Inside story: how do the dentine and the dental pulp work together to protect teeth? Ruksana Miah

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Introduction

Teeth play an important role in both an individuals’ health, speech and appearance hence it is crucial that there are protective mechanisms in place to protect these structures from chemical processes and trauma. Dentine is a mineralized vital tissue located underneath the enamel and cementum. It consists of 33% organic matter, 45% hydroxyapatite and 22% water [17]. The dentin layer encloses the pulp. This includes odontoblasts that are involved in dentinogenesis, fibroblasts, macrophages, neurons and vascular tissue [17]. Dentinal tubules are microscopic channels that extend between the cementoenamel junction and the pulp layer beneath it; they are involved in the regeneration process, nerves also pass through allowing the dentin to transmit pain [17]. Functionally and histologically the dentin and pulp are regarded as a single entity and are therefore considered to be a complex [19]. The aim of this poster is to understand the protective functions of each structure, how they work together and whether one can work in isolation to another.

Tertiary dentin

Dentin functions as the substructure of the enamel tissue as it has the ability to absorb functional loads and flex without fracturing, it also acts as a barrier protecting the underlying pulp from pathogens [17]. Tertiary dentin develops in response to trauma or restorative procedures. It is formed by the cells directly affected by the stimulus hence the structure and amount depends on the intensity and duration of the stimulus [17]. Tertiary dentin is subdivided into refractory dentin, which is formed by existing odontoblasts in response to mild stimuli and reparative dentine which is deposited by newly differentiated odontoblasts like cells [17]. Extensive caries or abrasion may result in death of the odontoblast processes in response the undifferentiated perivascular cells located deeper inside the pulp replace the injured odontoblasts [17]. As a result a complex of primary and reparative dentin are less permeable to the external environment thus providing protection from harmful pathogens and irritants. Scrotic dentin production is accelerated by external stimuli such as caries; this reduces permeation by deposition of calcified minerals within the tubules, prolonging pulp vitality [17].

Methods

Initially a mind map was created which covered potential areas to look into and how to organise the poster. Using the mind map key words were looked into further such as ‘tertiary dentin’ and ‘dentin permeability’ using search engines such as Google, Google scholar and PubMed. This provided journals and websites, which gave refined information on each structure. Several textbooks highlighted concise details and offered useful overview of how both the dentine and dental pulp work together to protect teeth. All the relevant information was collated a rough draft was completed using Microsoft word and finally presented on Microsoft PowerPoint template after editing. Vancouver style referencing was also implemented.

Results

To understand the key protective functions of the dentine-pulp complex four main areas need to be considered: tertiary dentin, the dental pulp, dentinal fluid and the immune response.

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Over time both the dentin and pulp become less effective in providing protection. The dentine is more prone to cracks that can cut through the dentinal tubules weakening the tooth and cell regeneration also decreased [21].

The dentin and pulp is considered a single unit in providing protection. Studies have shown removal of pulp following a root canal treatment can lead to more extensive bacterial invasion compared to vital teeth [18]. This is because they contain odontoblastic processes and collagen fibers that provide protection [20]. This suggests one structure cannot work effectively without the other. The dentine-pulp complex also contains cells such as macrophages, which provide a response to bacterial invasion. In addition the decreased permeability of dentin due to the formation of tertiary dentin and outward flow of dentinal fluid collectively provide enhanced protection [17-19]. The dentin and pulp can work separately however their functions are improved together. Collectively the dentine encloses the pulp and blocks the entry of pathogens that may damage the tooth whilst the dental pulp is involved in formation of dentin following trauma. Therefore, ideally both structures need to work together to provide optimum protection.

Dental fluid

When dentin is exposed the intratubular fluid is able to move in response to osmotic, thermal or evaporative stimul [21]. This causes mechanical irritation and damage depending on the magnitude of the fluid shift. The tubules provide diffusion channels for the microorganisms, which may provoke an inflammatory response [21]. However the pulpal tissue responds to this by increasing interstitial fluid turnover this makes the exposed dentin less permeable due to outward fluid flow [21]. Overall this decreases the rate of diffusion of toxins from the mouth into the pulp. The response of the pulp to irritation of dentin illustrates the dynamic nature of the dentin-pulp complex.

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Discussion and Conclusions

Dental pulp

Studies have also proved that the dental pulp plays an essential role in protecting the teeth against bacteria. For example one study compared resistance to bacterial invasion in dentinal tubules of both vital and nonvital teeth [17]. The results illustrated significant statistical differences between the rate of bacterial invasion in vital and nonvital teeth. It was suggested that teeth with pulp removed and restored with root canals were more prone to bacterial invasion than the root canals and compared to vital teeth that contained pulp [17]. This study confirms that the dental pulp has a key role in protecting the teeth from harmful substances [17].

Immune response

Cells within the dental pulp have a broad range of response patterns to pathogens and activate both adaptive and innate immunity. Several toll receptors found on odontoblasts enable them to detect and respond to pathogens and thereby alert the immune system [17]. Activation of these receptors results in the production of chemokines and pro-inflammatory cytokines, which in turn triggers the release of immune cells. Odontoblasts can directly kill bacteria by the release of antimicrobial peptides [17]. Substances that control vascular permeability are also secreted. Following this macrophages and dendritic cells are responsible for antigen presentation this in turn stimulates a response from T-lymphocytes [17]. Greater number of t and b lymphocytes are present in cells with increasing lesion depth of caries [21]. In addition pulp affected by caries contains antimicrobial substances and immunoglobulins such as IgG, IgA and IgG that provide further protection against bacterial infections [21].

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References

