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Platelet Rich Fibrin (PRF), Future of Pulp Preservation: An Umbrella Review

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KEYWORDS

vital pulp therapy, direct pulp capping, platelet rich fibrin, regeneration

ABSTRACT:

Introduction: Vital pulp therapy is to preserve and maintain pulp tissue that has been damaged but not completely destroyed by trauma, dental caries, or other iatrogenic causes. PRF is a second-generation platelet concentrate and an autologous healing biomaterial.

Population: - Databases were evaluated with adult patients with pulp exposure having either mature or immature roots, reversible pulpitis.

Intervention: - Data extraction and analysis of research papers based on Platelet Rich Fibrin (PRF).

Comparison: - MTA, Biodentine, calcium-based silicates, calcium hydroxide, glass ionomer, resin modified glass ionomer, blood clot, plasma rich platelet (PRP), Artificial scaffolds and other pulp capping agents.

Outcome: - PRF has regenerative properties, stimulate proliferation and differentiation of dental pulp cells, conducive to healing, dentin bridge formation.

Objective: The aim of the study was to study the effectiveness of platelet rich fibrin as direct pulp capping agent in young permanent teeth.

Methods: Electronic databases such as Scopus, Ebsco and PubMed were searched. In the search systematic review and meta- analysis, clinical studies and randomized clinical trials were included.

Results: Platelet Rich Fibrin (PRF) can be used as a direct pulp capping agent.

Conclusions: Platelet Rich Fibrin (PRF) can be a suitable biological and economical choice for pulp capping agent owing to its regenerative properties. It could be promising alternative for direct pulp capping procedures.

1. Introduction

The goal of vital pulp therapy is to preserve and maintain pulp tissue that has been damaged but not completely destroyed by trauma, dental caries, or other iatrogenic causes[1]. It further includes two main approaches i.e. indirect pulp capping (IPC) and direct pulp capping (DPC)[1].

In IPC, protective dressing is placed over thin layer of remaining sound dentin[1]. In DPC, a dressing is applied to the pulpal exposure site, preventing additional harm and promoting healing and repair[1].

Compared to conventional root canal treatment (RCT), vital pulp therapy has a number of benefits. Maintaining the tooth's vitality promotes continuation of root development, enhances the strength of affected tooth and protective resistance against masticatory forces[1].

DPC is the upcoming trendiest approach with the current mindset of maintaining the vitality of the tooth. So, this mainly includes two approaches i.e. conventional approach and the other is the biological approach[2]. Conventional approach is basically usage of various pulp capping agents while biological approach includes the

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use of platelet concentrates such as platelet rich fibrin (PRF).

Synthetic pulp capping agents such as calcium hydroxide, resin modified glass ionomer cements, mineral trioxide aggregate are used. Calcium hydroxide has various disadvantages like unable to eradicate enterococcus faecalis in the dentin. It has the inability to provide microleakage seal due to the tunnel defects seen in recently formed tertiary dentin[1]. Resin modified glass ionomer cements (RMGIC) showed poor outcomes when came in direct interaction with the pulp during capping procedures as well as absence of dentin bridge formation[1]. Although mineral trioxide aggregate (MTA) has better success rate than calcium hydroxide but clinically MTA has its own drawbacks too such as longer setting time which further leads to discoloration or staining of teeth and handling problems[1,3,16].

Nonetheless, there is growing optimism towards the biological approach for treating pulp exposures. It includes the use of platelet rich plasma (PRP) and platelet rich fibrin (PRF). It comes under the regeneration endodontics.

Whitman et al. were the first to employ PRP in oral surgery in 1997[14]. He reported significant advantages because it stimulates osteoprogenitor cells in the host bone and bone graft. However, it presented risk because of bovine thrombin, which was used to handle PRP. It may produce antibodies against thrombin, factors V, and XI, which could result in coagulopathies that could be fatal[4].

In 2001, Dr. Joseph Choukroun and Dr. David Dohan's original study led to the invention of a platelet concentrate where blood was collected without anticoagulant. It was rapidly spun at 750 g for 12 min in a centrifuge. While the platelets and WBC became trapped in the fibrin clot as they descended, the RBC settled down. PRF, or platelet-rich fibrin, was the name given to this formulation. It was first used in specific oral and maxillofacial surgical procedures and has several advantages over PRP[5].

Although both PRP and PRF are prepared by centrifugating patient's blood, however, PRP requires addition of anticoagulant while PFR does not. PRP separates platelets from the blood plasma while PRF isolates a fibrin clot containing platelets, growth factors and other cells potentially enhancing tissue regeneration. Also, there is sustained release of growth factors in case of PRF which leads to longer period of regeneration. PRF is highly biocompatible[7].

PRF is actually a second-generation platelet concentrate and autologous healing biomaterial. It serves as a reservoir of leukocytes, platelets and various growth factors that promote cell proliferation and differentiation of human dental pulp cells and stimulate reparative dentinogenesis. PRF has found to increase osteoprotegrin and alkaline phosphatase (ALP) expression[6]. These are essential for biomineralization and considered to promote differentiation of cells of odontoblasts.

2. Objective

Studying PRF's effectiveness as a direct pulp capping agent in young permanent teeth was the goal of this systematic evaluation.

3. Methods

Electronic databases such as Scopus, Ebsco and PubMed were searched. In the search systematic review and meta-analysis, and randomized clinical trials were included. Data restrictions were made from 2011 to 2025.

Population: - Databases were evaluated with patients with permanent teeth with pulp exposure having either mature or immature roots, and reversible pulpitis.

Intervention: - Data extraction and analysis of research papers based on pulp regeneration cases using Platelet Rich Fibrin (PRF).

Comparison: - MTA, Biodentine, calcium hydroxide, glass ionomer, resin modified glass ionomer, blood clot, plasma rich platelet (PRP), and other pulp capping agents.

Outcome: - Success of PRF as direct pulp capping agent.

Prisma guidelines were followed (Figure 1). The data was subjected for further statistical analysis.

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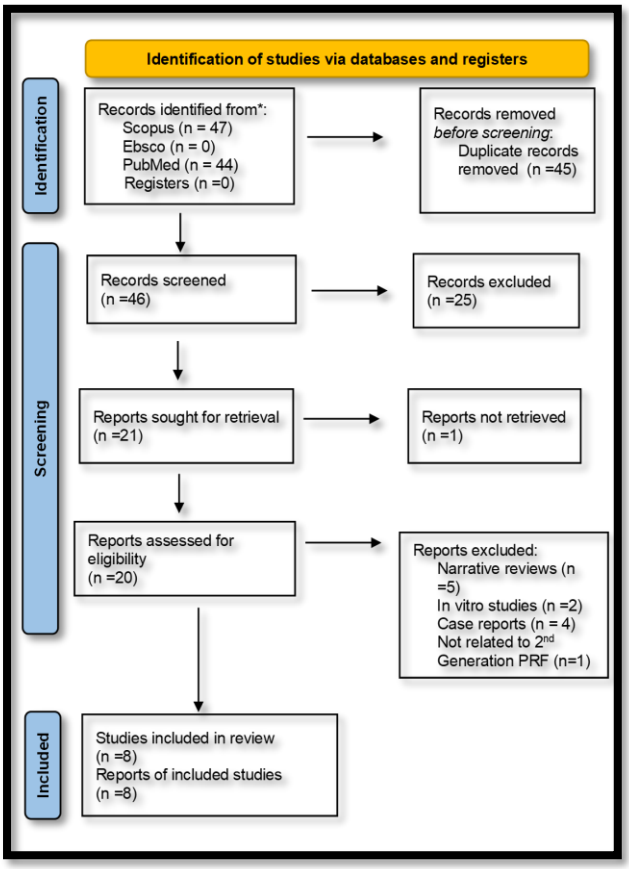

Figure 1 Prisma Flowchart

Statistical analysis was done using Cochrane Risk of Bias Assessment (ROB 2) (Figure 2).

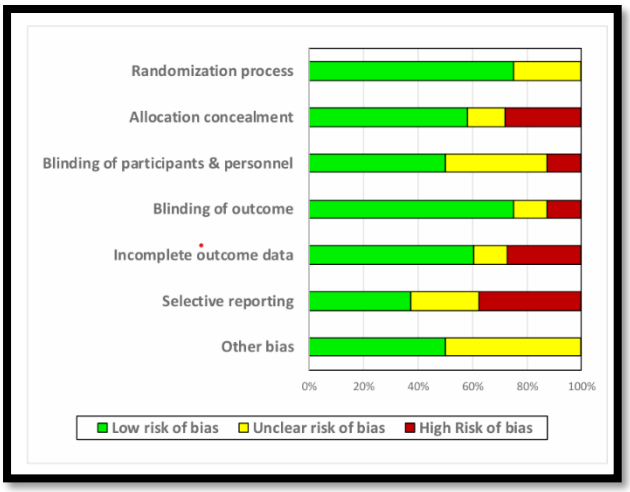

Figure 2 Cochrane Risk of Bias Assessment

4. Results

The individual studies' scores ranged from 10 to 40 out of a possible 42 for the QATSDD, indicating significant variation in study quality. 28.0 was the average score (6.1). The mean score for each of the 14 quality assessment categories is displayed in the table (Table 1). A total potential score of 3 means that all of the papers fully met the criteria, while a mean score of 0 indicates that none of the papers met all of the criteria's components.

Table 1 Mean score for each of the 14 quality assessment categories

Quality Criteria	Mean Score (SD, Range)
Evidence of user involvement in design	1.1 (0.2, 0-0.9)
Explicit theoretical framework	1.4 (0.4, 0.3-1.6)
Evidence of sample size considered in terms of analysis	1.1 (1.1, 0-3)
Statistical assessment of reliability and validity of measurement tools	1.3 (0.9, 1-3)
Strength and limitations critically discussed	1.9 (1.3, 0-3)
Good justification for method of analysis	2.2 (1.2, 0-3)
Clear description of research setting	1.9 (1.6, 1-3)
Description of procedure for data collection	2.6 (1.1, 1-3)
Statement of aims/objectives in body of report	2.4 (0.9, 1-3)
Detailed recruitment data	1.8 (1.3, 1-3)
Representative sample of reasonable size	2.7 (0.9, 1-3)
Rationale for choice of data collection tool	2.5 (1.1, 1-3)
Fit between research question and method of analyis	2.6 (1.2, 1-3)
Fit between research question and method of data analysis	2.5 (1.1. 1-3)

Some quality criteria were adequately addressed by the included studies, in particular the match between the research question and method of data collection and analysis. However, none of the included papers had proof of user involvement in the design, and there was absence of explicit theoretical framework supporting the majority of the studies. Two other domains that received less attention were the approaches used to determine the sample size and evaluation of the validity and reliability of the measurement tools used. For the quality assessment, there was overall agreement between independent reviewers of 241 of 280 (86.07 %) of quality criteria scores. Since quality assessment was, however, an ordered variable, a weighted kappa was also carried out to establish relative concordance between reviewers. It was assumed that the differences between individual quality scores were equal. The inter-rater agreement (kappa with linear weighting) was 0.795 (95% CI, 0.64–0.92) indicating substantial to perfect agreement.

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5. Discussion

Maintaining the pulp vitality is essential for tooth homeostasis and durability[8]. Therefore, vital pulp therapy is commonly promoted now a days while root canal treatment leads to devitalization of the tooth and makes it susceptible to post operative complications and fractures. It may also lead to infections or periapical lesions and hinders in root development. Endodontic treatment makes the tooth vulnerable to masticatory forces and sometimes show discoloration as well[8]. Hence, dentin-pulp regeneration is the need of the hour.

Vital pulp therapy aims to preserve the vitality of pulp tissue by inducing dentin bridge formation within the scarred tissue to maintain its function and experiencing reversible pulp injury of that particular tooth[8]. Both direct and indirect pulp capping preserve the vitality with the only difference being that there is mechanical exposure of pulp in the former. For this purpose, existing pulp capping agents have shown positive results. The new ones are also being experimented for the same. Ideal pulp capping agent should be able to stimulate reparative dentin formation. It should be able to resist masticatory forces and provide tight bacterial seal. It should be sterile, bacteriostatic and be able to release fluoride[1].

In the limelight of the 2 approaches i.e. conventional approach and the other is biological approach[2]. The former approach includes use of synthetic pulp capping agents such as calcium hydroxide, resin modified glass ionomer cement (RMGIC), mineral trioxide aggregate (MTA), biodentine, polysaccharides like alginate and chitosan. These have their own advantages and disadvantages. Calcium hydroxide has the inability to kill enterococcus faecalis and to provide bacterial seal. It is unable to adhere to dentin properly and is highly soluble in oral fluids. RMGIC show moderate inflammatory responses and show absence of dentin bridge formation. Although MTA shows dentin formation and less pulpal inflammation, it has high potential for discoloration due to presence of bismuth oxide which chemically interacts with dentin collagen. Also, it is difficult to handle, has long setting time and is expensive. Biodentine show tertiary dentin formation and good bacterial seal[16]. Polysaccharides like alginate is biocompatible and non-immunogenic but show poor cell adhesion and low chemical strength. Chitosan although being biocompatible and antimicrobial, show poor solubility and high crystallity[1].

The path of biological approach looks into the molecular and cellular basis of pulp tissue regeneration. It includes the platelet concentrates such platelet rich plasma (PRP), platelet rich fibrin (PRF), collagen, blood clot, polylactide-co-glycolide (PLGA), extracellular matrix components (ECM) and many upcoming biomaterials. Generally, existing biomaterials lack specific temporal and spatial control over biologic signalling required for progenitor cell homing and differentiate to eventually fully restored structure and functional characteristics of tissue[8]. These are limited to control inflammation and infection to promote reparative dentin formation. PRF is suggested to have strong, flexible properties as compared to blood clot, collagen and PLGA, owing to its richness of growth factors required for cell differentiation and angiogenesis[1]. PRP requires an addition of anticoagulant, has limited mechanical stiffness and experiences rapid shrinkage and degeneration[8]. PLGA is synthetic and it leads to accumulation of acidic degradation products which might be a concern[8]. ECM scaffolds are challenging to process as they have batch to batch variation[8]. PRF is the most promising scaffold for regenerative endodontics[8].

PRF is a second- generation platelet concentrate developed by Choukran et al's technique which is an easy and low cost procedure[3]. It is a natural biological scaffold that is rich in platelets, leukocytes, various growth factors and pro-inflammatory cytokines[1]. Its autologous nature makes it extremely biocompatible. Existing studies have shown that there is sustained release of growth factors[15] over 1week up to 28 days so PRF membrane could release growth factors for wound healing. Thus, this suggests the idea of using PRF membrane as a pulp capping agent[9]. PRF has been found to increase osteoprotegrin (OPG) and alkaline phosphatase (ALP) expression required for regeneration of lost or damaged pulpal tissue. Increase in the latter, is essential for biomineralization. TGF-β, one of the growth factors in PRF, has been demonstrated in pulp tissues after injury and is implicated in differentiation of odontoblasts like cells and repair of pulp tissue[9]. By releasing cytokines like Interleukin 4 and blocking the stimulatory effects of MMP-1 and MMP-3 as well as prostaglandin-E2 production, PRF actively contributes to pulpal healing[10].

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A randomized control study by Shekhar Shobana et al., demonstrated that volume of dentin bridge formation was significantly more in PRF and PRP as compared to MTA, suggestive of platelet concentrates being future of vital pulp therapy[2].

Ammar Eid et al. carried out a study with the goal of comparing and examining the effects of platelet-rich fibrin (PRF), nano-hydroxyapatite, and fast setting MTA (MMA-MTA) as pulpotomy agents in permanent immature molars with incomplete root development. According to the study's findings, the groups treated with MM-MTA and NHA showed a higher tendency for canal obliteration, suggesting that PRF ought to be the initial pulpotomy agent of choice[11].

In order to assess and compare the effects of PRF and MTA as pulpotomy agents in permanent teeth with insufficient root growth, Deepa Keswani et al. conducted a study. According to the findings, at 24 months, 88.8% of the roots in the PRF group and 80.07% of the roots in the MTA group had complete apical closure. Therefore, they came to the conclusion that PRF can be utilized as a viable biological and cost-effective substitute for MTA in pulpotomy treatments for permanent teeth with incomplete root development[12].

The study by I.B. Geeta et al concluded that PRF has a physiologic architecture that is favorable for the healing, obtained due to the slow polymerization process[13].

Hence, PRF owing to its various advantages, is suitable to use as direct pulp capping agent.

6. CONCLUSION

Multiple pulp capping agents such as calcium hydroxide, resin modified glass ionomer cement, mineral trioxide aggregate and various other upcoming agents can used in vital pulp therapy which having their own advantages and disadvantages. Nonetheless, numerous studies have demonstrated PRF's clinical and radiological success. Thus, it can be concluded that PRF can be used as a suitable alternative for direct pulp capping agent in cases of reversible pulpitis with mature or immature roots. This research study has led to better in depth understanding of PRF.

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