Chapter 7

An Endodontist's Perspective on Vital Pulp Treatments

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Abstract

Vital pulp treatments (VPT) are minimally invasive approaches in endodontics that focus on the preservation of biological tissue. The aim of these methods is to maintain the natural structure and biomechanical durability of the tooth by maintaining the vitality of the pulp tissue. From the endodontist's perspective, success is closely related to correct diagnosis, appropriate material selection, patient compliance and regular follow-up processes.

VPT modalities include direct pulp cover, partial pulpotomy and full pulpotomy. Careful evaluation of indications and contraindications plays a decisive role in the clinical decision process. Protection of the pulp, especially in young permanent teeth, is critical for the completion of root development.

Nowadays, calcium silicate-based biomaterials, especially MTA, Biodentine and bioceramics, come to the forefront in VPT thanks to their high biocompatibility and dentin bridge formation capacity. Elimination of symptoms, preservation of periapical health and dentin bridge formation in clinical and radiographic follow-up are the main criteria for evaluating the success of treatment.

The advantages of VPT include preservation of the tooth structure, shorter procedure time and cost effectiveness. However, diagnostic uncertainties, control of pulp haemorrhage, material cost and patient compliance are the main difficulties encountered in practice.

In the future, new biomaterials, regenerative approaches and artificial intelligence-assisted diagnostic methods will increase the predictability and clinical success of VPT. In conclusion, VPT are becoming increasingly important in modern endodontics by offering a biologically based alternative to root canal treatment.

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1.Introduction

VPT represent one of the most up-to-date and preventive approaches in endodontics. The aim of these treatments is to keep the pulp tissue alive and preserve its biological functions. Today, these methods, which can be an alternative to root canal treatment, are important in terms of ensuring the continuation of root development, maintaining the biomechanical durability of the tooth and increasing long-term treatment success, especially in young permanent teeth (Duncan et al., 2019).

From the endodontist's point of view, VPT require a meticulous approach not only to reduce invasive procedures but also to critical processes such as diagnosis and material selection. Accurately assessing the degree of pulp inflammation is the most fundamental step to maintain vitality. In this context, clinical symptoms, radiographic findings and intraoperative observations are evaluated together ("AAE Position Statement on Vital Pulp Therapy," 2021).

The protective approach is also supported by the development of biologically based materials. The biocompatibility of MTA and bioceramic materials, their ability to promote dentin bridge formation and their long-term success rates have increased the reliability of VPT. However, the clinical experience of the endodontist and patient co-operation continue to be decisive in treatment success (Silva et al., 2023).

In conclusion, VPT have shifted the paradigm in endodontics from the removal of infected tissue to the preservation of biological tissue. This approach both increases the patient's chances of preserving the natural tooth for a long time and guides clinical practice in accordance with the minimally invasive dentistry approach (Duncan et al., 2019).

2.Clinical Perspective of the Endodontist

The endodontist's approach to VPT is primarily based on determining the correct indications and contraindications. Cases with deep carious lesions but symptoms indicating early stages of pulpitis are suitable candidates for VPT. VPT has a very high success rate in reversible pulpitis. On the other hand, findings such as widespread spontaneous pain, percussion tenderness, presence of radiographically evident periapical pathology or uncontrolled bleeding draw the limits of VPT and necessitates a turn to root canal treatment (Duncan, 2022).

Diagnosis and decision making are one of the critical responsibilities of the endodontist. Clinical findings (type of pain, thermal tests, electrical pulp

test), radiographic examinations and the nature of the bleeding when the pulp chamber is opened play a decisive role in treatment guidance. Especially in young patients, the ongoing root development makes the protection of the pulp a priority for the endodontist. In adults, treatment planning is made by considering functional and aesthetic expectations.

Patient expectations also have an important place in the clinical perspective of the endodontist. Most patients associate the success of treatment with the elimination of pain and the ability of the tooth to function in the mouth for a long time. Therefore, the endodontist needs to clearly and understandably convey to the patient the potential advantages of VPT (shorter treatment time, lower cost, higher biological protection) and its limitations (the need to switch to root canal treatment in case of failure).

As a result, the clinical perspective of the endodontist includes not only technical applications but also correct diagnosis, material selection, patient communication and long-term follow-up strategies. This holistic approach ensures that VPT can be safely applied in modern endodontic practice.

3.Treatment Modalities

3.1. Direct Pulp Cover

Direct pulp coverage is the process of covering the pulp surface exposed in a limited area due to caries or mechanical reasons with biocompatible materials. The most critical point for the endodontist is that the pulp opening should be small and controlled, the bleeding should be easily stopped and there should be clinical evidence that the pulp tissue is healthy. Although calcium hydroxide has been used as the gold standard for many years, today MTA and bioceramic materials are preferred due to their superior biocompatibility and potential for dentin bridging. Success rates are quite high, especially in young individuals (Wang et al., 2022).

3.2. Partial Pulpotomy

Partial pulpotomy is the removal of inflamed tissue in a limited area in the pulp chamber to reach healthy pulp tissue and to cover this surface with biomaterials. It is widely preferred by endodontists for the continuation of root development, especially in young permanent teeth. The advantage of partial pulpotomy is the preservation of the remaining healthy pulp tissue with the removal of inflammation. This method both maintains the vitality of the pulp and may reduce the need for root canal treatment in the future (Camoni, Cagetti, Cirio, Esteves-Oliveira, & Campus, 2023).

3.3. Full Pulpotomy

Complete pulpotomy is based on the removal of all coronal pulp tissue in the pulp chamber, leaving only the radicular pulp alive. Especially in cases of symptomatic irreversible pulpitis, it is performed considering that the root pulp may be healthy. From the endodontist's point of view, complete pulpotomy is a more conservative alternative to root canal treatment. In recent years, high long-term success rates of complete pulpotomies with biomaterials such as MTA and Biodentine have been reported. This suggests that VPT may be a reliable option for some cases traditionally referred to root canal treatment (Ather, Patel, Gelfond, & Ruparel, 2022).

4. Role of Biomaterials

4.1. Calcium Hydroxide

Calcium hydroxide has been the most widely used material in VPT for many years. It has been widely accepted in the clinic due to its antibacterial effect, alkaline pH and ability to induce dentin bridge formation. However, the disadvantages that have emerged over time - solubility, susceptibility to microleakage and the presence of tunnelling defects in the formed dentin bridges - have led endodontists to be more cautious when using this material alone (Cox, Sübay, Ostro, Suzuki, & Suzuki, 1996).

4.2. Mineral Trioxide Aggregate (MTA)

MTA has been a milestone in VPT. It is safely preferred by endodontists due to its high biocompatibility, excellent sealing properties and success in dentin bridging. One of its most important clinical advantages is that it supports healing even in inflamed pulp. However, it has limitations such as long curing time and high cost (Silva et al., 2023).

4.3. Biodentine

Biodentine is a calcium silicate-based material developed to overcome the deficiencies of MTA. It has become popular among endodontists due to its shorter curing time, easy applicability and good biological properties. In clinical applications, high success rates have been reported in both direct pulp cover and pulpotomy procedures (Bastos, Albuquerque, Filho, Silva, & Rolim, 2024).

4.4. Bioceramic Materials

Bioceramic materials introduced to the market in recent years have raised the expectations of endodontists in VPT even further. They offer advantages such as easy applicability, excellent biocompatibility, hardening in humid environment and long-term stability. In addition, the antimicrobial properties of these materials and their capacity to induce biomineralisation increase the success of treatment (Duncan, 2022).

5.Success Criteria and Follow-up

5.1. Clinical Success Criteria

Success in VPT is primarily evaluated by the disappearance of the patient's symptoms. Absence of spontaneous pain after treatment, absence of pathological findings in thermal and percussion tests, and preservation of functional stability of the tooth after restoration are the main indicators of clinical success. One of the most critical points for the endodontist is to monitor whether pulp vitality is maintained after treatment (Asgary et al., 2024).

5.2. Radiographic Success Criteria

In addition to clinical improvement, radiographic findings are indispensable in the evaluation of long-term success. Root resorption, periapical lesion formation or widening of the periodontal space should not be observed after treatment. Instead, the formation of a dentin bridge, the maintenance of normal periodontal space and continued root growth are favourable criteria for the endodontist (Guan et al., 2021).

5.3. Long Term Follow-up

The success of VPT is determined not only by short-term observations but also by long-term follow-up. Clinical protocols usually recommend 6-month, 12-month and then annual follow-ups. During this period, the endodontist monitors the absence of symptoms, radiographic stability and functional vitality of the pulp. Especially in young permanent teeth, the completion of root development is the most important finding proving the success of VPT.

5.4. Differentiation of Success and Failure

In case of failure, persistent symptoms, uncontrollable pain, development of periapical pathology or loss of pulp response in vitality tests are usually

observed. In such cases, the endodontist revises the treatment plan and switches to root canal treatment. Therefore, the evaluation of success in VPT is a dynamic and long-term process, not just an instantaneous one (Asgary et al., 2024).

6.Advantages and Challenges

6.1. Advantages

The most important advantage of VPT is that they allow the natural structure of the tooth to be preserved. It offers a more conservative approach compared to root canal treatment and preserves the biomechanical strength of the tooth to a great extent. In addition, the relatively short duration of the procedure, the lower cost and the contribution to the continuation of root development in young permanent teeth make this treatment attractive for endodontists. The high biocompatibility offered by modern biomaterials also supports these advantages.

6.2. Diagnostic Difficulties

From the endodontist's point of view, the biggest challenge is to make the correct diagnosis. The degree of pulp inflammation can often not be accurately determined by clinical and radiographic findings. The grey areas in the distinction between reversible pulpitis and irreversible pulpitis directly affect the success of VPT. Therefore, diagnostic uncertainty poses a significant decision-making problem for endodontists (Zeng, Chen, Zheng, Wei, & Liu, 2024).

6.3. Clinical Practice Challenges

Another clinical challenge is the control of bleeding after pulp opening. Prolonged or intense bleeding may be an indication that the pulp is severely inflamed and is a contraindication for VPT. Cost and applicability of biomaterials are also limiting factors in some clinics (Briseño Marroquín, Borgschulte, Savic, Ertl, & Wolf, 2024).

6.4. Patient Compliance and Expectations

Patient compliance is also an important factor in maintaining success in VPT. Patients should not neglect post-treatment controls; permanent restoration should be performed on time and oral hygiene should be maintained. However, in practice, these conditions are not always fulfilled, which may adversely affect the long-term success of the treatment.

7. Future Perspective

7.1. Development of New Biomaterials

One of the most remarkable developments in the future of VPT is advances in the field of biomaterials. In addition to calcium silicate-based materials, nanotechnology-supported biomaterials, antimicrobial peptides and bioactive glass-containing products aim to make pulp protection more reliable. The potential of these materials for rapid hardening, superior biocompatibility and enhanced regenerative capacity will expand the treatment options for endodontists.

7.2. Regenerative Approaches

Regenerative endodontics is seen as a natural extension of VPT. The use of pulp stem cells, bioengineered products and treatments supported by growth factors aim not only to preserve the pulp but also to reconstruct it functionally. These developments will not only support stem development, especially in young individuals, but will also increase biological treatment alternatives in adults.

7.3. Artificial Intelligence and Imaging Technologies in Diagnosis

More precise determination of pulp vitality and degree of inflammation is a critical factor in the success of VPT. At this point, artificial intelligence-supported diagnostic algorithms and advanced imaging methods (e.g. CBCT-based assessments, optical coherence tomography) will provide more reliable decision support to endodontists. These technologies have the potential to improve treatment success by reducing grey areas in diagnosis.

7.4. Transformation of the Endodontist's Role

In the future, the role of endodontists will evolve from a practitioner who only removes infected tissue to a clinician who protects biological tissue and supports it with regenerative treatments. With the strengthening of the understanding of minimally invasive dentistry, endodontists will be in a more effective position in both clinical and research aspects of VPT.

8.Conclusion

VPT are one of the most important approaches in modern endodontic practice focusing on the preservation of biological tissue. Thanks to these methods, pulp tissue can be kept alive, and the natural structure and biomechanical durability of the tooth can be preserved for a long time.

For the endodontist, VPT are not only a technical application; it is a multifaceted process such as correct diagnosis, appropriate material selection, patient compliance and long-term follow-up. The high success rates provided by current biomaterials and the emergence of regenerative approaches increase the clinical reliability of these treatments day by day.

In the future, artificial intelligence-assisted diagnostic methods, next-generation biomaterials and tissue engineering-based solutions will make VPT more predictable and standardised. Endodontists will be the pioneers of approaches centred on the preservation of biological tissue in this transformation.

In conclusion, VPT strengthen the protective and biological aspects of endodontics and are gaining more importance in dental practice with their potential as an alternative to root canal treatment.

References

AAE Position Statement on Vital Pulp Therapy. (2021). *J Endod, 47*(9), 1340-1344. doi:10.1016/j.joen.2021.07.015

Asgary, S., Roghanizadeh, L., Eghbal, M. J., Akbarzadeh Baghban, A., Aminoshariae, A., & Nosrat, A. (2024). Outcomes and predictive factors of vital pulp therapy in a large-scale retrospective cohort study over 10 years. *Sci Rep, 14*(1), 2063. doi:10.1038/s41598-024-52654-8

Ather, A., Patel, B., Gelfond, J. A. L., & Ruparel, N. B. (2022). Outcome of pulpotomy in permanent teeth with irreversible pulpitis: a systematic review and meta-analysis. *Sci Rep, 12*(1), 19664. doi:10.1038/s41598-022-20918-w

Bastos, M. C., Albuquerque, F. G. A., Filho, E. L. C., Silva, P. G. B., & Rolim, J. (2024). Clinical and radiographic success of pulpotomy and pulpectomy in primary and permanent teeth: a Systematic Review and Meta-Analysis. *J Clin Exp Dent, 16*(9), e1120-e1128. doi:10.4317/jced.61346

Briseño Marroquín, B., Borgschulte, M., Savic, A., Ertl, T. P., & Wolf, T. G. (2024). Pulp Vitality Diagnosis by Means of an Optical Pulp Scanning Device. *Dent J (Basel), 12*(10). doi:10.3390/dj12100326

Camoni, N., Cagetti, M. G., Cirio, S., Esteves-Oliveira, M., & Campus, G. (2023). Partial Pulpotomy in Young Permanent Teeth: A Systematic Review and Meta-Analysis. *Children (Basel), 10*(9). doi:10.3390/children10091447

Cox, C. F., Sübay, R. K., Ostro, E., Suzuki, S., & Suzuki, S. H. (1996). Tunnel defects in dentin bridges: their formation following direct pulp capping. *Oper Dent, 21*(1), 4-11.

Duncan, H. F. (2022). Present status and future directions-Vital pulp treatment and pulp preservation strategies. *Int Endod J, 55 Suppl 3*(Suppl 3), 497-511. doi:10.1111/iej.13688

Duncan, H. F., Galler, K. M., Tomson, P. L., Simon, S., El-Karim, I., Kundzina, R., . . . Bjørndal, L. (2019). European Society of Endodontology position statement: Management of deep caries and the exposed pulp. *Int Endod J, 52*(7), 923-934. doi:10.1111/iej.13080

Guan, X., Zhou, Y., Yang, Q., Zhu, T., Chen, X., Deng, S., & Zhang, D. (2021). Vital Pulp Therapy in Permanent Teeth with Irreversible Pulpitis Caused by Caries: A Prospective Cohort Study. *J Pers Med, 11*(11). doi:10.3390/jpm11111125

Silva, E., Pinto, K. P., Belladonna, F. G., Ferreira, C. M. A., Versiani, M. A., & De-Deus, G. (2023). Success rate of permanent teeth pulpotomy using bioactive materials: A systematic review and meta-analysis of randomized clinical trials. *Int Endod J, 56*(9), 1024-1041. doi:10.1111/iej.13939

Wang, Y., Luo, S., Tang, W., Yang, L., Liao, Y., & Liu, F. (2022). Efficacy and safety of mineral trioxide aggregate (MTA) pulpotomy for caries-exposed permanent teeth in children: a systematic review and meta-analysis. *Transl Pediatr, 11*(4), 537-546. doi:10.21037/tp-22-68

Zeng, Q., Chen, M., Zheng, S., Wei, X., & Liu, H. (2024). Efficacy of vital pulp therapy for carious pulp injury in permanent teeth: a study protocol for an open-label randomized controlled noninferiority trial. *Trials, 25*(1), 700. doi:10.1186/s13063-024-08559-y