Biological oriented preparation technique (BOPT) for tooth preparation: A systematic review and *meta*-analysis

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A B S T R A C T

Purpose: This systematic review is aimed to evaluate in fixed prosthodontics treated teeth, the effect of the BOPT on periodontal health compared to the horizontal preparation technique using a chamfer finishing line or to the baseline.
Methods: The electronic databases Cochrane Central Library, PubMed, Scopus, and ScienceDirect were searched based on specific MeSH keywords. The Randomized controlled clinical trials (RCTs) and prospective clinical trials on BOPT printed in English up to July 2022 were selected. Screening, selection, and data extraction were done. The studies were assessed for risk of bias, and descriptive and meta-analyses were performed.
Results: Eight studies were included in the systematic review and only three RCTs were involved in the *meta*-analysis. Two RCTs were assessed as low risk while one has some concerns. were grouped as good, fair, and poor based on NOS. Three of the prospective studies were considered to be of good quality and one study was fair. The *meta*-analysis revealed no statistically significant difference in the effect of BOPT and chamfer preparation on periodontal health status and success rate (P > 0.05).
Conclusions: Considering the limitation of this review, the BOPT is comparable to chamfer preparation and it resulted in an acceptable effect to maintain periodontal health with a high success rate. However, more evidence is required to support these findings.

1. Introduction

Fixed prostheses are intended to restore the function and esthetic of the teeth without impairing the abutment and their supporting periodontal tissues (Bader et al., 1991). Conventionally, the abutment tooth is prepared using a horizontal preparation technique in which a chamfer or shoulder finish line will be created to determine the crown margins at the subgingival, equigingival, or supragingival level. The supragingival finish line has the advantages of being atraumatic to the gingiva, simpler impression making, as well as easy to prepare, evaluate the fit, and maintain the fixed prostheses. Moreover, supragingival finish lines have been associated with the lowest gingival index scores despite their unaesthetic appearance owing to the visible tooth–prosthesis junction. Thus, an incomplete tooth profile alteration of this finish line limits its uses in an esthetic zone (Abduo and Lyons, 2017).

Currently, the equigingival margins are not encouraged as they can accumulate more plaque compared to supragingival and/or subgingival margins and consequently trigger gingivitis. Additionally, any minor recession of the gingiva will create unaesthetic margin display (Shenoy et al., 2012). Subgingival restorations enhance the aesthetic appearance

though they have been associated with periodontal-related diseases such as apical migration of the marginal gingival (Pelaez et al., 2012; Paniz et al., 2016).

Vertical preparation or feather edge finishing line was pioneered in 1999 by Carnevale et al, during periodontal surgery. They demonstrated no statistically significant differences in periodontal health status between restored and natural control teeth. This finding emphasized the importance of precise restoration margins rather than their position (Carnevale et al., 1990). In 2013, the employment of a modified vertical preparation, also known as a biologically oriented preparation technique (BOPT), was proposed to have a potential benefit on soft tissue stability in both the short and long term (Loi and Di Felice, 2013).

BOPT is a procedure of eliminating the crown's anatomical appearance at the cementoenamel junction (CEJ) and creating a new junction with the fixed prosthesis during prosthesis placement (Agustín-Panadero et al., 2016; Loi and Di Felice, 2013). The key element of BOPT relies on the fabrication of the interim prosthesis since it determines the new supporting emergence of the marginal gingiva. This will direct the healing and thickening of the gingiva that will be imitated when the final prosthesis is employed (Agustín-Panadero et al., 2018). The

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advantages of BOPT are to provide better gingival stability in the long-term, improve prosthesis' emergence profile, facilitate maintenance of oral hygiene, and create a natural appearance (Agustín-Panadero et al., 2017).

To our acquaintance, there has been no systematic review to assess the obtainable evidence from the published clinical trials on the efficiency of BOPT and its influence on the periodontal tissues' health. Furthermore, considering the evidence level, the rationale and suggestions for upcoming research shall be more effectively planned. Therefore, this study aimed to systematically review and qualitatively and quantitatively assess the current literature and to also identify the suitability of BOPT to be established as a routine preparation technique comparable or alternative to conventional horizontal preparation techniques in clinical practice outlined under the aforementioned settings.

2. Methods

2.1. Protocol registration

The current review protocol was developed, and registered in PROSPERO (CRD42022319545) and it followed the Reporting for the review in consistent with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA) (Page et al., 2020). It is available from: (https://www.crd.york.ac.uk/prospero/displayrecord.phpID=CRD42022319545). The methodology quality of the current review was assessed using AMSTAR 2 tool (Shea et al., 2017) (supplementary file).

2.2. Search strategy

An electronic search was accomplished on March 2022, and updated in July 2022, within the relevant published literature restricted to the English language by two examiners (AA& KS) separately. The used databases were MEDLINE via PubMed (National Library of Medicine), Scopus, ScienceDirect, and Cochrane Central Library (clinicaltrials.gov, US National Library of Medicine). The grey literature and the references of full-text articles were hand-searched in order to attain any further studies eligible for inclusion. The Boolean operators 'AND' and 'OR' were employed to combine the keywords and generate the search strategy. Table 1 presents the full search strategy and keywords.

2.3. Eligibility criteria and study selection

Randomized controlled trials (RCTs) and prospective clinical trials were included in this review. Participation: tooth-supported fixed prosthesis, Intervention: BOPT or vertical preparation for abutment, Comparison: horizontal preparation technique or baseline (non-preparation) and Outcome: periodontal tissue health status (PDI) including; bleeding index, plaque index, gingival thickness and recession, bone

Table 1
Search strategy and MeSH/keywords used.

Cochrane Central Library	biological oriented preparation technique in Title Abstract Keyword OR vertical preparation technique in Title Abstract Keyword OR feather edge finishing line in Title Abstract Keyword AND fixed prosthesis
Pubmed	(((((((biological oriented) OR (vertical)) OR (feather edge)) OR (finishing line)) AND (preparation technique))) AND (fixed prosthesis))
Scopus	(((((((biological oriented) OR (vertical)) OR (feather edge)) OR (finishing line)) AND (preparation technique))) AND (fixed prosthesis))
ScienceDirect	"biological oriented preparation technique" OR" vertical preparation technique" OR "feather edge finishing line"

level, failure, and success or survival rates.

The studies excluded were case reports, case series, studies without a control group, studies of previously prepared teeth, and studies without periodontal health outcomes. Titles, abstracts, and full-text assessments were performed by two independent reviewers (AY, AN). Disagreement between reviewers was settled by discussion and agreement. Data were extracted in consistent tables by both reviewers. A kappa score of > 0.85 was found between them on the numerous domains.

2.4. Data extraction

Data were extracted according to the Cochrane Handbook for Systematic Reviews of Interventions guidelines (Higgins et al., 2022) which contains study characteristics with intervention and comparator, and periodontal health clinical outcome measures.

2.5. Quality assessment and risk of bias

The quality assessment was evaluated using the revised Cochrane Risk of Bias Tool for Clinical Randomized Trials (RoB 2.0). The domains assessed were randomization process, deviations from the intended interventions, missing outcome data, measurement of the reported result, and overall bias. The selected studies were classified into a low risk of bias, some concerns, and a high risk of bias (Higgins et al, 2016). The prospective clinical trials were assessed using the Newcastle-Ottawa Quality Assessment Scale for cohort studies (NOS) (Wells et al., 2011). Review Manager (RevMan, Version 5.4., Cochrane Collaboration, 2020) was utilized for data analysis. Proportion (%) for the plaque index, gingival index, gingival recession, survival, and success rate were performed to analyze the outcome of interventions with a direct comparison. The association between periodontal health status and preparation type (BOPT and Horizontal preparation with chamfer finishing line) was assessed using the risk ratio (RR) with a confidence interval (CI) of 95%. Heterogeneity was assessed using I^2 statistic. A random-effect model was implemented for significant heterogeneity ($I^2 \geq 50\%$) and a fixed-effect model for low/moderate heterogeneity.
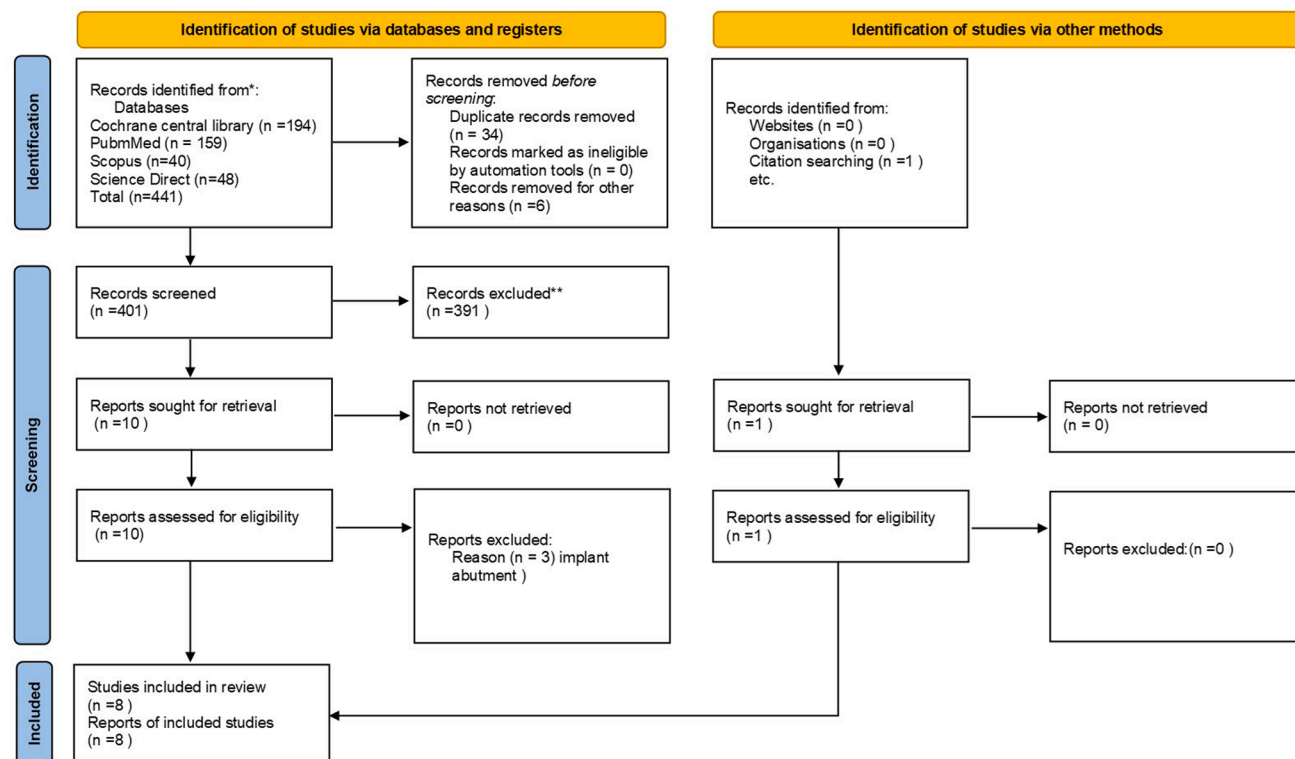
3. Result

3.1. Study selection

The flow chart of the selection, inclusion, and exclusion of studies in accordance with PRISMA is presented in Fig. 1. The search provided 442 hits; 402 hits out of duplication were screened; 11 studies were relevant and attained in full text. Full article screening excluded three references (Agustín-Panadero et al., 2019a, 2019b; Canullo et al., 2020) due to the implant abutment used. Eventually, the remaining eight studies (Amesti-Garaizabal et al., 2020; Agustín-Panadero et al., 2018, 2021; Cagidiaco et al., 2019; Paniz et al., 2016; Scutellà et al., 2017; Serra-Pastor et al., 2019, 2023) were included in this systematic review.

3.2. Characteristics of included studies

Table 2 presents the characteristics of the included studies. Briefly, all trials included patients who required fixed prostheses with natural teeth as abutments. A total of 328 patients with ages ranging from 18 to 65 years were involved. 857 teeth were treated with 557 crowns and 129 fixed dental prostheses. Among the 8 trials, only 3 studies (Agustín-Panadero et al., 2021; Cagidiaco et al., 2019; Paniz et al., 2016) were randomized control trials with BOPT as the intervention group and chamfer preparation as the control group. Four studies included previously treated restoration where the former prostheses were removed, and the existing chamfer margins were refined into vertical preparation or biological-oriented preparation.

Only three studies (Agustín-Panadero et al., 2021; Cagidiaco et al., 2019; Scutellà et al., 2017) investigated on posterior zone whereas the

Fig. 1. Literature search according to PRISMA flow diagram on selection, inclusion, and exclusion of studies at each of screening stage.

remaining studies (Amesti-Garaizabal et al., 2020; Agustín-Panadero et al., 2018; Paniz et al., 2016; Serra-Pastor et al., 2019, 2023) involved mostly anterior or aesthetic regions. The provisional phase ranges from 8 to 12 weeks which corresponds to the recommended BOPT protocol (Loi and Di Felice, 2013) except for one study whose interim period was shortened to 2–3 weeks (Cagidiaco et al., 2019; Scutellà et al., 2017). The final prostheses follow-up period was between 6 months to 6 years. Unexpectedly, one study investigated up to interim phases, and no permanent crowns were delivered (Cagidiaco et al., 2019). The final restoration was porcelain layered zirconia crowns in the majority of the studies, except for one that cemented monolithic zirconia crowns (Paniz et al., 2016). Surprisingly, one of the studies provide metal-ceramic restoration on BOPT margins but further clarification on the selection of this material was not elaborated (Scutellà et al., 2017).

3.3. Quality assessment and risk of bias

Fig. 2 illustrates the risk of bias in all included studies. Two RCTs were assessed as low risk (Agustín-Panadero et al., 2021; Paniz et al., 2016) while one has some concerns (Cagidiaco et al., 2019). The prospective studies were grouped as good, fair, and poor based on NOS. Three studies were considered to be of good quality (Agustín-Panadero et al., 2018; Serra-Pastor et al., 2019, 2023) and one study was fair quality (Amesti-Garaizabal et al., 2020).

3.4. Effect of BOPT on periodontal tissues health status and clinical outcomes

3.4.1. Plaque index

The plaque index was reported during the follow-up period in five studies (Paniz et al., 2016; Scutellà et al., 2017; Serra-Pastor et al., 2019, 2023) as shown in Table 3. Paniz et al, (2016) found that at after 12

months, 14.4 % of the restorations with a chamfer finish line showed an increase in plaque index from 0 to 1, while 3.8 % showed an increase from 0 to 2. On the other hand, 17.4 % of the restorations with BOPT showed an increase in plaque index from 0 to 1, and none of the restorations presented a plaque index of 2. Nevertheless, no statistically significant difference was noticed amongst the two finish lines. Likewise, Agustín-Panadero et al, study showed that 40% of participants with a chamfer finish line have a plaque index of 1 at one year, 68.4% at 3 years & 5 years, while 21% of participants with the BOPT technique had a plaque index of 1 at 1 and 3 years, 30% at 5 years (Agustín-Panadero et al., 2021).

Meanwhile, another study found 11% of the treated teeth were reported to have a plaque index (Scutellà et al., 2017). Whereas Serra-Pastor et al, concluded that 38.9% of the teeth that had refined BOPT margins, presented plaque in the first and second year follow-up that rise up to 21.45% and 20.1% in the third and fourth year respectively (Serra-Pastor et al., 2019). 58% of the participants obtained score 0 for Plaque index in the first two years; increased to 82.6% in the 3rd year and subsequently reduced to 57.1% in 6th year of follow up (Serra-Pastor et al., 2023).

3.4.2. Gingival index and bleeding on probing (BOP)

Three of the reviewed articles investigated the gingival index, where Paniz et al, (2016) found a significant difference between the baseline and 12-month follow-up. However, no statistically significant difference was demonstrated between chamfer and BOPT finishing lines. Serra-Pastor et al, measured the gingival index and found out that 89.3% presented 0 index at 1 year, 77.3% at 2 years, 82.2% at 3 years, 89% at 4 years, 81.9% at 5 and 6 years (Serra-Pastor et al., 2023). Agustín-Panadero et al, showed 40% of the participants who received restorations with chamfer finish line have GI 1 at 1 year, 68.4% at 3 and 5 years, while 21% of participants with BOPT have GI 1 at 1 and 3 years, 30% at

Table 2
Characteristics of the included studies.

Study ID	Year	Type of study	No of patients	Age	Tooth/zone involved	No of Teeth	Types of Prostheses	Control	Interim period	follow-up
Paniz et al.	2016	Prospective RCT double blind	58	30–64 (50.3)	Anterior maxilla, SubGingival margin	106 chamfer vs 94 feather but 4 failed so total 196	Single, full coverage monolithic zirconia	Chamfer	12 weeks	12 months
Scutellà et al.	2017	Prospective clinical trial	21	>18	All teeth except 3rd molars	137	50% metal ceramic, 27% zirconia, 23% lithium disilicate	None	15 days	18.2 Months
Agustín-Panadero et al.	2018	Prospective cross sectional single arm	52	18–65	Teeth for redo crowns and bridges (incisors, canines and premolars)	149 (74 teeth supporting crown, 75 teeth supporting FPDs)	Layered zirconia single crowns and FPDs	None	8–12 weeks	2 years
Cagidiaco et al.	2019	RCT	50	45.7	Posterior, 30 Molars, 20 Premolars, all with natural opposing dentition, SubGingival margin	25 chamfer vs 25 feather	Single, full coverage layered zirconia	Chamfer	3 weeks	4 years
Serra-Pastor et al.	2019	Prospective Cross sectional single arm	52	18–65	Teeth for redo crowns and bridges (incisors, canines, premolars and first molar)	149 - (drop out) = 144 total (71 teeth supporting crown, 73 teeth supporting FPDs)	74 crowns, 27 FPDs, layered zirconia	None	8–12 weeks	Annually for 4 years (T1- T4)
Amesti-Garaizabal et al.	2020	Prospective Cross sectional single arm	31	>18	Maxillary anterior tooth for redo crowns	31 converting chamfer to BOPT	Only up to interim phase	None	8–12 weeks, 30° first 2 weeks then 60°	No follow up
Serra-Pastor et al.	2023	Prospective clinical trial	24	18–65	Maxillary teeth for redo bridges (incisors, canines, premolars)	75 - (drop out) = 70 total	25 FPDs, layered zirconia	None	8–12 weeks	6 months, Annually for 6 years (T1- T6)
Agustín-Panadero et al.	2021	Prospective RCT	40	>18	Posterior (Chamfer 18 Molars, 20 Premolars, 2 canines), (BOPT 20 Molars, 20 Premolars)	40 chamfer vs 40 BOPT	40 3-unit FPDs, layered zirconia	Chamfer	8 weeks	1, 3, and 5 years after treatment

5 years (Agustín-Panadero et al., 2021).

Regarding Bleeding on probing (BOP), 4 of the articles studied BOP, two of them recorded 36.5% and 55.5 % with a chamfer finish line and 52.2 % and 48% with a feather edge finish line (Cagidiaco et al., 2019; Paniz et al., 2016). In addition, Serra-Pastor et al, found 3% at 1 year, 19.5% at 2 years, 13.3% at 3 years, and 12% 4 years (Serra-Pastor et al., 2019). Agustín-Panadero et al, reported 19.5% of treated abutments experienced bleeding on probing after 2 years of treatment (Agustín-Panadero et al., 2018). Only one study reported no significant difference in the BOP (Scutellà et al., 2017) (Table 3).

3.4.3. Gingival recession

Seven studies evaluated gingival recession (Agustín-Panadero et al., 2018, Paniz et al., 2016; Scutellà et al., 2017; Serra-Pastor et al., 2019), one of these studies reported 11.5% of gingival recession associated with chamfer finish line at 12 months of follow up while 3.3 % of the restoration with feather edge finish line presented with recession (Paniz et al., 2016). On the other hand, no recession was recorded in relation to BOPT in three of the studies (Agustín-Panadero et al., 2018; Serra-Pastor et al., 2019, 2023). One study found 31.6% to 57.9% of gingival recession associated with chamfer finish lines (0.5 to 2 mm) while BOPT recorded 0% gingival recession (Agustín-Panadero et al., 2021). Another prospective study showed significant differences in the buccal gingival recession with an apical displacement of 0.262 ± 0.246 mm, and the lingual gingival of 0.39 ± 0.279 mm apical displacement (Amesti-Garaizabal et al., 2020). On the contrary, no significant differences in recession were recorded in relation to BOPT in four of the studies (Agustín-Panadero et al., 2018; Scutellà et al., 2017; Serra-Pastor et al., 2019, 2023) (Table 3).

3.4.4. Survival and success rates of the prostheses

Three of the studies showed a 100% survival rate with BOPT (Agustín-Panadero et al., 2018, 2021; Serra-Pastor et al., 2023) whereas another one gave 96% survival rate (Serra-Pastor et al., 2019). Similarly, high survival rate of 95% was reported with chamfer margins when compared with 100% of BOPT (Agustín-Panadero et al., 2021). On the contrary, 100% of the restorations with chamfer margin survived as compared with feather edge margin (96%) (Cagidiaco et al., 2019). Only three of the selected articles documented success rates (Cagidiaco et al., 2019; Serra-Pastor et al., 2019, 2023) with 96% of the prostheses remained successful throughout the follow up period (Serra-Pastor et al., 2019, 2023). Cagidiaco et al, reported a less success rate of restoration with BOPT of 80% compared to 76% of chamfer finishing line (Cagidiaco et al., 2019) (Table 3).

3.5. Meta-analysis

The data of three RCTs (Agustín-Panadero et al., 2021; Cagidiaco et al., 2019; Paniz et al., 2016) compared between BOPT and horizontal preparation technique using chamfer finishing line demonstrated there was no significant differences between in plaque index, gingival index, gingival recession, survival and success rate ($P > 0.05$) (Fig. 3).

4. Discussion

Apical displacement of the marginal gingiva is the common complication of a fixed dental prosthesis which is mainly associated with compromised marginal fit and iatrogenic damage caused during tooth preparation (Serra-Pastor et al., 2019; Subasi et al., 2012; Paniz et al., 2017). The horizontal and vertical preparation techniques are used for fixed prosthesis and the difference between the two preparations is the type of finishing line and its position as the finishing line is placed by the dentist and well-defined on the abutment for the horizontal technique whereas the vertical prepared finishing line is placed by the laboratory technician based on the information of gingival tissue (Loi and Di Felice, 2013).
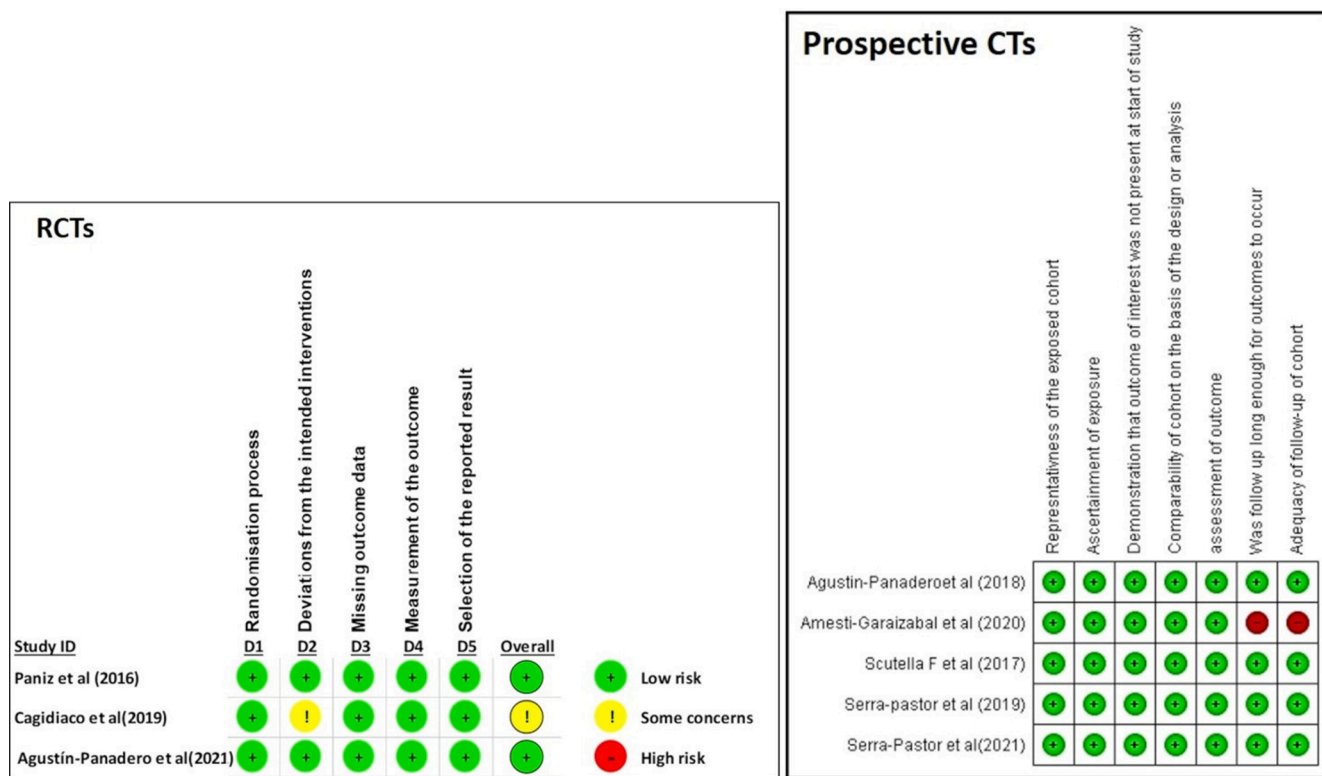
Fig. 2. A. Quality assessment results of RCTs studies according to the revised Cochrane Risk of Bias Tool for Randomized Trials (RoB 2.0) and **B.** Prospective clinical trials according to Newcastle-Ottawa Quality Assessment Scale for cohort studies.

Vertical preparation includes feather-edge margin which has no definite visible finishing line of reference and knife-edge margin which have a definite junction between prepared and unprepared tooth structure. The ideology of the sliding edge in vertical tooth preparation comprises two parallel opposing vertical surfaces which maintain contact alongside the complete length of the crown-tooth interface (Loi and Di Felice, 2013).

The procedure for the interim prosthesis fabrication is very crucial since it establishes the new emergence profile and positions it at different levels within the gingival sulcus. This helps the adjacent soft tissue to accommodate its shape and location to the new prosthetic silhouette, thus aiding in healing and the thickening of the gingival tissue (Agustín-Panadero et al., 2016, 2018). This has been reported to improve the prognosis of the prosthesis by reducing bacterial infiltration and enhancing periodontal health (Salido et al., 2012; Scutellà et al., 2017). This preparation design is also designated for teeth with gingival recession, where the finish line could be in proximity to the CEJ, conserving the tooth structure (Poggio et al., 2012; Scutellà et al., 2017). Serra-Pastor et al, (2023) also recommended BOPT for the retreatment of tooth-supporting FPDs in the aesthetic region, particularly whenever periodontal complications in the neighboring tissues are presented.

The majority of reviews and *meta*-analyses of available literature have appraised the influence of fixed prostheses on the status of gingival and periodontal health focusing on the type of the prosthesis, location of the finishing line, and restoration materials (Müller, 1986; Reitemeier et al., 2002; Valderhaug and Birkeland, 1976; Valderhaug et al., 1993; Weishaupt et al., 2007). One *meta*-analysis study focused on the effect of horizontal preparation on periodontal health compared to the natural untreated teeth (León-Martínez et al., 2020). The influence of different finish line preparation designs in the fixed prosthesis is varied in literature and defining a specific conclusion was not feasible.

A new approach known as the biological orientation preparation technique (BOPT), which is similar to feather edge vertical preparation but the CEJ has erased anatomically and minimal gingival curettage is

performed to re-establish a new emergence profile following the laboratory-formed finishing line (Łabno and Drobnik, 2020). The feather-edge has been interchangeably used as BOPT in some studies (Cagidiaco et al., 2019; Casula, 2021; Loi and Di Felice, 2013; Paniz et al., 2016). This finishing line involves only axial reduction and it is recommended when the preparation is to be extended to the root surface (Abduo and Lyons, 2017). However, BOPT has no finishing line and the 'rotary gingival curettage' or gingittage is considered the main difference between BOPT and feather-edge, and BOPT was deliberated as an edge-less technique rather than shoulder-less (Łabno and Drobnik, 2020).

From this review, three RCTs (Agustín-Panadero et al., 2021; Cagidiaco et al., 2019; Paniz et al., 2016) compared BOPT with horizontal preparation using a chamfer finishing line; two of them (Agustín-Panadero et al., 2021; Paniz et al., 2016) found no significant differences in plaque index. However, the findings were contradictory on a gingival index where Paniz et al, (2016) observed no significant differences whereas Agustin-Panadero et al (2021) reported statistically significant differences favoring BOPT margins. BOP as well as gingival recession were found to be significantly different between the two types of margins but Paniz et al, (2016) claimed BOPT to have higher BOP whereas Cagidiaco et al., (2019) findings preferred BOPT. However, the *meta*-analysis of this review results demonstrated no significant differences in the effect of both techniques on periodontal health status including; plaque index, gingival index, gingival recession, survival, and success rates.

Fixed restorations on prepared teeth using horizontal finish line have been stated to be associated with a higher plaque index than those prepared with vertical finishing line (Paniz et al., 2016, 2017). However, the plaque index is associated with the oral hygiene of the patient and is not necessarily to be influenced by the type of tooth preparation or restoration type (Serra-Pastor et al., 2023).

Prosthesis survival was expressed as the lasting of the fixed prosthesis in situ with or without modification for the observation interval

Table 3

Clinical outcomes and effect of preparation techniques on periodontal tissues.

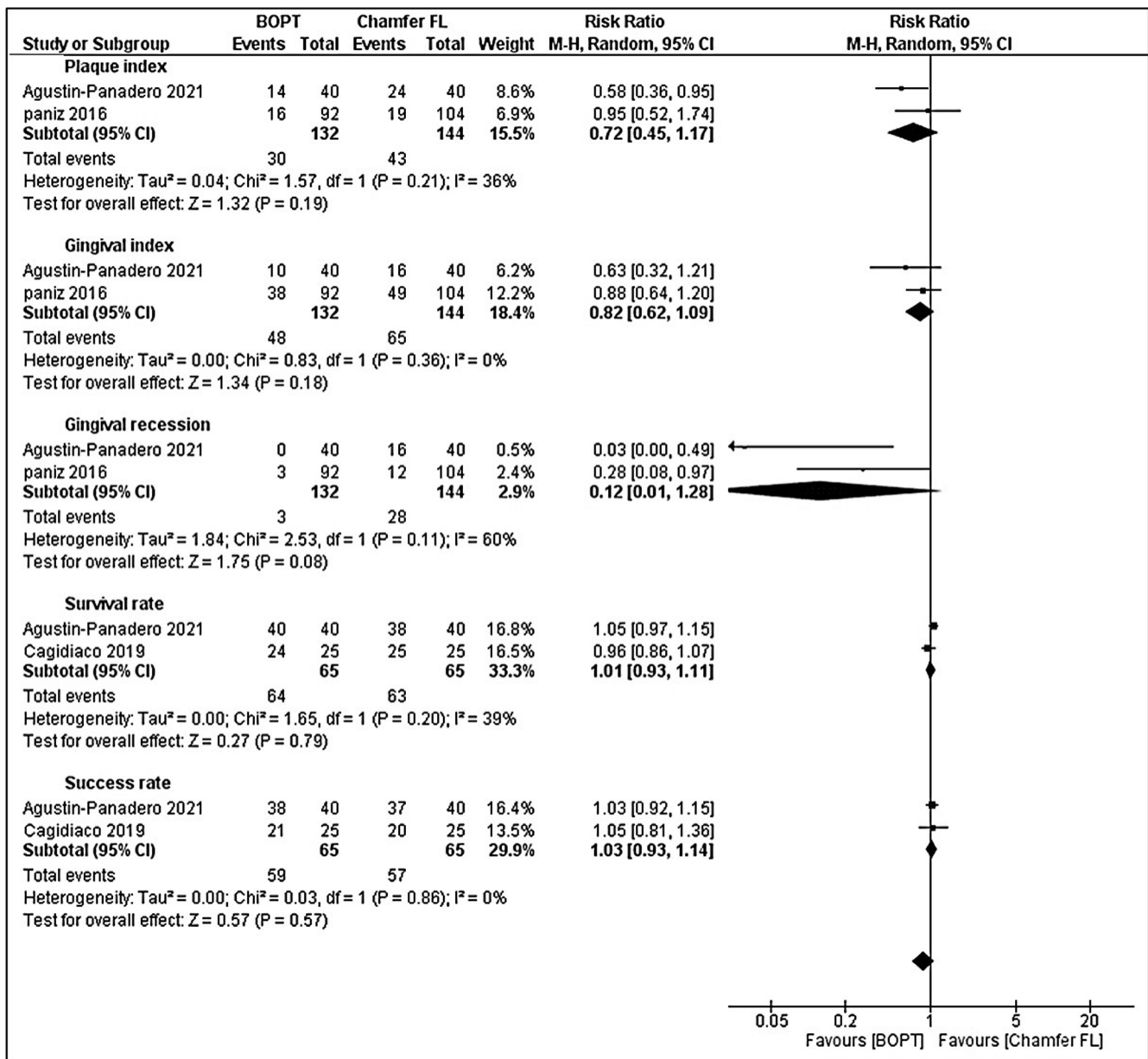| Study ID	Plaque Index	Gingival index	BOP	Gingival recession	Failure/lost	Survival/Success rate
Paniz et al.	Chamfer: 14.4% had score1& 3.8% had score 2, BOPT: 17.4% had score 1 and no score 2.	Chamfer: 33.7% had score 1, 11.5% had score 2& 1.9% has score 3. BOPT: 31.5% had score 1& 9.8% had score 2.	Chamfer: 36.5%, BOPT: 52.2%	11.5% chamfer, 3.3% feather	2 fracture root, 2 fracture restoration regardless the technique.	Not stated
Scutellà et al.	11%, no sig diff (p = 0.09) in terms of perio biotype	Not mentioned	18%,	5.1%	2 prosthetic complication (loss of retention and caries)	Not stated
Cagidiaco et al.	Not stated	Not stated	Chamfer: 55.5% BOPT: 48.0%	Not stated	Chamfer: 5 crowns chipped BOPT: 4 crowns chipped and 1had irreparable fractures and to be replaced,	Chamfer: 76% success & 100 survival. BOPT: 80% success& 96% survival.
Amesti-Garaizabal et al.	Not stated	Not stated	Not stated	Buccal had apical displacement of 0.262 mm, lingual had an apical displacement of 0.39 mm	Not stated	Not stated
Agustín-Panadero et al.	Not stated	Not stated	19.5% at 2 years	Gingival margin stability with 0% recession.	2% biological complication i.e. pulpitis, vertical fracture at 2 years	100% survive
Serra-Pastor et al.	38.9% of the teeth in year 1&2, 21.45% in year3 & 20.1% in year4	Not stated	6.3% in year1, 19.5% in year2, 13.3% in year 3, 12% in year 4.	Gingival margin stability. 0% recession in year1 & 2, 1.4% in year3 and year 4	2% biological complication at year2 i.e. pulpitis, vertical fracture, 1.5% mechanical complication i.e. fracture at year 3	96.6% success
Serra-Pastor et al.	58% obtained 0 score in the first two years; 82.6% in year 3, 78.3% in year 4, 61.9% in year 5$ 57.1% in year 6	89.3% presented 0 index in year1, 77.3% in year2, 82.2% in year3, 89% in year4, 81.9% in year5 &6.	Not stated	No recession was recorded. P = 1.00 no sig tendency toward recession	3 complication (1 Pulpitis in T1, 2 Prosthetic fracture in T2), No stat sig diff for biological failures (p = 0.317), mechanical (p = 0.155)	100% Survive & 96% Success
Agustín-Panadero et al.	60% of participants with chamfer have PI 1 1 year, 57.9% in 3 years & 5 years 15% of participants with BOPT have PI 1 in T1, 15% in T3, 35% in T5. No one with chamfer has PI 2 but 20% BOPT have PI 2 in T1, 10% in T2. (no stat sig diff btw groups p = 0.102)	40% of participants with chamfer have GI 1 in year1, 68.4% in year 3 & 5, BOPT: 21% have GI 1 in year1 & 3, 30% in year 5.	Not stated	Chamfer: 55% chamfer have 0.5–1 mm recession in year1, 57.9% in year3 & 5, 31.6% have 1–2 mm recession in year 3 & year 5, 0% BOPT: 0% at 1–5 years	Chamfer: 15% chipping of ceramic veneer & 2.5% vertical root fracture. BOPT: 10% chipping of ceramic veneer & 2.5% irreversible pulpitis	Chamfer: 95% survive and 92.5% success BOPT: 100% survive & 95% success

Fig. 3. A forest plot of the plaque index, gingival index, gingival recession, survival and success rate of BOPT and horizontal preparation using chamfer finishing line at 12 months.

whereas success outcomes referred to the remaining of the prosthesis with no modification over a follow-up (Sailer et al., 2015). In this review, high survival rates for both techniques were reported to be within 96 to 100% in all included studies which are comparable to another systematic review on survival rates of all-ceramic restorations (Sailer et al., 2015).

Interim fabrication plays an essential role in the BOPT restoration's success. The provisional crowns and bridges enable the surrounding gingival to form and hence, are oriented biologically toward the newly prepared margin. Thus, the interim period is also a point to be considered when preparing such finishing lines. All the included studies reported a minimum of 8 weeks except for two studies that had a period of 2–3 weeks only (Cagidiaco et al., 2019; Scutellà et al., 2017). A minimum of 4 weeks is required for stabilization of the gingival tissue and since BOPT is determined by the final gingival contouring, it is advisable to keep the provisional prostheses for at least 4 weeks (Loi and Di Felice, 2013).

The most critical principle of the BOPT technique is the adaptability of the gingival tissue to a prosthetic model. The healing of tissues after vertical preparation is similar to the mechanisms of physiological wound healing by which new blood vessels, fibroblasts, and myofibroblasts stimulated the granulation tissue to grow and fill up the space created through the ginigittage (Rodríguez et al., 2017). Therefore, a suitable design for cervical emergence of the crown has an essential part of employing this procedure besides the use of a shoulder-less convergent finish line (Cabanes-Gumbau et al., 2019).

In this review, only RCTs were involved in the *meta*-analysis because these studies have a similarity in design and this can reduce the bias in the summary effect and derive a more precise estimate of this effect. While prospective clinical trials included were different in the design, populations, interventions, and outcomes measured. It was reported that observational studies are not the most suitable to evaluate the association between an intervention and an outcome as several characteristics might vary or change over time between the various intervention groups (Metelli and Chaimani, 2020). Thus the results of prospective studies were reported descriptively as suggested (Deeks, 2002).

The limitation of the study was including only the literature published in English due to a lack of translation expertise from different languages which may have caused the missing of some data available in different languages. It is reported that the BOPT technique is simpler and quicker during preparation, impression taking, and creating the crowns' profiles (Srimaneepong et al., 2022), However, BOPT is a sensitive technique and it should not be recommended for daily practice (Drafta et al., 2022). The evidence from the current analysis showed no significant differences between vertical and horizontal finishing lines on the periodontal health status and hence, supports the usage of BOPT among dental practitioners, particularly where aesthetics is a demand, Nevertheless, BOPT should be applied with precaution on performing gingival curettage using the appropriate recommended burs.

More RCTs that assess the periodontal health parameters within similar case selection criteria and large sample size as well as long-term follow-ups comparing BOPT to horizontal preparation technique are required. This could raise the level of evidence to promote BOPT as a daily practice or keep it as a niche technique.

5. Conclusion

Considering the limitation of this review, the BOPT is comparable to chamfer preparation and it resulted in an acceptable effect to maintain periodontal health with a high success rate. However, more evidence is required to support these findings.

Ethical statement

This study does not involve any human or animal specimens and subsequently is not required an ethical clearnce.

CRediT authorship contribution statement

Afaf Al-Haddad: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Noor Addeen Abo Arsheed:** Investigation, Methodology, Writing – original draft. **Ang Yee:** Investigation, Methodology, Writing – original draft, Writing – review & editing. **Shivani Kohli:** Formal analysis, Investigation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sdentj.2023.10.004.

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