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Mini Review

Cementum Proteins: The Foundation of Dental Health

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Abstract

Destruction of the periodontium is normally associated with periodontal disease, although many other factors, such as trauma, aging, infections, orthodontic tooth movement and systemic and genetic diseases, can contribute to this process. Strategies (such as guided tissue regeneration) have been developed to guide and control regeneration using bioresorbable membranes and bone grafts. Although effective to a certain point, these strategies have the problem that they are not predictable and do not completely restore the architecture of the original periodontium. To achieve complete repair and regeneration it is necessary to recapitulate the developmental process with complete formation of cementum, bone and periodontal ligament fibers. Detailed knowledge of the biology of cementum is key for understanding how the periodontium functions, identifying pathological issues and for developing successful therapies for repair and regeneration of damaged periodontal tissue. It is the purpose of this review to focus on the role of cementum and its specific components in the formation, repair and regeneration of the periodontium. As cementum is a matrix rich in growth factors that could influence the activities of various periodontal cell types, this review will examine the characteristics of cementum, its composition and the role of cementum components, especially the cementum protein-1, during the process of cementogenesis, and their potential usefulness for regeneration of the periodontal structures in a predictable therapeutic manner.

Keywords: *Cementum Proteins; Dental Health; Cementogenesis*

Introduction

Cementum, a crucial component of the tooth's anatomy, plays a significant role in dental health. Cementum is characterized as calcified, mesenchymal tissue with few or no blood vessels that shapes the external covering of the physical root [1]. Understanding the proteins present in cementum is vital for comprehending its functions in dentistry.

This review will focus on several key cementum proteins: Cementum attachment protein (CAP), Cementum-derived growth factors (CGFs), Cementum protein 1 (CEMP1), Osteonectin, bone sialoprotein (BSP), and Osteopontin (OPN) and glycosaminoglycans.

Composition of cementum

The significant natural part of cementum is collagen [2]. The major kind of collagen is type I collagen, which represents 90% of all collagens and assumes an underlying part during the bio-mineralization process, filling in as a repository for hydroxyapatite nucleation, which progressively forms into intrafibrillar apatite crystals [3]. Type III collagen, which coats type I collagen fibrils, is additionally present, albeit in extensively lower amounts [5]. In addition to collagens, carboxylated and sulfated mucopolysaccharides (glycosaminoglycans) are available in human cementum [4].

Classification of cementum

Histologically cementum can be partitioned into two sorts, acellular and cellular, as indicated by the presence of cementocytes implanted inside its lattice. Also, cementum has been additionally ordered by the idea of its natural grid. In this way, by and large, four sorts of cementum are perceived [6].

Cellular cementum is one of the main categories, characterized by the presence of cementocytes within its matrix [7].

Acellular extrinsic fiber cementum, on the other hand, lacks cementocytes and is primarily composed of extrinsic collagen fibers [8]. It provides attachment for the periodontal ligament fibers, contributing to tooth stability [9].

Another form is acellular intrinsic fiber cementum. Which contains intrinsic collagen fibers but no cementocytes [10]. This type of cementum is vital for maintaining tooth support and resisting external forces [11].

Mixed stratified cementum combines characteristics of both cellular and acellular cementum [12]. It is present in various parts of the tooth root, playing a role in anchoring the tooth to the alveolar bone [13].

Types of cementum proteins

Cementum attachment protein (CAP): CAP is necessary for the attachment of cementum to PDL fibers [14]. The integration of PDL fibers into the cementum matrix is dependent on this protein's ability to promote cell adhesion and migration [15]. CAP also impacts the transformation and activity of cementoblasts, the cells responsible for establishing and maintaining cementum [16].

Cementum-derived growth factors (CDGFs): CGFs, such as transforming growth factor-beta (TGF-β) and insulin-like growth factor (IGF), are important regulators of cementoblast differentiation and proliferation [17]. The cementum-PDL complex's structural stability is aided by the extracellular matrix proteins produced by these growth factors [18]. In addition, CGFs support periodontal tissue regeneration and repair after damage or disease [19].

Cementum protein 1 (CEMP1): By affecting the orientation and production of hydroxyapatite crystals, CEMP1 controls the mineralization of cementum [20]. It is important for the acellular cementum's formation because it anchors PDL fibres to the tooth root [21]. Additionally, CEMP1 controls the expression of other cementogenesis-related proteins, promoting the healthy development and upkeep of cementum [22].

Osteonectin: Osteonectin is important in controlling cell-matrix interactions and cementum mineralization. It is sometimes referred to as secreted protein acidic and rich in cysteine (SPARC) [23]. This protein facilitates the development and upkeep of a stable cementum layer by improving cementoblast adherence to the extracellular matrix [24]. Additionally, osteonectin is involved in the remodelling and healing of cementum, especially in the aftermath of injury and mechanical stress [25].

Bone sialoprotein: A glycoprotein called BSP is extensively expressed in the cementum and is essential for the initiation and development of hydroxyapatite crystals [26]. It is essential for the mineralization of both cellular and acellular cementum, which increases the tooth root's overall stability and hardness [27]. Furthermore, BSP improves the mechanical integrity of the tooth-PDL interface by facilitating PDL fibre binding to the cementum surface [28].

Osteopontin: A multifunctional protein called osteopontin controls cell signalling and mineralization in the cementum [29]. By preventing the growth of big hydroxyapatite crystals, it keeps the cementum's mineral structure fine and stable [30]. Moreover, it contributes to the immune response by shielding periodontal tissues from inflammation and bacterial invasion [31].

Glycosaminoglycans: GAGs have two main functions in cementum: they modulate the mineralization process and act as a scaffold for interactions between proteins [32]. To help these proteins adhere and align inside the cementum matrix, they interact with a variety of cementum proteins, including osteopontin and bone sialoprotein [33].

Moreover, GAGs are essential for controlling cellular processes, such as the growth and differentiation of cementoblasts, the cells that create cementum [34]. GAGs enhance the biological activity of these molecules by binding to growth factors and helping to localise and concentrate them within the cementum [35].

Conclusion

Cementum proteins are essential components of dental tissues that contribute to tooth stability, periodontal health, and potential dental regeneration. Ongoing research in this field holds promise for advancing dental treatments and improving our understanding of tooth development and repair mechanisms. As the field of dentistry continues to evolve, cementum proteins remain a subject of interest and investigation for dental professionals and researchers alike.

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