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Glass Ionomer Cement in Management of Non-Carious Cervical Lesions

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ABSTRACT:

Non carious lesions(NCCLS) are one of the most commonly occurring problem in dentistry affecting majorly adult population .These lesions are characterized by loss of tooth structure at the cement enamel junction which if not treated often results in hypersensitivity along with certain esthetic concerns. Glass ionomer cements(GIC) are employed in the management of non carious cervical lesions due to its unique properties .This review provides a comprehensive review to overview the use of GIC in the management of NCCL and discusses on successful management of NCCL depending on patients profile.

Introduction

Dentists often face the issue of hard tissue loss at the cementoenamel junction (CEJ) during their clinical practice. This condition, known as non-carious cervical lesions (NCCLs), can manifest in various forms, including large wedge-shaped defects, wide scooped-out lesions, or shallow grooves. These lesions can affect the labial, lingual/palatal, or proximal surfaces of the teeth.Early diagnosis of these lesions is important in prevention of difficulties and complications that could have a negative influence on patients' quality of life(1).

Non carious cervical lesions (NCCLs) are indeed becoming a significant concern for dental health. These lesions involve the loss of hard tissue from the cervical areas of teeth due to factors other than dental caries, such as erosion, abrasion, and possibly occlusal stress (abfraction). Noncarious cervical lesions (NCCLs) affect various aspects of dental health, including tooth sensitivity, plaque retention, caries incidence, structural integrity, and pulp vitality. These lesions present unique challenges for restoration, involving multiple steps such as isolation, adhesion, insertion technique, and finishing and polishing. Successful diagnosis and treatment require keen observation, a thorough patient history, and careful evaluation. (2)

This work aims to enhance understanding of the characteristics and etiological factors of NCCLs, improve prognosis assessment, assist in proper case selection for treatment, and aid in selecting appropriate treatment protocols for the condition.

ETIOLOGY

The clinical appearance of non-carious cervical lesions (NCCLs) can vary based on the type and severity of the underlying etiological factors. Research indicates that abfraction, like other NCCLs, has a complex etiology. Among the numerous potential factors associated with NCCLs, occlusal stress forces have been the focus of many studies in recent years. The interplay between chemical, biological, and behavioural factors is crucial, which explains why some individuals exhibit multiple types of cervical lesion mechanisms compared to others. (3) Indeed, NCCLs have been observed in individuals of all ages, but epidemiological studies have highlighted a significant rise in their occurrence among older adults. Kolak et al. found that in a group of patients over 55 years old, 94.7% had NCCLs, and one-third of these patients had more than three lesions. As life expectancy increases, leading to an older population, it becomes essential to focus on certain oral health-related factors that can impact quality of life (QoL). Advancing age is associated with a rise in chronic diseases as well as dental and oral issues. In

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particular, carious pathology and periodontal disease tend to worsen with age, resulting in a compromised masticatory system. Tooth hard-tissue loss can be categorized as either physiological or pathological. Physiological loss occurs over time due to the natural chewing action and may also be localized at the interproximal level due to friction between tooth surfaces. In contrast, pathological loss involves significant tissue destruction, requiring dental intervention. Non-carious cervical lesions (NCCLs) have a multifactorial etiology, resulting from various phenomena such as abrasion, abfraction, erosion, and attrition, which may occur simultaneously. (4)

PREVALENCE AND COMMON LOCATIONS

The prevalence of non-carious cervical lesions (NCCLs) has shown considerable variation, with lower percentages reported as 13.1% and higher percentages as 93%. The percentage of individuals with at least one typical V-shaped NCCL has been reported as 49.1%, while those with at least one lesion stood at 62.2%. The prevalence of non-carious cervical lesions (NCCLs) tends to rise with age; however, these lesions can be found across all age groups, including younger individuals. For instance, a study of 40 first-year dental students revealed that 29 of them had at least one affected tooth. Additionally, 129 out of 1,131 teeth in the sample exhibited NCCLs. After three years, there was an increase of 57 additional lesions among the same students. Non-carious cervical lesions (NCCLs) are frequently observed on the facial surfaces. However, slight lingual erosion has been noted in 3.6% of younger individuals and 6.1% of older individuals, with severe lingual erosion being rare. Multiple studies have identified maxillary premolars as the most commonly affected teeth, whereas another study found that mandibular first premolars were most commonly affected, followed by mandibular second premolars and then canines. (5)

PATHOPHYSIOLOGY OF DEMINERALIZATION

Demineralization is recognized as the most widespread chronic disease globally. It often leads to conditions such as osteoporosis (OP), which affects over 10% of the world population. Non-carious cervical lesions (NCCLs) have an even higher prevalence compared to osteoporosis, indicating their significant impact on dental health. Furthermore, dental caries remain one of the most common chronic diseases worldwide, affecting a vast number of individuals across different age groups and regions. The high prevalence of these conditions underscores the need for increased awareness and proactive measures in dental and overall health care. NCCLs, which can occur due to factors like abrasion, erosion, and stress, compromise the integrity of teeth, leading to sensitivity and potential dental complications. Non-carious cervical lesions (NCCLs) represent the second most prevalent manifestation of demineralization disease in the body. A non-carious cervical lesion (NCCL) has a complex etiology that utilizes the same demineralization mechanisms but presents in a unique pattern for each tooth. While patients may have multiple NCCLs, each lesion differs in its manifestation. It's uncommon for both sides to be affected symmetrically; usually, only one tooth is impacted. Cariogenic bacteria do not play a role in the development of NCCLs. However, other oral microorganisms, such asFusobacteriales, may help protect cervical lesions from acidic degradation through bacterial interactions and pH regulation. (5)

1. EROSION

Erosion occurs when the hard tissues of the teeth gradually wear away due to chemical processes rather than bacterial activity. This type of dental erosion is particularly prevalent on the smooth surfaces of the front teeth and premolars. The consumption of acidic foods and beverages, such as citrus fruits, sodas, and certain sports drinks, contributes significantly to this chemical wear. Over time, the acid exposure weakens and dissolves the tooth enamel, leading to the erosion of the tooth tissue. This process can have several detrimental effects on dental health. As the protective enamel layer erodes, the underlying dentin becomes exposed, increasing the risk of tooth sensitivity. Patients may experience discomfort or pain when consuming hot, cold, or sweet foods and drinks. Additionally, the structural integrity of the teeth can be compromised, making them more susceptible to fractures and other forms of damage.

The prevalence of cervical erosion lesions is not well-documented, but a 1949 study found that 27% of examined patients had tooth tissue loss on the facial surfaces due to erosion. The study also noted that both the prevalence and severity of these lesions increased with age. Additionally, more lesions were observed in the upper teeth compared to the lower teeth, with the first premolars being the most commonly affected. Acids play a significant role in the development of these lesions. (6)

Clinical feature

- Erosion involves the irreversible loss of dental hard tissue due to a chemical process that does not involve bacteria.
- This type of tooth surface loss is part of a broader context of tooth wear, which also includes attrition, abrasion, and potentially abfraction.
- Classic erosion lesions are characterized by their smooth, disc-shaped, rounded, and concave appearance, lacking sharp edges or developmental grooves.

Radiographic feature

- They appear as radiolucent defects on the crown, characterized by either well-defined or diffused margins.

2. ABRASION

Abrasion refers to the abnormal wearing away of a substance or structure due to mechanical processes. When it comes to non-carious cervical lesions (NCCLs), toothbrush abrasion, caused by the mechanical action of brushing, has been identified as a potential contributing factor. (6)The distribution of lesions can assist dentists in accurately identifying risk factors. For instance, unilateral lesions in the second quadrant might be linked to improper brushing techniques in a right-handed person. Additionally, abrasion lesions can occur on the occlusal surfaces of the teeth due to an abrasive diet or the chewing of abrasive substances such as tobacco. (4)

Clinical feature

- Abrasion refers to the pathological wearing away of tooth substance due to an abnormal mechanical process, usually occurring on the exposed root surfaces of teeth, though it can also be seen on the incisal edges in certain circumstances.
- The most common cause of root surface abrasion is the use of an abrasive dentifrice.
- Abrasion from dentifrice typically appears as a V-shaped or wedge-shaped ditch on the root side of the cementoenamel junction in teeth with some gingival recession.
- The angles formed in the depths of the lesions, as well as those at the enamel edges, are typically sharp, and the exposed dentin appears highly polished.
- Other less common forms of abrasion can be related to habits or occupations. For instance, the habitual opening of bobby pins with the teeth can result in notching of the incisal edge of one maxillary central incisor. Similar notching can be observed in carpenters, shoemakers, or tailors who hold nails, tacks, or pins between their teeth.

Radiographic feature

- These defects appear as well-defined, semicircular or semilunar radiolucent areas at the cervical level of the tooth.
- The borders of these defects show increased radiopacity, and obliterated pulp chambers are often observed.

3.ABFRACTION

Some experts suggest that additional factors may contribute to the development of non-carious cervical lesions (NCCLs) that have not been traditionally considered. One hypothesis is that the pressure from biting and chewing can cause the tooth to bend and flex, leading to enamel damage at the cervical region. This type of damage, termed "abfraction" by Grippo, has been studied alongside the effects of friction on enamel. Research indicates that friction can create cracks and weaknesses in the enamel rods and the material between them, making the enamel more susceptible to damage.

Clinical feature

- Abfraction are characterized by the pathological loss of both enamel and dentin due to biomechanical loading forces.
- These lesions, found at the cervical regions of teeth, are typically wedge-shaped with sharp internal and external line angles.
- The location of these lesions correlates directly with the direction of lateral forces exerted on the tooth. Commonly affected teeth include anterior and premolar teeth, with mandibular premolars being the most prone, followed by maxillary premolars.

Radiographic feature

- In some cases, dental X-rays can help determine whether the lesions have affected the inner layers of the tooth, such as the dentin or pulp. (6)

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4.ATTRITION

Attrition wear refers to the natural, physiological wearing down of teeth that occurs when opposing teeth come into contact, without the involvement of any abrasive substance. This type of wear is influenced by both the magnitude of the applied load and the duration for which this load is applied. Over time, these factors contribute to the gradual loss of tooth substance.Non-axial, or lateral, loads that arise from chronic clenching (a condition known as parafunction) further exacerbate this wear. Such lateral forces cause the tooth surfaces to flex at the cervical region, which can exceed the established stress limits of enamel, leading to its failure. This flexure and resultant stress can cause cracks and eventual loss of the enamel in these areas, highlighting the importance of managing parafunctional habits to maintain dental health.
In clinical practice, understanding the contribution of both axial and non-axial loads to attrition wear is crucial for diagnosing and treating dental wear effectively. Identifying the signs of attrition early can help prevent more severe damage, and implementing measures such as night guards or other occlusal devices can mitigate the effects of parafunctional habits. This comprehensive approach is essential for preserving the integrity of the teeth and maintaining overall oral health.

GLASS IONOMER CEMENT FOR NCCL

Glass ionomer cements (GICs) are indeed widely used in restorative dentistry particularly for non-carious cervical lesions. They are favoured for their ability to bond well with bothenamel and dentin, their prolonged fluoride release, and their biocompatibility, which promotes good biological responses. These properties make GICs a versatile choice for various clinical applications, including the restoration of cervical lesions .GICs offer some unique advantages, especially in specific clinical situations. Some of the key clinical applications of glass ionomer cements (GIC) includes as pit and fissure sealant,lutingagent,cavity liner or bases.as restorative agent, as an cementation and core buildup material.GIC has also been employed for repair of defective margins,rootperforations,root resorption and ART techniques
The development of glass ionomer cement (GIC) by Wilson and Kent in the early 1970s was a revolutionary milestone in restorative dentistry owing to its unique properties to make it an attractive choice for various dental applications. Attributes of GIC iinclude:

- **Moisture Tolerance:** GIC can adhere to slightly moist enamel and dentin without the need for additional adhesive systems.
- **Fluoride Release:** They release fluoride over a prolonged period, providing anti-cariogenic benefits.
- **Thermal Expansion:** Their thermal expansion is similar to that of enamel, reducing the risk of cracking or shrinkage.
- **Aesthetics and Biocompatibility:** GIC offers better aesthetics and is less sensitive to dentin moisture, making it a biocompatible option for patients.

GICs have numerous advantages but their brittleness, poor fracture toughness, and sensitivity to moisture during the early stages of placement are notable drawbacks.(16 To address these issues, researchers have made several modifications:

- **Powder Component:** Enhancements in the glass powder used in GICs have aimed to improve its strength and durability.

- **Liquid Component:** Modifications in the polyacid and water content of the liquid component have sought to enhance its handling properties and reduce moisture sensitivity.

Newer advances of Glass Ionomer Cement

1. **Water-hardening glass ionomer cements (16)** address some of the challenges posed by conventional glass ionomers. When polyacid is used in solution, its increased molecular weight or concentration can raise the viscosity of the liquid, making the cement paste harder to manipulate. Therefore, polyacrylic acid is often used in solid form mixed with the glass ionomer powder.
In water-hardening glass ionomers, the liquid component for cement formation is either plain water or an aqueous solution of tartaric acid. This adjustment helps maintain a more manageable consistency while preserving the beneficial properties of the material.
2. **Metal-reinforced glass ionomer cements (16)** represent another significant advancement in dental materials. Sced and Wilson's research demonstrated that incorporating metal fibers significantly enhanced the flexural strength of glass ionomer cements. Building on this idea, Simmons proposed mixing amalgam alloy powders into the cement, leading to the development of a product known as "Miracle Mix."

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This approach combines the benefits of both glass ionomer cements and metal reinforcement, resulting in a material with improved mechanical properties while retaining the desirable characteristics of GICs, such as fluoride release and biocompatibility.

3. **Cermet ionomer cements (16)** are another notable advancement in the field of restorative dentistry. Developed by McLean and Gasser, these cements aim to improve resistance to abrasion. By sintering metal and glass powders together, a strong bond is achieved between the metal and the glass, enhancing the overall durability and wear resistance of the material. These enhancements make cermet ionomer cements particularly useful in situations where high mechanical strength is required. They maintain many of the beneficial properties of traditional glass ionomers, such as fluoride release and biocompatibility, while offering improved performance in terms of abrasion resistance.

4. **Resin-modified glass ionomer cements (RMGICs)(16)** were specifically developed to address the limitations of conventional glass ionomers, particularly their sensitivity to moisture and their lack of command cure (ability to set on demand). RMGICs combine the desirable properties of glass ionomers, such as fluoride release and biocompatibility, with the improved physical properties of resin composites. This makes them less susceptible to moisture during placement and provides better mechanical strength and esthetics.

5. **Highly viscous conventional glass ionomer cements (17)**were developed to offer a more user-friendly alternative to amalgam for posterior preventive restorations. These high-viscosity formulations simplify the insertion process and provide reliable performance in load-bearing areas. Examples of such highly viscous glass ionomer cements include Fuji IX and Ketac Molar.These materials maintain the beneficial properties of traditional glass ionomers, such as fluoride release and biocompatibility, while offering improved handling characteristics and enhanced mechanical strength, making them a valuable option in restorative dentistry.

6. **Strontium oxide added to glass ionomer cements (18)** indeed brings several benefits. Strontium, being a cement-forming ion, helps to slow down the setting reaction at both 21°C and 37°C. This controlled setting process improves the material's handling properties. Additionally, strontium oxide imparts greater radiopacity to the GIC compared to calcium aluminate, which enhances the visibility of the material on radiographs. This is particularly useful in clinical settings for easier monitoring and assessment of restorations.

7. **Amalgomer (19)**, a ceramic-reinforced glass ionomer cement, is a noteworthy innovation in restorative dentistry. It's designed to match the strength and durability of dental amalgam while offering several advantages:

- Fluoride Release: Amalgomer contains a high level of fluoride, which helps prevent caries.
- Aesthetics: It provides good esthetics, blending well with the natural tooth structure.
- Minimal Cavity Preparation: It requires only minimal cavity preparation, preserving more of the natural tooth.
- Bonding: Amalgomer bonds well to the tooth structure, ensuring a secure and lasting restoration.
- Biocompatibility: It boasts excellent biocompatibility, making it safe for use in patients.

This combination of properties makes Amalgomer a versatile and effective choice for various restorative applications.

8. **Giomers (20)** are indeed a fascinating development in restorative dentistry. They combine the beneficial properties of both glass ionomer cements and composite resins. Here's a quick breakdown of their key features:

- Fluoride Release: Giomers release fluoride, offering protective benefits similar to those of glass ionomers.
- Light-Cured: They cure upon exposure to light, much like composite resins, allowing for control over the setting time.
- Esthetics: Giomers provide excellent esthetic results, blending well with natural tooth color.
- Ease of Handling: They are easy to manipulate during the restorative process, making them user-friendly for dental professionals.
- Improved Physical Properties: The set material boasts enhanced physical properties, ensuring durability and longevity.

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- This hybrid nature makes giomers a versatile and effective choice for a variety of restorative applications.

9. Fluorinated Graphene

The study by Sun et al. highlights the promising benefits of incorporating fluorinated graphene into conventional glass ionomer cement (GIC). Their research found that this addition significantly enhances the mechanical strength, biological compatibility, and antibacterial properties of GIC. Importantly, it does not negatively impact key characteristics such as color, solubility, and fluoride ion release, maintaining the desirable properties of the original material.

10. **Nano-filled resin-modified glass ionomer cement (RMGIC) (22,23)** represents a significant advancement in dental materials. It consists of glass powder and a polyacid solution, combined with a polymer resin component that sets through self-activated (chemical) or light-activated polymerization. These "hybrid" materials are designed to merge the mechanical properties of resin composites with the anti-cariogenic benefits of traditional glass ionomer cements.RMGICs have been observed to not only release fluoride, which helps in preventing caries, but they also exhibit high flexural strength compared to conventional GIC. Additionally, they have lower solubility, making them more durable in the oral environment.

11. Calcium Aluminate GIC/Ceramir

The latest innovation in bioactive chemically bonded dental cements, primarily used in restorative dentistry, is the calcium aluminate–glass ionomer luting cement (CM Crown & Bridge, initially called Xera Cem). This luting cement is a hybrid that merges calcium aluminate and glass ionomer chemistry. Ceramir's setting mechanism combines a glass ionomer reaction with an acid-base reaction akin to that in hydraulic cements.

The glass ionomer component offers several benefits including low initial pH, enhanced flow and setting characteristics, early adhesive and strength properties to tooth structure. The calcium aluminate component contributes to increased strength and retention over time, biocompatibility, better sealing of the tooth-material interface, bioactivity due to apatite formation, stability with sustained long-term properties and lack of solubility or degradation.This combination results in a durable, biocompatible material suitable for various restorative applications.

The ongoing search for novel modifications of glass ionomer cement (GIC) is indeed crucial for enhancing its performance, especially in giatric dental practice. Collaboration between material research scientists and clinicians is essential to develop dental materials with improved adhesion and biocompatibility. With advancements in technology and research facilities in material science, achieving these goals for GIC-based dental materials is becoming increasingly feasible. The future looks promising for innovations that could significantly impact restorative dentistry, particularly for the elderly patients.(24)

Conclusion

Glass ionomer cement (GIC) is indeed a popular choice for restoring non-carious cervical lesions (NCCLs) in geriatric patients due to its beneficial properties like fluoride release and biocompatibility. Each older adult has unique dental needs, so the treatment approach must be tailored to the individual's profile. Resin-modified glass ionomer cements (RMGICs) are often preferred for their improved mechanical properties and ease of use. However, in certain cases, conventional GIC may be more suitable despite its lower mechanical strength..The current guidelines for using these materials in geriatric dentistry are still evolving, and more research is needed to provide clearer evidence. This ongoing exploration will help refine treatment protocols and improve patient outcomes in this age group.

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