Cementum in Health and Disease

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Introduction
The periodontium is defined as those tissues supporting and investing the tooth.

- It consists of the cementum,
- the periodontal ligament,
- the alveolar bone and
- the gingiva.

Cementum is the least understood one of these four tissues.
• The Cementum is a hard, avascular, calcified connective tissue covering the root dentin and gives insertion to the periodontal fiber bundle.

• It can be regarded as a “bone of attachment”.

• It is pale yellow and softer than dentin.
• Cementum is formed throughout life and is resistant to resorption.

• Cementum functions as an area of attachment for the periodontal ligament fibers.
Thickness of cementum:

- The thickness of cementum varies considerably
  - coronal third may be 16-60 µm thick (thickness of hair)
  - apical third and furcation areas can be 150-200 µm or even thicker (greatest thickness)
• It is thicker in distal surfaces than in mesial surfaces.

• Between 11 and 70 years, the average thickness of cementum increases threefold, with greatest increase in apical region.

• Average thickness: 95 µm at 20yrs and 215 µm at 60yrs
Chemical Composition
Permanent teeth contains

- 45-50% inorganic substance
- 50-55% organic material and water.
• The inorganic portion consists of calcium and phosphate in the form of hydroxyapatite (Ca$_{10}$[Po$_4$]$_6$[OH]$_2$).

• They are thin, needle-shaped crystals.

• It is less than that of bone (65%), enamel (97%), dentin (70%).
• The organic portion of the cementum is composed primarily of type I (90%) and type III (about 5%) collagens.

• Sharpey’s fibers, which constitute the major portion of cementum are composed of mainly collagen type I.
cells
Cementoblasts originate from the ectomesenchymal cells in the dental follicle surrounding the developing tooth.
Cementocytes

- These are spider-like cells incorporated into cellular cementum.
- They lie in lacunae.
- A typical cementocyte has numerous cell processes or canaliculi radiating from its cell body.
Cementogenesis
• The formation of cementum is called cementogenesis.

• The zone immediately in contact with the dental organ and continuous with the ectomesenchyme of the dental papilla is the dental follicle.

• The dental follicle gives rise to cementoblasts, osteoblasts, and fibroblasts.

• Cementoblasts are the cells responsible for cementogenesis.
Two forms of cementum develop

1. acellular
2. cellular

One of the major current hypotheses is that cells producing cellular cementum migrate from the adjacent area of bone.

Cells producing acellular cementum arise from the dental follicle.
Classification
Based on the location
Coronal cementum

• After enamel formation is completed, the ameloblastic epithelium is reduced, this reduced enamel epithelium disappears, placing the enamel surface in contact with the connective tissue.

• Connective tissue cells deposit thin layer of cementum called coronal cementum on the enamel.
Radicular cementum

- The cementum that is found on the root surface.
- The cementoblasts are responsible for the production of radicular cementum.
Based on the time of formation
Primary Cementum

- Primary cementum is formed before the tooth reaches the occlusal plane.
• Secondary cementum forms after the tooth reaches the occlusal plane.
Based on its cellularity
Cellular cementum

- Cementum containing cementocytes in lacunae that communicate with each other through a system of anastomosing canaliculi.
• It is less calcified.

• Sharpey’s fibers occupy a small portion.

• Sharpey’s fibers may be completely or partially calcified or may have a central, uncalcified core surrounded by a calcified border.
Acellular cementum

- Acellular cementum forms first.
- Acellular cementum contains a secreted matrix of proteins and collagen fibrils.
• It covers approximately the cervical third or half of the root, and does not contain the cells.

• Its thickness ranges from 30 to 230 µm.

• Sharpey’s fibers make up most of the structure and is completely calcified, with the mineral crystals oriented parallel to the fibrils.
Based on the presence / absence of collagenous fibrils
Fibrillar cementum

- Cementum with a matrix that contains well-defined fibrils of type I collagen.
A fibrillar cementum

• Cementum that has a matrix devoid of detectable type I collagen fibrils.

• The matrix tends to have a fine, granular consistency.
Based on origin of collagenous fibrils
Extrinsic fiber cementum

- Sharpey's fibers continuous with the principal fibers of the periodontal ligament.

- Since the fibers were originally produced by periodontal ligament fibroblasts, they are considered "extrinsic" to the cementum.

- These fibers are orientated more or less perpendicularly to the cementum surface and play a major role in tooth anchorage.
Intrinsic fiber cementum

• Fibers produced by cementoblasts and are orientated more or less parallel to the cementum surface.

• This form of cementum is located predominantly at sites undergoing repair, following surface resorption.

• It plays no role in tooth anchorage.
Schroder's classification of cementum (1986)
Acellular Afibrillar Cementum (AAC)

- Found deposited on mature enamel surfaces.
- It may be deposited during tooth formation, during tooth eruption or after it.
- Appears as cemental spurs or cementum islands on the crown of erupted teeth.
• This type of cementum is probably of little significance as it is not involved in fiber insertion and tooth anchorage.

• Neither contains cells nor extrinsic or intrinsic collagen fibres.
Acellular Extrinsic Fiber Cementum (AEFC)

- It contains densely packed collagen fibers that project in a perpendicular manner from the cementum matrix into the periodontal ligament.

- This type of cementum forms on the newly synthesized dentin surfaces.

- It extends from the cervical margin of the tooth and covers at least two thirds of the root.
Acellular Extrinsic Fiber Cementum (AEFC)
Cellular mixed stratified cementum (CMSC)

- It is composed of (Sharpey’s fibres) and intrinsic fibres and may contain cells.
- It is a co-product of fibroblasts and cementoblasts.
- It appears primarily in the apical third of the roots and apices and furcation areas.
- Its thickness ranges from 100 to 1000µm.
Cellular intrinsic fiber cementum (CIFC)

- It is considered to be a form of reparative cementum.
- This type of cementum is commonly associated with the repair of resorptive defects and healing of root fractures.
Acellular intrinsic fiber cementum (AIFC)

- It is a acellular variant of cellular intrinsic fiber cementum that is also deposited during adaptive responses to external forces.

- It forms without leaving cells behind.

(Bosshardt and Schroeder 1990)
Intermediate cementum

• It is a form of secondary cellular intrinsic fiber cementum restricted to the apex of the tooth.

• It is not involved in tooth attachment and has no functional significance.
Mixed stratified cementum

- It describes a layered arrangement of apical cementum that consists of alternate layers of acellular extrinsic and cellular fiber cementum.
Cemento Enamel junction (CEJ)

Three types of relationships at the CEJ

1. 60% - 65% cases, cementum overlaps the enamel
2. 30% there is an edge to edge butt joint and in
3. 5% to 10% the cementum and enamel fail to meet
Cementodentinal junction (CDJ)

- The terminal apical area of cementum where it joins the internal root canal dentin is known as the CDJ.
- Width appears to be stable even as age increases.
- It is about 2 to 3 µm wide.
- The fibril poor layer contains proteoglycans, and fibrils intermingle between the cementum and dentin.
NORMAL FEATURES OF CEMENTAL SURFACES

• Extensive variation in surface topography of cementum can be observed with scanning electron microscope (SEM).
• Resting cemental surfaces, where mineralization is more or less complete, exhibit low rounded projections known as cemental mounts.

• Cemental surfaces with actively mineralizing fronts have numerous small openings.

• Represent unmineralized cores of fibers.
CHANGES IN DISEASED CEMENTUM

• Many Gram negative bacteria have the ability to attach to gram positive bacteria in the cementum and the epithelial cells (Slots and Genco, 1984).
CEMENTUM FROM PERIODONTITIS AFFECTED TEETH

- The affected root surface inhibits the demineralization effects.
- Periodontitis affected cementum, is not appreciably altered in appearance, it has only a faintly mat-like surface texture.
- Calculus affected cementum undergoes changes that reduce the effects of demineralizing agents.
ROOT SURFACE WALL OF PERIODONTAL POCKET

- In normal cementum the collagen fibers are embedded in the cementum.

- These fibers are destroyed in pathological pocket wall with the exposure of cementum.

- Collagen remnants of Sharpey’s fibers in cementum undergo degeneration creating an environment favorable for penetration of bacteria.
Changes in cementum after instrumentation

• Firm scaling strokes used to remove subgingival calculus, also remove a small amount of cementum resulting in some notching of root surface.

Necrotic Cementum

• Cementum exposed by apical migration of junctional epithelium is altered by exposure to subgingival plaque within the pocket.
• It may become hypermineralized, demineralized or necrotic.
AGE CHANGES IN CEMENTUM

• Cementum deposition appears to be continuous throughout life, a direct relationship has been shown between age and cementum thickness.

• Cementum deposition is less near cementoenamel junction and greater in apical areas.

• Cementsal deposition slows in old age.

• In addition, the attachment of cementum to dentin may be weakened.
DEVELOPMENTAL AND ACQUIRED ANOMALIES ASSOCIATED WITH CEMENTOGENESIS

Enamel projection:

Occur in localized areas, particularly in furcations of mandibular teeth. It is suggested that projections may predispose the teeth to periodontal defect involving the furcation.
Enamel Pearls:

- This anomaly consists of globules of enamel on the root surface in the cervical region.

- They resemble small pearls up to several millimeters in diameter.

- They appear to form as a result of localized failure of Hertwig’s root sheath to separate from the dentin surface.
• They mimic calculus clinically and radigraphically, they cannot be sealed off and elimination can only be accomplished by grinding.

• Large pearls may contain pulp extensions.

Cementicles:

• These are globular masses of acellular cementum, generally less than 0.5 mm in diameter which form within periodontal ligament
Hypercementosis:

- Hypercementosis is a non-neoplastic deposition of excessive cementum that is continuous with the normal radicular cementum.

- It occurs predominantly in adulthood, and the frequency increases with age.
Factors causing hypercementosis:

Local factors

- Abnormal occlusal trauma,
- Unopposed teeth \( \text{(e.g. impacted, embedded, without antagonist)} \)
- Adjacent inflammation

Systemic factors

- Acromegaly and pituitary gigantism
- Arthritis
- Paget’s disease \( \text{(Generalized hypercementosis)} \)
- Rheumatic fever
- Thyroid goiter
- Vitamin A deficiency
Ankylosis

- Ankylosis may occur at any age clinically they are most obvious

- The most commonly involved tooth is primary first molar, the majority of cases occurring in the mandible.

- A sharp, solid sound may be noted on percussion of the involved teeth.
• Radiographically, absence of periodontal ligament space may be noted;

• Ankylosed teeth lead to a number of dental problems → The adjacent teeth often incline towards the affected tooth, with the development of subsequent occlusal and periodontal problems.

• In addition the opposing teeth often show supra eruption. Occasionally, the ankylosed teeth lead to impaction of the underlying permanent teeth.
Hypophosphatasia:

- It is a rare familial disease, characterized by incomplete bone mineralization.

- This condition was first described by Rathbun (1984) and is characterized by low levels of serum kidney and bone alkaline phosphatase and elevated levels of phosphoethanolamine in serum and urine (Watanabe et al, 1993)
CENTRAL LESIONS RELATED TO CEMENTUM

Based on clinical radiographic and histological features, bony lesions of cementum were classified by Pinborg et al in 1971 as:

- Periapical cemental dysplasia
- Benign cementoblastoma
- Cementifying fibroma
- Gigantiform cementoma
- Cemento-osseous dysplasia.
Cemental resorption occurs due to:

**Local factors**
- Trauma from occlusion
- Orthodontic movement
- Pressure from malaligned teeth, cysts, and tumors
- Teeth without a functional antagonist
- Embedded teeth
- Replanted and transplanted teeth
- Periapical disease
- Periodontal disease

**Systemic conditions**
- Calcium deficiency
- Hypothyroidism
- Hereditary fibrous osteodystrophy
- Paget’s disease
CONCLUSION

• With the development of newer concepts of regenerative cementogenesis and role of cementum in implants,
• the need for us to better understand this basic tissue should be understood and implemented.
THANK YOU