with transfixed glass fiber post and SonicFill 2® system.	MO cavity	Bulkfill flow resin (3M ESPE, St. Paul, MN, USA)+ Single-Fill TM Bulk fill resin (Kerr Corporation, Orange, CA, USA)	Reforpost® (Angelus, Londrina, PR, Brazil) glass fiber posts	Vertical compressive load. 10kN/0.5mm/min	The glass fiber, regardless of composition, increases the fracture strength of endodontically treated teeth. The use of a glass fiber post attached to the dental crown seems to provide more favorable rehabilitation when the fracture position is determined.
Beltrão *et al.* [5]	Brazil	Maxillary third molars	Group 1: healthy tooth (positive control); Group 2: endodontically treated teeth without restoration (negative control); Group 3: MOD cavity + endo + transfixed post; Group 4: MOD cavity + endo + composite resin; Group 5: MOD cavity + endo + composite resin + transfixed post.	MOD cavity	Flow resin composite (DFL Indústria e Comércio Ltda., Rio de Janeiro, RJ, Brazil) + Resin composite Filtek Z-250 (3M Espe, St. Paul, MN, USA)	Reforpost® (Angelus, Londrina, PR, Brazil) glass fiber posts	Vertical compressive load. 10kN/1mm/min	The fiber glass post transfixed horizontally in a MOD cavity significantly increased the fracture resistance of the teeth restored with resin composite.
Bromberg *et al.* [15]	Brazil	Maxillary third molars	Group 1: healthy tooth (positive control); Group 2: onlay indirect restoration; Group 3: inlay indirect restoration; Group 4: direct composite resin; Group 5: direct composite resin + transfixed post.	MOD cavity	- Lava Ultimate (lot N719292, expiration date April 2020; 3M ESPE) - Resin composite Filtek Z350XT (3M Espe, St. Paul, MN, USA)	Reforpost® (Angelus, Londrina, PR, Brazil) glass fiber posts	Vertical compressive load. 10kN/1mm/min	Endodontically treated molars restored with transfixed fiberglass post plus composite resin had fracture resistance similar to those restored with onlay, which was higher than that for inlay or composite resin only.
Fávero *et al.* [6]	Brazil	Maxillary third molars	Group 1: healthy tooth (positive control); Group 2: endodontically treated teeth + MOD	MOD cavity	Flow resin composite (Ultradent Products, South Jordan, UT, USA.) +	Reforpost® (Angelus, Londrina, PR, Brazil) glass fiber posts	Vertical compressive load. 10kN/1mm/min	The use of two fiberglass posts with resin composite was able to increase the

			cavity + 2 fiber posts 1.5 mm in diameter + resin composite restoration; Group 3: endodontically treated teeth + MOD cavity + 2 fiber posts 1.1 mm in diameter + resin composite restoration; Group 4: resin composite restoration; Group 5: MOD cavity; Group 6: MOD cavity + endodontic treatment.		resin composite Amelogen Plus (Ultradent Products, South Jordan, UT, USA.)			fracture strength of endodontically-treated molars when compared with teeth restored with resin composite only
Ferri *et al.* [16]	Brazil	Double-rooted first premolars	Group 1: intact teeth (positive control); Group 2: endodontically treated teeth without restoration (negative control); Group 3: restoration with composite resin; Group 4: fiber post placed horizontally in the center of the middle third of the crown + restoration with composite resin; Group 5: fiber post placed horizontally 2 mm below the center of the middle third of the crown + restoration with composite resin.	MOD cavity	Bulkfill flow resin (3M ESPE, St. Paul, MN)+ resin composite Z250 resin (3M ESPE, St. Paul, MN)	Reforpost® (Angelus, Londrina, PR, Brazil) glass fiber posts	Vertical compressive load. 10kN/0.5mm/min	The position of a fiber post seems to affect fracture location. The use of fiber posts, regardless of position, increases fracture resistance of endodontically treated teeth.
Karzoun *et al.* [17]	Syria, Saudi Arabia, and Germany	Maxillary premolars	Group 1: intact teeth (positive control); Group 2: endodontically treated teeth without restoration (negative control); Group 3: MOD cavity with resin composite restoration; Group 4: MOD cavity with resin composite restoration and a horizontal fiber post inserted between buccal and palatal walls; Group 5: MOD cavity with a horizontal fiber post only.	MOD cavity	Flowable composite (Opallisflow; Dentscare LTDA, Joinville-SC, Brazil) + Resin composite Filtek Z350XT (3M Espe, St. Paul, MN, USA)	Whitepost DC® (FGM, Joinville, SC, Brazil) glass fiber posts	Vertical compressive load. 1mm/min	Horizontal glass fiber post in a MOD cavity increased significantly the fracture resistance of the endodontically treated upper premolars.
Mesquita *et al.* [18]	Brazil	Premolars with one and two roots	(S = single-rooted; D = double-rooted) Group SS: sound single-rooted; SNR: endodontics (E) + MOD cavity preparation; Group SR: E + MOD + resin restoration (RS); Group SP: E + MOD + RS + horizontal zirconia post (ZP); Group DS: sound double-rooted; DNR: E + MOD; Group DR: E + MOD + RS; Group DP: E + MOD + RS + ZP.	MOD cavity	Bulkfill flow resin (3M ESPE, St. Paul, MN) + resin composite Z250 resin (3M ESPE, St. Paul, MN)	Zirconia posts were manufactured and customized	Vertical compressive load. 10kN/0.5mm/min	Single-rooted premolars were more resistant to fracture than double-rooted premolars. The restorative treatment using a horizontally transfixed zirconia post improved fracture resistance, resembling that of a healthy tooth.
Mergulhão *et al.* [19]	Brazil	Maxillary premolars	Group 1: intact teeth (positive control); Group 2: conventional composite resin; Group 3: conventional composite resin with a horizontal glass fiber post inserted between buccal and palatal walls; Group 4: bulk-	MOD cavity	Flowable composite (Filtek Bulk Fill Flowable Restorative, 3M ESPE) + conventional composite resin Filtek Z350XT (3M ESPE, St. Paul, MN)	Whitepost DC® (FGM, Joinville, SC, Brazil) glass fiber posts	Vertical compressive load. 1mm/min	Endodontically treated maxillary premolars restored with conventional composite resin with or without horizontal fiber post, bulk-fill composite, and ceramic inlay showed fracture resistance similar to that of sound teeth.

			fill flowable and bulk-fill restorative composites; Group 5: ceramic inlay.					
Scotti *et al.* [20]	Italy, and Switzerland	Mandibular first molars	Group 1: intact teeth (positive control); Group 2: endodontically treated teeth without restoration (negative control); Group 3: direct composite restoration; Group 4: fiber-post-supported direct composite restoration; Group 5: direct composite reinforced with horizontal mesio-distal glass-fibers; Group 6: buccal-palatal glass-fibers.	MOD cavity	Flowable composite (GrandioSo Heavy Flow; Voco, Cuxhaven, Germany) + composite resin (GrandioSo; Voco)	Glass fiber posts (GranTEC; Voco)	Oblique compressive load (45°). 0.5mm/min	For the direct restoration of endodontically treated molars, reinforcement of composite resins with glass-fibers or fiber posts can enhance fracture resistance.
Scotti *et al.* [21]	Italy	Maxillary premolars	Group 1: intact teeth (positive control); Group 2: endodontically treated teeth without restoration (negative control); Group 3: direct composite restoration with fiber-reinforced composite (everX Posterior GC); Group 4: direct composite restoration (Filtek Supreme XTE); Group 5: a horizontal layer of high-viscosity flowable composite (G-aenial Flow) was placed on the pulp chambre floor, 10mmx3mm glass fibers were inserted into the cavity; Group 6: same procedure as in group 5 except the direct restoration was made incrementally with FSXTE; Group 7: composite overlays were placed.	MOD cavity	- composite resin (GrandioSo; Voco) - composite resin (GrandioSo; Voco) - composite resin (GrandioSo; Voco) + composite resin composite resin (GrandioSo; Voco)	Glass fiber posts (everStick NET, GC)	Oblique compressive load (30°). 0.5mm/min	For the direct restoration of endodontically treated premolars, the insertion of glass fibers into direct composite restorations was unable to guarantee a significant increase in the fracture resistance or a significant change in the fracture pattern.

DISCUSSION

The longevity and fracture strength of direct restorations in endodontically treated teeth is an important factor in clinical success. Studies show that tissue loss is the main factor affecting the tooth survival rate[22,23]. Previous systematic reviews[24,25] reported that the biomechanical behavior of endodontically-treated teeth, by using a fatigue test, is influenced by the number of surfaces of the teeth involved during these tests. The authors noted that the most importante biomechanical change in endodontically-treated teeth was related to the loss of dental tissue, which suggests that it should be preserved.

With the exception of Bainy et al.[14], most of the included studies simulated class II preparations (MOD). Magne[26] stated that, if both of the proximal marginal ridges were removed, the stress concentration becomes greater. MOD cavity preparation reduces the structural stability by about 63%[27].

Regarding the teeth evaluated, most studies tested premolars[12,13,16-19,21], with only few studies using molars[5,6,14,15,20]. Premolar teeth are more frequently exposed to destructive lateral forces than molar teeth[28]. According to Wu et al.[29], and Bianchi et al.[30], the premolar presentes an unfavourable anatomical configuration whose inclination of the cusps makes them more susceptible to fracture when subjected to occlusal loading, relative to the other posterior teeth.

The use of intraradicular posts, cemented inside the root canal, is proposed to promote retention to the restorative material, and not to increase the tooth fracture resistance per se[4]. According to Saatian et al.[31], all types of intraradicular posts produce some degree of tension within the root dentin, causing some stress force to be transmitted vertically along the root[32], which can cause deeper levels of fractures and complexity[11]. Thus, some studies have tested the capacity of strengthening the tooth structure with the use of posts transfixed in the buccolingual

direction in the crown, during the restorative process.

In order to assess the distribution of occlusal and masticatory loads of teeth, forces are usually applied parallel of obliquely to the tooth axis. Maximum bite force in human beings with normal occlusion is around 222 N to 445 N in premolars[33], and around 424 N to 630 N in molars[34].

In studies with premolars, it can be observed that the use of a post transfixed in the dental crown promoted an increase in resistance. Aslan et al.[12] (365.49 N in horizontal fiber post group; 416.07 N in positive control group; 86.88 N in negative control group), Bahari et al.[13] (1023.33 N in horizontal fiber post group; 1073.63 N in positive control group; 461.83 N in negative control group); Ferri et al.[16] (1253 and 1156 N in horizontal fiber post group; 2451 N in positive control group; 32.63 N in negative control group); Karzoun et al.[17] (961.3 N in horizontal fiber post group; 994.5 N in positive control group; 411.8 N in negative control group); Mergulhão et al.[19] (934.5 N in horizontal fiber post group; 949.6 N in positive control group); Mesquita et al.[18] (1438.8 N in horizontal fiber post group; 1619.3 N in positive control group; 524.9 N in negative control group); Scotti et al.[21] (515.96 and 499.79 N in horizontal fiber post group; 934.91 N in positive control group; 100.80 N in negative control group).

In studies with molars, positive results were also observed with the use of the transfixed post associated with the direct restorative technique. Bainy et al.[14] (2493 N in horizontal fiber post group; 3563 N in positive control group; 1001 N in negative control group); Beltrão et al.[5] (2645.4 N in horizontal fiber post group; 4289.8 N in positive control group; 549.6 N in negative control group); Bromberg et al.[15] (2693 N in horizontal fiber post group; 4514 N in positive control group); Fávero et al.[6] (3100.4 and 2988.5 N in horizontal fiber post group; 3830.4 N in positive control group; 572.93 N in negative control group); Scotti et al.[20] (499.26 and 582.22 N in horizontal fiber post group; 831.83 N in positive control group; 282.86 N in negative control group).

All analyzed studies tested posts transfixed in the dental crown in the buccolingual direction. Only in the study by Scotti et al.[20] also analyzed the transfixation of the post in the mesiodistal direction. According to the data obtained in the article, the fracture resistance did not differ significantly regarding the direction of the transfixed post.

The transfixed post procedure can be performed with either one or two posts. Beltrão et al.[5] obtained a mean resistance of 2,645 N by using a single fiberglass post, whereas Fávero et al.[6], using 2 posts of 1.1- or 1.5-mm diameter, produced 2,988 and 3,100 N, respectively. Despite the similarity, one can observe that using 2 posts produces higher fracture resistance.

Bainy et al.[14] also investigated the use of a fiberglass tape associated to a direct restoration with composite resin, and reported similar results to the transfixed post group. In tis study, the authors used Interlig® tape in all the inner surfaces of the pulp chamber (buccal, lingual, distal and mesial). According to Belli et al.[35], the use of polyethylene ribbon fibers beneath composite resin restorations in endodontically treated teeth can promote an increased fracture resistance compared to composite resin restorations only. Polyethylene ribbon fibers can modify the stresses at the restorative material-dentin interface. In this context, bonding ability of the fiber, associated to the composite resin, might increase the tooth fracture resistance. On the other hand, Bahari et al.[13] used a fiberglass tape under the restored occlusal surface and found no significant difference from the group in which only direct composite resin restoration was performed. The discrepancies between the results of studies might be attributed to the absence of standardized preparation techniques and/or differences in position of fibers.

Bromberg et al.[15], and Mergulhão et al.[19] compared, in the experimental groups, indirect inlay restorations, made in the laboratory and cemented in the tooth, to the situation of direct composite resin restoration with a transfixed post. The authors obtained lower strength data in the direct method.

The restorative procedure must be carefully planned, evaluating the prognosis and risk of coronary fracture. The use of a transfixed post associated with the direct restorative procedure does not present any technical difficulties. It is a technique that has a lower cost than indirect restorations and satisfactory esthetics[6]. According to Kim et al.[36], this is a relatively quick and simple procedure and can be performed by the endodontist or general dentist at a low cost. Furthermore, the use of a transfixed post, as observed in the study of Ferri et al.[16], can also predict and induce the location of a possible future fracture.The horizontal placement of posts in the center of the middle third of the crown is associated with a greater chance of fractures at the cusp level, without involvement of the pulp floor. These fractures have a better prognosis and result in better tooth survival and restoration. In this study, teeth that received other treatments, including the use of horizontally transfixed posts, placed 2 mm below the conter of the middle third of the tooth crown, most fractures were catastrophic, occurring at, or below, the floor of the pulp chamber.

However, in vitro studies with dynamic fatigue process and clinical studies are needed in order to

consolidate and confirm the laboratory findings of this alternative direct restorative technique.

CONCLUSION

Based on the analyzed studies, it is possible to conclude that the use of a transfixed post in the dental crown increases the fracture resistance of weakened and directly restored teeth. However, clinical studies are needed to validate this finding.

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Table 2 - Risk of bias assessment of the in vitro studies.

Study	Description of the sample calculation	Randomization process	Presence of control group	Description of restorative methods	Description of the fracture resistance test used	Statistical method	Risk of bias
Aslan *et al.* [12]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Bahari *et al.* [13]	Yes	Yes	Yes	Yes	Yes	Yes	Low risk
Bainy *et al.* [14]	Yes	Yes	Yes	Yes	Yes	Yes	Low risk
Beltrão *et al.* [5]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Bromberg *et al.* [15]	Yes	Yes	Yes	Yes	Yes	Yes	Low risk
Fávero *et al.* [6]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Ferri *et al.* [16]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Karzoun *et al.* [17]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Mesquita *et al.* [18]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Mergulhão *et al.* [19]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Scotti *et al.* [20]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Scotti *et al.* [21]	No	Yes	Yes	Yes	Yes	Yes	Low risk

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