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Regeneration of Dental Pulp- A Review

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Abstract:
The regenerative potential of dental pulp is very limited in mature teeth. However, our improved understanding of pulpal inflammation and repair and improved dental materials and technologies make vital pulp therapy a viable alternative to root canal treatment. This article explores our knowledge in this regard and the future potential of saving or even regenerating the pulp as a routine dental procedure.

INTRODUCTION

Dental pulp is the innermost and the softest tissue of the teeth. It has various functions namely nutritive, formative, protective and reparative. Pulp is the only vascularized tissue covered in highly mineralized structures like dentin, enamel and cementum. It also maintains the homoestatis of the tooth. [1] Endodontic treatment or root canal therapy for irreversible pulpitis is pulpectomy, involving pulp extirpation followed by root canal enlargement and obturation with gutta percha, a bioinert thermoplastic material. [2] A substantial amount of tooth structures, including enamel and dentin, is removed during endodontic treatment, potentially leading to posttreatment tooth fracture and trauma[2,4]. Endodontically treated teeth have lost pulpal sensation, and are deprived of the ability to detect secondary infections. [2,3,5] The complications of current endodontic treatment are inevitable because of pulp devitalization or the loss of the tooth's innate homeostasis and defense mechanisms. Pulpectomy, the most common endodontic treatment, involves extirpation of dental pulp, and therefore leaves no dental pulp stem cells in the same tooth for pulp regeneration. For a patient who requires endodontic treatment in a given tooth but has intact dentition otherwise, no healthy tooth is to be sacrificed for isolation of dental pulp stem cells. Even in patients whose autologous dental pulp stem cells can be harvested, for example, from extracted wisdom teeth, clinical therapy of dental pulp regeneration is difficult to develop due to excessive costs, including cell isolation, handling, storage, and shipping, ex vivo manipulation, immune rejection (for allogeneic cells), not to mention liabilities of potential contamination, pathogen transmission, and tumorigenesis that may be associated with cell transplantation . [14,15]

Cell homing has been regarded as a process of exit of hematopoietic stem cells from blood vessels by transendothelialization and subsequent migration. [16]. In tissue regeneration, cell homing is dubbed as active recruitment of endogenous cells, including stem/progenitor cells, into an anatomic compartment . [17,18] Particular discussion on this topic has been made to determine whether dental-pulp-like tissue can be regenerated in endodontically treated root canals of real-size, native human teeth by chemo taxis-induced cell homing, rather than cell transplantation. Our motivation for the study is to explore whether chemo taxis-induced cell homing is sufficient for the regeneration of dental-pulp-like tissue in endodontically treated root canals of real-size, native human teeth.

USAGE OF VITAL PULP

It is also essential to know the value of vital pulp in a fully formed tooth. Endodontic disease is apical periodontitis, and as such, the biologic rationale for endodontics is the prevention or treatment of apical periodontitis. For apical periodontitis to be present, the root canal must contain a necrotic infected pulp .[19] Therefore, the noninfected pulp ensures no apical periodontitis. Thus, maintaining the vital pulp prevents apical periodontitis, and the potential to regenerate an injured or necrotic pulp would be the best root filling possible.

REGENERATIVE POTENTIAL OF DENTAL PULP

Exposed Pulp

Treatment of the exposed pulp remains quite controversial, with different approaches endorsed by different dental specialties. Vital therapy on traumatically exposed pulps is very successful [21], whereas vital pulp therapy on the cariously exposed tooth is not nearly as successful . [22] The difference in success rates is explained by the status of the pulp at the time of the procedure . Capping the healthy pulp gives very high success rates, whereas capping the inflamed pulp results in lower and less predictable success. [23,24,25] On the other hand, with a carious exposure the area and depth of inflammation are very unpredictable, and pulp capping at the superficial exposure site is popular. Thus, it is very likely that we would be capping an inflamed pulp, and more failures (necrotic pulps) would result.

Another extremely important factor in the success of treating a vital exposure is the coronal seal after the pulp capping/pulpotomy. [26] Cox et al. showed that the pulp can withstand the toxicity of most dental materials, and that what was previously interpreted as toxicity was, in fact, due to the material not sealing adequately. Therefore, it is considered essential that a well-sealed coronal seal be placed over the vital pulp therapy. This is considered much more important than the material used on the vital pulp.

Unexposed Pulp

The inflamed pulp which is unexposed by caries or trauma has the ability to be repaired. Although our diagnostic ability to differentiate a vital from a necrotic pulp is good, differentiating between reversibly and irreversibly inflamed pulp remains an educated guess at best. [20] However, the younger the pulp is, the better will be its repair potential.

REGENERATION OF ROOT CANAL CONNECTIVE TISSUE

The connective tissue remaining in the root canal initiates various defense responses because of the presence of bacteria. The endodontic community has mainly focused its research on root canal disinfection and subsequent filling with an inert material. There is a large percentage of failures associated with periapical disease on badly treated teeth. Since root canal treatments are technically difficult to complete, especially by non-specialist clinicians, endodontics would benefit from alternative approaches [27].Various research have been done to regenerate a vascularized tissue in an empty canal; however, the absence of infection in these research has limited their relevance to the clinical situation [28]. Subsequently, the endodontic community has largely focused on more mechanical aspects of root fillings, including the use of disinfection methods, files and instrumentation, and alternative filling materials and techniques. For more than 30 years, little progress has been made on the design of new approaches in endodontics, other than shaping, disinfecting, and novel filling methods. Over the past decade, revascularization of the root canal has been re-proposed with a two-visit therapeutic approach [29]. In this procedure, the root canal system is disinfected with a mix of antibiotics, and a blood clot is subsequently induced in the canal itself by irritation of the periapical apex area with an endodontic file. This clot is then protected by a mineral trioxide aggregate plug, and the coronal cavity is sealed and restored by conventional treatment. Although case reports have been published based around this approach few have attempted to describe the regenerative processes taking place[30]. Although this was initially presented as a regenerative technique, indicating that the regenerated connective tissue was a dental-pulp-like tissue, many authors have described it as a revascularization approach rather than a regenerative one, meaning that there is no histological proof that the new tissue forming in the root canal is comparable with the pulp. Recently, Wang *et al*. described a combination of dentin, cementum, and pulp regeneration in a dog tooth following the use of a revascularization approach [31]. So far, our limited knowledge regarding the healing process has limited the development of new techniques. The hypothetical involvement of SCAP cells remaining viable even in very aggressive infection conditions implies a limitation to this therapy in immature necrotic teeth [32]. However, further work on SCAP cell use in this area is required. Many other scientific/clinical questions still remain in this area. While regeneration of the whole dental pulp would be ideal clinically, regenerating a connective tissue, mineralized or not, might provide an acceptable compromise. Indeed, the aim of our current research is to prevent any further infection of the tooth and protect the periapical tissues. The inert materials used in endodontics have limited sealing ability and, ultimately, a limited clinical longevity.

CLINICAL ADVANTAGE OF PULP REGENERATION

Although the success rate of endodontic treatment is relatively high (78–98%) [33-36] ,there are many problems associated with this aggressive treatment, which includes the following:

- Mostly Endodontic procedures are technically sensitive; mishaps occur such as blockage of the root-canal space, and breakage of instruments in the canals and create perforations [37 -42] which will leave infected tissue behind or even cause loss of the tooth;
- If the teeth is immature that has little dentin structure after loss of pulp tissue, endodontic treatment cannot prevent its susceptibility to fracture from traumatic injuries [43-47].
- Teeth after undergoing endodontic treatment lose a significant amount of tooth structure. Post-space plus crown preparation sacrifices more tooth structure, which weakens the tooth [48-50].
- Pulpless teeth have no sensation to irritations, rendering caries progression unnoticed by patients. Teeth loss is higher for endodontically treated teeth than nontreated teeth owing to secondary caries and complex restoration-associated problems [51-54].

CONCLUSION

Dental pulp regeneration is very helpful in finding about the inflammation of the pulp, fracture of pulp and other diseases associated with pulp.

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