e - ISSN – 2349-0683

Asian Pacific Journal of Nursing

Journal homepage: www.mcmed.us/journal/apjn

A REVIEW ON VITAL PULP THERAPY

Gaurav Solanki[1*], Kritika Rajoria[1], Renu Solanki[2]

[1]Jodhpur Dental College General Hospital, Jodhpur, Rajasthan, India.
[2]Lachoo Memorial College of Science and Technology, Jodhpur, Rajasthan, India.

ABSTRACT

Pulp vitality is an important issue for the tooth viability since it provides nutrition and acts as biosensor to detect pathogenic stimuli. In the dental clinic, most dental pulp infections are irreversible due to its anatomical position and organization. It is difficult for the body to eliminate the infection, which subsequently persists and worsens. Recently, potential for successful pulp regeneration and revascularization therapies is increasing due to accumulated knowledge of stem cells, especially dental pulp stem cells.

Key words: Pulp, Vital, Therapy etc.

Corresponding Author

Gaurav Solanki
Email:- drgauravsolanki@yahoo.com

Article Info

Received 12/06/2014; Revised 20/06/2014
Accepted 04/07/2014

INTRODUCTION

Endodontic therapy known as root canal treatment is one of the most commonly and widely used techniques in dental clinics nowadays [1]. Endodontic therapy is a procedure for removing contaminated or injured dental tissue, refilling and sealing off the created void with synthetic material to eliminate future contamination and infection. With advancements in antibiotic therapies, dental materials and endodontic technology, the success rate of endodontic therapy has increased [2]. The outcomes of certain cases which previously were considered of uncertain result now achieve high levels of clinical success. That is to say, endodontically treated teeth now can maintain their function, for prolonged periods of time without a living pulp.Current endodontic procedures replace the vital pulp with synthetic materials, rather than living tissue. Pulpless teeth lose their ability to sense environmental changes, making the progression of caries unnoticeable by patients [3]. Another advantage of maintained dental pulp vitality is to maintain the capacity for limited dentin regeneration. Reparative dentin formation is particularly important forimmature permanent teeth, because of their incomplete apical and dentinal wall development. The structural integrity of endodontically treated teeth may also be undermined if they are not properly restored, making them more vulnerable to masticatory forces. In terms of aesthetics, endodontic therapy can often result in discoloration of the tooth crown, mainly due to staining from endodontic filling material. Maintaining the vital pulp also helps reduce the occurrence of apical periodontitis by blocking bacterial infections [4].

The Biology of Dental Pulp: The dental pulp is a heterogeneous soft tissue located in the center of teeth. It also contains a variety of cell types and extra cellular matrix molecules. Both dentin and the pulp are derived from neural crest cells [5]. The primary function of pulp is to produce dentin, including primary dentin during early tooth development, secondary dentin throughout the entire life span of the tooth and tertiary dentin under pathogenic stimuli. Odontoblasts are the layer of cells lining the periphery of the pulp at the inner dentin surface and are specialized cell type capable of synthesizing dentin [6]. The dental pulp is a highly vascularized tissue with abundant myelinated and unmyelinated nerves. Anatomically, the dental pulp is almost fully encapsulated by hard dentin. The only connection between the dental pulp and the surrounding tissue is through the tiny root apexes. All of the main blood vessels and lymph drainages of dental pulp pass though the tooth root apexes, which

make the apex the main pathway for tooth nutrition and waste exchange. In some teeth, there are also much smaller openings of lateral canals, located near the apical foramen. This limited accessibility and unyielding environment of the dental pulp makes it difficult to eliminate inflammation, once it has occurred. Injured dental pulp has limited potential for self recovery [7]. If the stimuli are mild or progress slowly, such as occur in the cases of mild caries, moderate attrition, erosion, or superficial fracture, odontoblasts can usually survive and continue to produce the dentin barrier beneath the injury, allowing the underlying soft pulp tissue to retain its function. The essential strategy under these situations is to protect the remaining odontoblasts. When the stimuli are strong and/or rapidly progressing, such as occur in deep dentin caries, severe abrasion, and fracture, the primary odontoblasts will be destroyed. In these cases, the postmitotic terminally differentiated odontoblasts lack the ability to proliferate to replace injured odontoblasts or to produce new dentin. Under these circumstances, undifferentiated mesenchymal cells within the dental pulp can differentiate into odontoblasts and secrete reparative dentin. Under these circumstances, undifferentiated mesenchymal cells within the dental pulp can differentiate into odontoblasts and secrete reparative dentin [8]. Undifferentiated mesenchymal cells within the pulp also have the potential to differentiate into other cell types, including fibroblasts, to repair the damaged soft pulp tissue.

Regeneration and Revascularization of Dental Pulp: Although pulp regeneration and revascularization is not essential as the pulpless tooth can survive for a long time after a successful endodontic treatment still maintaining the vitality of dental pulp provides many benefits. There are two main approaches for dental pulp regeneration and revascularization, either vital pulp therapy, or whole pulp regeneration depending on the presence or absence of vital pulp [9].

- **Vital Pulp Therapy:** The aims of vital pulp therapy are to maintain the vitality of the dental pulp, and to stimulate the remaining pulp to regenerate the dentalpulp complex. Clinically, vital pulp therapy can be divided into two main groups: indirect pulp capping and direct pulp capping/pulpotomy. Indirect pulp capping is achieved by applying a protective agent on the thin layer of dentin remaining over a nearly exposed pulp, in order to allow the underlying dental pulp to recover [10]. Direct pulp capping is in which a protective agent is placed directly on the exposed pulp to protect the underlying pulp from further injury and to allow the dentin-pulp complex to regenerate. When dental pulp exposure is large, or the pulp is infected, all of the coronal pulp must be removed and direct pulp capping will subsequently be performed used for dental tissue regeneration. Tooth buds contain both dental epithelial and mesenchymal cells and several adjacent to the root pulp. This method is also called pulpotomy. After pulpotomy treatment, the dental pulp within the root canal can be preserved and the roots of immature teeth can continue to grow [11]. A successful vital pulp treatment requires a good sealant against bacteria, no severe inflammatory reactions, and stable haemodynamic within the pulp. The ideal prognosis also includes the formation of a continuous dentin bridge at the pulp-dentin border. This newly formed dentin is comparatively less mineralized and softer, as it contains more organic material. Still, it helps to block stimuli from the outside and thus to protect the pulp vitality. However, the formation of osteodentin, dentin with an osteotypic appearance and scar-like soft tissue is also regarded as successful healing, although osteotypic hard tissue cannot provide the necessary barrier effect to protect the pulp from exogenous destructive stimuli. Two separate responses can significantly influence the successful outcomes of pulp capping therapies. The first is the response to the operative procedure, and the second is the reaction to the restorative modalities [12]. As a basic requisite for successful healing, sterile principles should be applied during all restoration procedures. It is necessary to relieve the inflammatory reaction of the irritated pulp and to control the bleeding before restoring a tooth with a permanent material. A layer of restorative material can be applied on top of the wound after removing contaminated dental tissue and control the contamination. The restorative material should not only offer the dentin-pulp complex a relative stable environment, but also support the regeneration of dentin-pulp complex. In this regard, treatment modalities should be able to induce the differentiation of odontoblasts [13].

- **Whole Pulp Regeneration:** It should be considered if the pulp has to be removed completely [14]. The presence of differentiated odontoblasts lining the inner wall of the pulp chamber and root canal can facilitate repair of the functional dentin-pulp complex. However, when odontoblast differentiation occurs throughout the regenerated pulp, pulp stone formation may occur, which can block the blood supply, which is supplied only from the narrow apical end of the tooth, and cause pulp necrosis [15]. Stem-cell-based tissue engineering and autogenous tooth implantation provide potential strategies for successful pulp regeneration. The concept of tissue engineering was conceived by Langer and Vacanti in the early 1990s to describe the technique for biological tissue regeneration. Cells, molecular signals and scaffolds are the three main components of tissue engineering. The most promising cell sources for tissue engineering are stem cells. A stem cell is an undifferentiated cell, which has the potential to proliferate and generate progenitor cells that can differentiate into specialized cells throughout postnatal life. Tooth buds are another source of cells that have been groups have reported the formation of bioengineered teeth with anatomically correct tooth-crown shape and enamel,

dentin and pulp tissues, using dental cell re-aggregated tooth bud cells. Similar results were achieved by replacing dental mesenchymal cells with mesenchymal cells obtained fromother sources, including embryonic stem cells, neural stem cells, and adult bone-marrow-derived cells. Another essential component of tissue engineering is scaffolds. An appropriate scaffolding material must support the attachment, proliferation, and differentiation of seeded stem cells. For dental pulp regeneration, the ideal scaffold should also support vascularization and innervations of pulp tissue [16]. A regenerated highly vascularized soft tissue core with surrounding hard tissue seal would result in the best prognosis. Mooney et al. reported that human DPSCs seeded onto a 3D PGA matrix and grown in vitro formed new tissue with a cellularity similar to that of native pulp. Further studies from the same group showed limited cell proliferation on collagen gels, and no cell proliferation on alginate scaffolds. The third important factor for tissue engineering is to select appropriate growth factors [17]. Asmentioned earlier, morphogens such as BMPs can induce DPSCs to differentiate into odontoblast-like cells. Direct application of growth factors often results in only temporary release. As compared to protein therapy, gene therapy is an alternative approach that may overcome these disadvantages. The effectiveness of this kind of in vivo gene therapy highly depends on the vitality of the remaining dental pulp cells. Ex vivo gene therapy, involving the transfer of in vitro transfected cells back in vivo may provide a better solution.

Autogenous Tooth Transplantation: Dental implants and tooth transplantations are the two most commonly used techniques to fill edentulous spaces caused by tooth loss and genetic tooth agenesis. Dental implant success highly relies on clinician skill, the quality and quantity of the bone available at the implant site and also the patient's oral hygiene and overall health. However, as compared to dental implants, tooth transplantation is much faster and less expensive [18]. Autologous tooth transplantation using available third molar wisdom teeth is an economically feasible clinical therapy and teeth exhibiting two-thirds root formation are considered to be ideal for reimplantation. Another advantage of tooth transplantation is the possibility for pulp regenerationA blood clot needs to be produced to achieve possible root-canal revascularization. For endodontic treatment, it is recommended to create a blood clot after the contaminated tissue removal and infection control treatment [19]. The mechanism of how a blood clot benefits the root canal revascularization is not entirely clear, although one possible reason is that SCAP cells from the apical papilla may migrate into the root canal and produce dentin-pulp complex-like tissue.

Prospects for Pulp Regeneration [20]: The goal of pulp regeneration is to regenerate a vital dental pulp covered with dentin to seal the reinfiltration of pathogens. Histological examination can verify the vitality of dental pulp, but is not practical for clinicians who are limited to clinical and radiographic evaluations. For this reason, more sensitive methods and instruments need to be developed. It is possible that pulp regeneration using autologous DSC might become a routine therapy after endodontic treatment. Perhaps the most promising solution might be induced pluripotent stem cells. To date, no published reports of induced dental stem cells have been reported.

CONCLUSION

It is widely known that maintaining and regenerating dental pulp vitality is critical for long-term tooth viability. Complete pulp regeneration and revascularization can be achieved after successful vital pulp therapy even when little vital pulp remains. At the present time, stem-cell-based tissue engineering approaches provide the most promising solution. The ability to successfully use iPSC's and induced dental stem cells, for dental pulp regenerative therapies, could eventually provide a practical alternative cell source.

REFERENCES

1. West J. (2006) Endodontic update 2006. *Journal of Esthetic and Restorative Dentistry*, 18(50), 280–300.
2. Valderhaug J. Assessment of the periapical and clinical status of crowned teeth over 25 years. *Journal of Dentistry*, 1997, 25(2), 97– 105.
3. Nanci A. (2007). Ten Cate's Oral Histology, Development, Structure, and Function,Mosby, Elsevier, St. Louis,Mo, USA, 7th edition.
4. Eleazer P. (2008). Comparison of success of implants versus endodontically treated teeth. *Journal of Endodontics*, 34(11), 1302–1305.
5. Gulabivala K. (2008) Outcome of secondary root canal treatment, a systematic review of the literature. *International Endodontic Journal*, 41(12), 1026– 1046.
6. Nair P. (2006). On the causes of persistent apical periodontitis, a review. *International Endodontic Journal*, 39(4), 249–281.
7. Ceyhan J. (2009). Restorations of endodontically treated teeth, new concepts, materials, and aesthetics. *Practical Procedures & Aesthetic Dentistry*, 21(2), 81–89.
8. Glickman G. (2000). 21st-century endodontics. *Journal of the American Dental Association*, 131(6), 39–46.

9. Klinge R. (1999). A microradiographic and electron microscopic study of tertiary dentin in human deciduous teeth. *Acta Odontologica Scandinavica*, 57(2), 87–92.
10. Smith A. (2002). Effects of alginate hydrogels and TGF-β1 on human dental pulp repair in vitro. *Connective Tissue Research*, 43(2), 387– 390.
11. Smith A. (2000). Stimulation of the rat dentine-pulp complex by bone morphogenetic protein- 7 in vitro. *Archives of Oral Biology*, 45(2), 173–177.
12. Lin L. (2006). Histological study of periradicular tissue responses to uninfected and infected devitalized pulps in dogs. *Journal of Endodontics*, 32(1), 34–38.
13. Coll P. (2004). Caries control and other variables associated with success of primary molar vital pulp therapy. *Pediatric Dentistry*, 26(3), 214– 220.
14. Silva L. (2008). Biofilm on the apical region of roots in primary teeth with vital and necrotic pulps with or without radiographically evident apical pathosis. *International Endodontic Journal*, 41(8), 664–669.
15. Bishop B. (2002). Modern endodontic therapy for an incompletely developed tooth. *General Dentistry*. 50(3), 252–256.
16. Dammaschke T. (2008). The history of direct pulp capping. *Journal of the History of Dentistry*, 56(1), 9–23.
17. DeRosa T. (2006). A retrospective evaluation of pulpotomy as an alternative to extraction. *General Dentistry*, 54(1), 37–40.
18. Fitzgerald M. (1990).Autoradiographic analysis of odontoblast replacement following pulp exposure in primate teeth. *Archives of Oral Biology*, 35(9), 707–715.
19. Fuks A. (2008). Vital pulp therapy with new materials for primary teeth, new directions and treatment perspectives. *Pediatric Dentistry*, 30(3), 211–219.
20. Fong C. (2002). Partial pulpotomy for immature permanent teeth, its present and fixture. *Pediatric Dentistry*, 24(1), 29–32.