JOURNAL OF HEALTHCARE SCIENCES
Volume 3 Issue 7 2023, Article ID: JOHS2023000672
http://dx.doi.org/10.52533/JOHS.2023.30708
e-ISSN: 1658-8967

Review

The Influence of Pulp Capping Procedures on the Long-Term Prognosis and Survival of Teeth

Waleed Alshargawi[1], Shoug Alaamer[2], Entesar Alharabi[3], Sarah Alzaid[2], Saeed Alghamdi[4], Bandary Almarshedy[5], Abdullah Alhammad[6], Norah ALharbi[3], Salman Alshammari[7], Maha Aldahami[5], Aljaze Alhaif[2]

[1] *Department of Endodontics, Al Thager Hospital, Jeddah, Saudi Arabia*
[2] *College of Dentistry, Dar Al Uloom University, Riyadh, Saudi Arabia*
[3] *East Riyadh Dental Center, Second Health Cluster Central Region, Riyadh, Saudi Arabia*
[4] *General Dentist, Bin Dammas Medical Center, Jeddah, Saudi Arabia*
[5] *East Riyadh Dental Center, Ministry of Health, Riyadh, Saudi Arabia*
[6] *General Dentist, Ministry of Health, Riyadh, Saudi Arabia*
[7] *College of Dentistry, University of Hail, Hail, Saudi Arabia*

Correspondence should be addressed to **Waleed Alshargawi**, Department of Endodontics, Al Thager Hospital, Jeddah, Saudi Arabia. Email: waldosh55@hotmail.com

Received: 24 July 2023, Revised: 28 July 2023, Accepted: 29 July 2023, Published: 31 July 2023

Abstract

Pulp capping is a dental procedure to treat deep caries and preserve the vitality of affected teeth. It involves placing a biocompatible material directly on the exposed pulp (direct pulp capping) or using a medicated liner to protect the pulp (indirect pulp capping). The choice of biomaterials, such as calcium hydroxide or mineral trioxide aggregate (MTA), significantly impacts the success of pulp capping. Patient-related factors, including age, oral hygiene, and systemic health conditions, influence treatment outcomes. Younger patients generally have better results due to higher pulp vitality and regenerative capacity. Maintaining good oral hygiene and managing systemic health conditions are crucial for long-term success. Complications and treatment failure can occur in pulp capping, depending on factors like cavity size, infection, and initial pulp condition. Early detection and intervention are important to prevent further issues. Success in pulp capping is assessed based on factors like continuous root development, preserved pulp vitality, minimal inflammation, and formation of reparative dentin. Success rates may decrease over time, and further research is needed to understand why. Understanding procedural techniques, biomaterial selection, patient-related factors, and complications are vital for informed decision-making, optimizing outcomes, and increasing the longevity of pulp-capped teeth.

Keywords: *pulp capping, biomaterial selection, treatment outcomes, mineral trioxide aggregate, calcium hydroxide*

Introduction

Pulp capping is a dental therapeutic modality that aims to uphold the long-term prognosis and survival of teeth affected by deep caries (1). With the potential to preserve the vitality of the dental pulp and promote the formation of reparative dentin, pulp capping offers an attractive alternative to more invasive treatments, such as root canal therapy or tooth extraction (2). However, achieving optimal outcomes in pulp capping requires a comprehensive understanding of the intricate dynamics and influences that govern treatment success. Pulp capping involves multifaceted aspects, including procedural techniques, biomaterial selection, patient-related factors, and the risk of complications, to shed light on the intricate relationship between this therapeutic approach and the ultimate longevity of treated teeth (3).

Pulp capping techniques can be broadly categorized into two approaches: direct pulp capping and indirect pulp capping (4). In direct pulp capping, a biocompatible material, such as calcium hydroxide or mineral trioxide aggregate (MTA), is placed directly over the exposed pulp to facilitate healing and stimulate the formation of dentin (5). Conversely, indirect pulp capping involves the application of a medicated liner to protect the pulp from further irritation and promote the formation of a dentin bridge (6). Understanding the nuances and comparative effectiveness of these techniques is vital in determining the most appropriate approach to maximize the long-term prognosis and survival of treated teeth.

The selection of biomaterials used in pulp capping procedures significantly impacts treatment outcomes (5). Calcium hydroxide has long been the material of choice due to its antibacterial properties and ability to stimulate reparative dentinogenesis (7). However, the advent of mineral trioxide aggregate (MTA) has revolutionized pulp capping, offering improved biocompatibility and dentinogenic potential (8). The success of pulp capping relies on the ability of these materials to establish a favorable interface between the pulp tissue and the restorative material, promoting pulp healing and preventing bacterial microleakage (9). Exploring the characteristics and comparative effectiveness of various biomaterials in pulp capping procedures is essential in guiding evidence-based clinical decision-making.

Patient-related factors play a critical role in determining the long-term prognosis of pulp-capped teeth (10). Age has been identified as a significant predictor of treatment outcomes, with younger patients generally exhibiting higher pulp vitality and regenerative capacity (11). Moreover, meticulous oral hygiene practices and regular dental visits are pivotal in maintaining the overall health of teeth and can influence the success of pulp capping procedures. Factors such as systemic health conditions, immune status, and genetic predisposition may also influence treatment outcomes (12). Investigating the interplay between patient-related factors and the success of pulp capping techniques is crucial in tailoring treatment approaches and optimizing clinical outcomes.

While pulp capping aims to mitigate the need for more invasive interventions, it is essential to evaluate the risk of complications or treatment failure associated with these techniques. Factors such as the size and location of the cavity, the presence of pulp inflammation or infection, and the development of periapical lesions can significantly impact the long-term prognosis (13). Recognizing the incidence and nature of such complications is vital for early detection, timely intervention, and appropriate patient management.

Methodology

This study is based on a comprehensive literature search conducted on June 4, 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the influence of pulp capping procedures on the long-term prognosis and survival of teeth. There were no

http://dx.doi.org/10.52533/JOHS.2023.30708

restrictions on date, language, participant age, or type of publication.

Discussion

In Barthel et al.'s study in which pulp capping was performed by dental students, the 10-year success rate was 13% (14). The success of pulp capping procedures relies on numerous interrelated factors that contribute to the long-term prognosis and survival of treated teeth (6). An in-depth understanding of the specific treatment factors influencing the outcomes of pulp capping, encompassing procedural techniques, biomaterial selection, patient-related factors, and the risk of complications enables the dentist to make evidence-based decisions, optimize treatment outcomes, and enhance the longevity of pulp-capped teeth (2). The key parameters affecting treatment outcomes of pulp therapy are a correct evaluation of the pulp status before therapy, elimination of decay, avoidance of leakage, and the adoption of an aseptic approach. The long-term outcome of pulp capping is typically correlated with the degree of crown damage and the capacity to restore a tooth (15). The sort of pulp capping biomaterial used (16), the technique used (17), the depth of the carious pulpal exposure (18), the period of examination (14), the final site and integrity of the dentin bridge, the existence of bacteria with infection thereafter, and the inflammatory situation of the pulpal tissue all play a part in assessing the prognosis (15). Also, failure of the pulp capping must be distinguished from the breakdown of the underlying restoration (19). There are certain restrictions on how the long-term effectiveness of pulp capping may be assessed, such as the difficulties of routinely recalling patients and the challenge of assessing histological success (13). Based on the patient's medical history, clinical and radiographic results, the possibility of long-term success, and the potential for tooth restoration, a carefully considered decision should be made regarding the optimal course of therapy (19).

The two main procedural techniques in pulp capping are direct and indirect pulp capping. Direct pulp capping involves placing a biocompatible material, such as calcium hydroxide or mineral trioxide aggregate (MTA), directly over the exposed pulp (20). Several factors influence the success of direct pulp capping, including the management of pulpal bleeding, the quality of pulp tissue debridement, and the sealing efficacy of the restorative material. Achieving an effective seal is crucial to prevent bacterial microleakage and subsequent pulp inflammation or infection. Two factors have been stressed as being essential to the effectiveness of calcium hydroxide direct pulp capping (21). Pulp-capping should only be done on teeth that are asymptomatic, and a well-sealed restoration has to be put in place as soon as possible after pulp capping. Indirect pulp capping is employed when the pulp is not exposed but is at risk of pulpal inflammation or infection due to deep caries proximity (22). The use of a medicated liner, such as calcium hydroxide or resin-modified glass-ionomer cement, helps create a protective barrier and promotes the formation of a dentin bridge (23). Factors such as the selection and thickness of the liner, the timing of liner placement, and the evaluation interval impact the success of indirect pulp capping.

Biomaterial selection plays a vital role in determining treatment prognosis in these procedures. Biomaterials used in pulp capping should have a number of qualities, such as the capacity to get rid of pathogens, establish a good seal, stimulate mineralization, and promote normal root development (24). For many years, calcium hydroxide has been regarded as the "gold standard" for direct pulp capping. In a review of 19 clinical studies with more than 2,400 patients, the success rates of calcium hydroxide pulp-capping ranged from roughly 60% to almost 100% when performed by a skilled clinician (25). Calcium hydroxide has been a longstanding material of choice in pulp capping due to its antibacterial properties and ability to stimulate dentinogenesis (9). The alkaline pH of calcium hydroxide facilitates the neutralization of bacterial acids and promotes the formation of a hard tissue bridge (26). However, limitations such as its low mechanical strength and potential for degradation over time have led to the exploration of alternative biomaterials. MTA has gained

http://dx.doi.org/10.52533/JOHS.2023.30708

popularity in recent years due to its superior biocompatibility, sealing ability, and potential to induce dentin formation (27). MTA promotes the differentiation of dental pulp stem cells into odontoblast-like cells, leading to the deposition of a dentin bridge (28). MTA's advantageous properties make it an attractive choice for pulp capping procedures, but considerations such as handling characteristics and cost must be taken into account. Emerging materials such as biodentine and resin-based materials offer additional alternatives for pulp capping. Biodentine, a bioactive calcium silicate-based material, exhibits properties similar to MTA and has shown promising results in pulp capping procedures (29). Resin-based materials, including adhesive systems and composite resins, offer advantages in terms of bonding and aesthetics (30). Animal pulp capping experiments comparing MTA to calcium hydroxide show that MTA generally results in pulp healing of higher grade (31). The majority of human trials demonstrated similar calcium hydroxide and MTA pulp cap results. In a study using 11 pairs of third molars and direct pulp capping, it was feasible to see that MTA groups displayed greater pulp healing than calcium hydroxide groups. These teeth's pulps were mechanically exposed, covered in ZOE, covered in MTA or calcium hydroxide, then restored with amalgam (32). Following tooth extraction, histological analysis at 1-week, 2-, 3-, 4-, and 6-month intervals showed that the MTA-treated teeth had less pulp hyperemia, less inflammation and necrosis, and more predictable and consistent dentinal bridge construction (32). Other researchers have reported getting similar results (33). The five-year success rate for MTA was 78-98% (34, 35) and with calcium hydroxide in permanent teeth pulp capping has been found to range between 59-69% (8, 35). MTA seems to be more successful than calcium hydroxide at preserving long-term pulp vitality.

Patient-related factors also play a role in long-term success of vital pulp therapy. Age has a significant impact on the long-term prognosis of pulp-capped teeth (36). Younger patients generally exhibit higher pulp vitality and regenerative capacity, contributing to more favorable treatment outcomes (37). Age-related factors such as dentin thickness, immune response, and reparative capabilities influence the success of pulp capping procedures (38). Meticulous oral hygiene practices, including regular brushing, flossing, and professional cleanings, play a crucial role in maintaining the overall health of teeth. Good oral hygiene reduces the risk of recurrent decay, pulp inflammation, and secondary infection, thereby enhancing the long-term prognosis of pulp-capped teeth. Systemic health conditions, such as diabetes or immunocompromised states, can impact the success of pulp capping procedures (12). Certain medications, such as bisphosphonates, may affect bone metabolism and healing, potentially influencing treatment outcomes. Careful consideration of patient medical history and medication usage is essential for treatment planning.

Despite appropriate treatment, the risk of pulp inflammation or infection remains a concern. Factors such as the size and location of the cavity, the presence of microorganisms, and the pulp's initial condition can influence the occurrence of complications (13). Timely detection and intervention are crucial to prevent the spread of infection and maintain the long-term viability of the tooth. Periapical lesions, such as periapical granulomas or cysts, can develop as a consequence of untreated or persistent pulpal inflammation (6). The presence of periapical lesions poses a risk to the long-term prognosis of pulp-capped teeth and may necessitate additional endodontic intervention. The two main clinical and radiological criteria listed below are, in accordance with various authors (15, 39 {Bergenholtz, 2004 #3330), the signs of successful treatment: Continuous root development and apexogenesis of teeth, preservation of pulp vitality, minimal pulp inflammatory responses, development of a continuous layer of reparative dentin, nonexistence of postoperative clinical signs or symptoms of thermal or periapical and/or both sensitivity, such as pain or swelling, lack of radiographic evidence of internal or external root resorption, periapical and/or inter-radicular radiolucency, uneven calcification, or other

http://dx.doi.org/10.52533/JOHS.2023.30708

pathologic alterations (39, 40). Numerous studies have shown that success rates decline over time (41). Further research is required because there isn't a clear explanation for this fact at this time. Infection brought on by either lingering bacteria or new microorganisms entering the restored margins results in unfavorable effects. Therefore, using a rubber dam and maintaining aseptic conditions during therapy are of great importance in addition to the quick deployment of a bacteria-tight restoration. Practitioners are less certain about the effectiveness of pulp capping, despite clinical research suggesting that the its success rates in caries-exposed immature permanent teeth may be comparable to the success rate of root canal treatment (42). Following pulp capping, several problems could arise, thus patients should be closely monitored. According to studies, there is a greater than 95% chance that a tooth with a successful treatment outcome five years after VPT will continue to be functional. As a result, it may be too soon to perform an adequate postoperative follow-up evaluation after 1-2 years, as is frequently advised (41).

Conclusion

Pulp capping treatment offers a conservative approach to preserve the vitality and function of teeth affected by deep caries. The long-term prognosis and survival of treated teeth are influenced by a multitude of factors, including procedural techniques, biomaterial selection, patient-related variables, and the risk of complications. An understanding of these specific factors is crucial for optimizing treatment outcomes and enhancing the longevity of pulp-capped teeth. By considering these aspects and conducting further research, dental professionals can refine treatment protocols, tailor approaches to individual patients, and provide predictable and successful outcomes in pulp capping procedures.

Disclosure

Conflict of interest

There is no conflict of interest

Funding

No funding

Ethical consideration

Non applicable

Data availability

Data that support the findings of this study are embedded within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection, and final writing of the manuscript.

References

1. Ouacher O. Vital pulp therapy versus endodontic treatment: a narrative revision 2022.

2. Islam R, Islam MRR, Tanaka T, Alam MK, Ahmed HMA, Sano H. Direct pulp capping procedures–Evidence and practice. Japanese Dental Science Review. 2023;59:48-61.

3. Asgary S, Fazlyab M, Sabbagh S, Eghbal MJ. Outcomes of different vital pulp therapy techniques on symptomatic permanent teeth: a case series. Iranian endodontic journal. 2014;9(4):295.

4. Stark MM, Nicholson RJ, Soelberg KB. Direct and indirect pulp capping. Dental Clinics of North America. 1976;20(2):341-9.

5. Paula A, Carrilho E, Laranjo M, Abrantes AM, Casalta-Lopes J, Botelho MF, et al. Direct pulp capping: which is the most effective biomaterial? A retrospective clinical study. Materials. 2019;12(20):3382.

6. Dumsha T, Hovland E. Considerations and treatment of direct and indirect pulp-capping. Dental Clinics of North America. 1985;29(2):251-9.

7. Ba-Hattab R, Al-Jamie M, Aldreib H, Alessa L, Alonazi M. Calcium hydroxide in endodontics: An overview. Open Journal of Stomatology. 2016;6(12):274-89.

8. Bogen G, Kim JS, Bakland LK. Direct pulp capping with mineral trioxide aggregate: an observational study. The Journal of the American Dental Association. 2008;139(3):305-15.

http://dx.doi.org/10.52533/JOHS.2023.30708

9. Murray PE, Windsor LJ, Smyth TW, Hafez AA, Cox CF. Analysis of pulpal reactions to restorative procedures, materials, pulp capping, and future therapies. Critical Reviews in Oral Biology & Medicine. 2002;13(6):509-20.

10. Stangvaltaite L, Schwendicke F, Holmgren C, Finet M, Maltz M, Elhennawy K, et al. Management of pulps exposed during carious tissue removal in adults: a multi-national questionnaire-based survey. Clinical oral investigations. 2017;21:2303-9.

11. Bogen G, Chandler NP. Pulp preservation in immature permanent teeth. Endodontic Topics. 2010;23(1):131-52.

12. Segura-Egea JJ, Cabanillas-Balsera D, Martín-González J, Cintra LT. Impact of systemic health on treatment outcomes in endodontics. International Endodontic Journal. 2023;56:219-35.

13. Ward J. Vital pulp therapy in cariously exposed permanent teeth and its limitations. Australian Endodontic Journal. 2002;28(1):29-37.

14. Barthel CR, Rosenkranz B, Leuenberg A, Roulet J-F. Pulp capping of carious exposures: treatment outcome after 5 and 10 years: a retrospective study. Journal of Endodontics. 2000;26(9):525-8.

15. Aguilar P, Linsuwanont P. Vital pulp therapy in vital permanent teeth with cariously exposed pulp: a systematic review. Journal of endodontics. 2011;37(5):581-7.

16. Aljandan B, AlHassan H, Saghah A, Rasheed M, Ali A. The effectiveness of using different pulp-capping agents on the healing response of the pulp. Indian Journal of Dental Research. 2012;23(5):633.

17. Nair P, Duncan H, Pitt Ford T, Luder H. Histological, ultrastructural and quantitative investigations on the response of healthy human pulps to experimental capping with mineral trioxide aggregate: a randomized controlled trial. International endodontic journal. 2008;41(2):128-50.

18. Stanley HR. Pulp capping: conserving the dental pulp—can it be done? Is it worth it? Oral Surgery, Oral Medicine, Oral Pathology. 1989;68(5):628-39.

19. Bjørndal L, Mjör IA. Pulp-dentin biology in restorative dentistry. Part 4: Dental caries--characteristics of lesions and pulpal reactions. Quintessence international. 2001;32(9).

20. Li Z, Cao L, Fan M, Xu Q. Direct pulp capping with calcium hydroxide or mineral trioxide aggregate: a meta-analysis. Journal of endodontics. 2015;41(9):1412-7.

21. Murray PE, Hafez AA, Smith AJ, Cox CF. Bacterial microleakage and pulp inflammation associated with various restorative materials. Dental Materials. 2002;18(6):470-8.

22. Ricucci D, Siqueira Jr JF, Li Y, Tay FR. Vital pulp therapy: histopathology and histobacteriology-based guidelines to treat teeth with deep caries and pulp exposure. Journal of dentistry. 2019;86:41-52.

23. Schuurs A, Gruythuysen R, Wesselink P. Pulp capping with adhesive resin-based composite vs. calcium hydroxide: a review. Dental Traumatology: Review article. 2000;16(6):240-50.

24. Witherspoon DE. Vital pulp therapy with new materials: new directions and treatment perspectives—permanent teeth. Pediatric dentistry. 2008;30(3):220-4.

25. Akhlaghi N, Khademi A. Outcomes of vital pulp therapy in permanent teeth with different medicaments based on review of the literature. Dental research journal. 2015;12(5):406.

26. Estrela C, Holland R. Calcium hydroxide: study based on scientific evidences. Journal of Applied Oral Science. 2003;11:269-82.

27. Malkondu Ö, Kazandağ MK, Kazazoğlu E. A review on biodentine, a contemporary dentine replacement and repair material. BioMed research international. 2014;2014.

28. Paranjpe A, Smoot T, Zhang H, Johnson JD. Direct contact with mineral trioxide aggregate activates and differentiates human dental pulp cells. Journal of endodontics. 2011;37(12):1691-5.

29. Singh H, Kaur M, Markan S, Kapoor P. Biodentine: A promising dentin substitute. J Interdiscipl Med Dent Sci. 2014;2(140):2.

http://dx.doi.org/10.52533/JOHS.2023.30708

30. Duke ES. Adhesion and its application with restorative materials. Dental Clinics of North America. 1993;37(3):329-40.

31. de Souza Costa CA, Duarte PT, De Souza P, Giro E, Hebling J. Cytotoxic effects and pulpal response caused by a mineral trioxide aggregate formulation and calcium hydroxide. American journal of dentistry. 2008;21(4):255-61.

32. Aeinehchi M, Eslami B, Ghanbariha M, Saffar A. Mineral trioxide aggregate (MTA) and calcium hydroxide as pulp-capping agents in human teeth: a preliminary report. International endodontic journal. 2003;36(3):225-35.

33. Benoist FL, Ndiaye FG, Kane AW, Benoist HM, Farge P. Evaluation of mineral trioxide aggregate (MTA) versus calcium hydroxide cement (Dycal®) in the formation of a dentine bridge: a randomised controlled trial. International dental journal. 2012;62(1):33-9.

34. Al-Hiyasat AS, Barrieshi-Nusair KM, Al-Omari MA. The radiographic outcomes of direct pulp-capping procedures performed by dental students: a retrospective study. The Journal of the American Dental Association. 2006;137(12):1699-705.

35. Naito T. Uncertainty remains regarding long-term success of mineral trioxide aggregate for direct pulp capping. Journal of Evidence Based Dental Practice. 2010;10(4):250-1.

36. Gizani S, Seremidi K, Stratigaki E, Tong HJ, Duggal M, Kloukos D. Vital pulp therapy in primary teeth with deep caries: an umbrella review. Pediatric dentistry. 2021;43(6):426-37.

37. Schmalz G, Widbiller M, Galler KM. Clinical perspectives of pulp regeneration. Journal of endodontics. 2020;46(9):S161-S74.

38. Lin L, Rosenberg P. Repair and regeneration in endodontics. International endodontic journal. 2011;44(10):889-906.

39. M Hargreaves K, Cohen S. Cohen's pathways of the pulp: Mosby Elsevier; 2011.

40. Cohenca N, Paranjpe A, Berg J. Vital pulp therapy. Dental Clinics. 2013;57(1):59-73.

41. Dammaschke T, Leidinger J, Schäfer E. Long-term evaluation of direct pulp capping—treatment outcomes over an average period of 6.1 years. Clinical oral investigations. 2010;14:559-67.

42. Mejare I, Cvek M. Partial pulpotomy in young permanent teeth with deep carious lesions. Dental Traumatology. 1993;9(6):238-42.

http://dx.doi.org/10.52533/JOHS.2023.30708