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Review Article

Scope of an alkasite restorative material in paediatric dentistry: A review

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ABSTRACT

Regardless of barriers linked to the patient's age and behaviour, restoring primary teeth can be technically challenging, and researchers have long searched for an appropriate replacement for glass ionomer cement, composites, and silver amalgam that is cost-effective, fluoride-releasing, convenient to use, and fulfils both strength and acceptable aesthetics. An Alkasite is a resin -based modified composite resin restorative material, comprising alkaline fillers responsible for leaching acid-neutralizing ions like fluoride, calcium, and hydroxide ion. This Alkasite Cention-N is available in A2 tooth shade and has advantages of both Amalgam and GIC and provides better aesthetics and high flexural strength with the additional characteristic of optional light-curing.

1. Introduction

Over the years, the focus on treating severely carious primary teeth has evolved from extraction to restoration. If the affected tooth is treated early, its biological features, aesthetics, and functioning can be repaired and restored with restorative materials.[1] The selection of dental materials is determined by several factors, including procedure repeatability, material qualities, cavity design, and aesthetic considerations.[2] However, there is a lack of concrete evidence and consensus in dental literature on the preference of the best restorative materials for primary dentition.[3] Progressive developments in restorative dentistry have made it convenient to treat carious teeth in children with an array of direct filling materials, such as amalgam (AM), glass ionomer cement (GIC), resin-modified glass ionomer cement (RMGIC), high-viscosity glass ionomer cement (HVGIC), composite resin (CR), pre-made steel crowns (SSC), and compomer (CP).[4,5] Although amalgam, GIC, and composite have all been utilised extensively as restorative materials in paediatric dentistry, none of these materials simultaneously satisfy the biological, functional, and aesthetic requirements.[6] Amalgam restorations present high longevity, but their use has been increasingly discontinued, notably due to the ill effects of mercury toxicity and environmental pollution.[7] In addition, tooth preparation for amalgam restoration requires retention features that lead to the removal of healthy tooth structure.[8,9] The disadvantages and poor aesthetics of amalgam restorations have led to the development and availability of alternative restorative materials, such as resin composites and glass ionomer cement (GICs). These approaches are more conservative, with cavity preparation limited primarily to the decay and maintaining intact tooth structures.[10] GIC distinguishes out for its exceptional ability to release fluoride, which aids in the prevention of enamel demineralization, promotes remineralization, reduces plaque formation, and so aids in the prevention of dental caries. Also, traditional GICs bond to the tooth structure and do not shrink.[11] Considering no etchants or adhesives are required, and the material is self-

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curing, there is a significant potential for employing GICs in younger and less cooperative patients where adequate isolation is not possible and operating quickly in a precise manner is crucial.[2] However, GIC is somewhat opaque in colour and has low flexural strength hence is not a good option for stress-bearing areas.[11] RM-GICs possess improved adhesion[12] and flexural characteristics but still have low abrasion resistance and must be laminated as per the manufacturer's instructions.[13] The ongoing research in restorative dentistry has led to the introduction of resin-based composites, which claim to have better aesthetics than GIC and are used as direct restorative materials due to their relatively better mechanical and aesthetic properties.[6,14] Composite resins involve minimal tooth preparation and offer superior aesthetics and fair durability. The physical and mechanical properties of dental composites are comparable to or better than amalgam. Polymerization shrinkage and contraction stress are possible with currently available composites, necessitating meticulous bonding and placement. With an inadequate marginal seal, there is a risk of developing secondary caries around the tooth-restoration interface.[15–18] Also, being technique-sensitive and tedious,[1,19] composite restorations are usually not ideal for class II restorations in primary dentition, especially in an uncooperative and young child, with high caries risk.

Regardless of barriers linked to the patient's cooperativeness or age, restoring primary teeth can be technically challenging, considering they are significantly smaller than permanent ones. Due to these issues, researchers have long searched for an appropriate replacement for glass ionomer cement, composites, and silver amalgam that is also cost-effective, fluoride-releasing, convenient to use, and fulfils both strength and acceptable aesthetics. Cention N (IvoclarVivadent, USA), an Alkasite, is one of the recently introduced aesthetic restorative materials offering these qualities and an edge over amalgam and glass ionomer cement. An Alkasite is a resin-based modified composite resin restorative material comprising alkaline fillers responsible for leaching acid-neutralizing ions like fluoride, calcium, and hydroxide. This material is easy to handle and has properties like type-IX GIC. Since it is dual-cured, it can serve as a bulk-filling material.[20]

1.1. Cention N as a restorative material

Cention N is a tooth-coloured, bioactive restorative material for direct restorations with minimal polymerization shrinkage. It is classified as an "alkasite," an emerging category of dental material, like compomer or ormocer materials, which is a subgroup of composite materials.[21] It is a urethane dimethacrylate (UDMA)-based, self-curing powder/liquid type dental material with an added light-curing option. Conventional polymerization lights can be used to cure the material, as optional light curing is possible with blue light with a wavelength range of about 400– 500 nm.[21] According to the manufacturers, Cention N can be applied quickly and easily in bulk and is ideal for restoring Class I, II or V cavities in deciduous and permanent dentition.

1.2. Composition

Cention N is available in Powder: Liquid form. The powder in Cention N consists of a mixture of glass fillers, initiators, and pigments, while the liquid includes dimethacrylates and initiators. The particle size of the inorganic fillers present in the powder component is about 0.1 μm and comprises 78.4 wt.% of the material's volume. The purpose of adding the following fillers in Cention N is to achieve the mixed material's strength and desired handling properties.(Table 1)[2]

Table 1: Composition of powder[21]

Filler	Weight%	Function
Barium aluminium silicate glass	20-30	Increase the strength of the material
Ytterbium trifluoride	5-10	Provides Radiopacity
Isofiller [Made of pre-polymerized UDMA fragments]	15-25	It diminishes polymerization shrinkage.
Calcium barium aluminium fluorosilicate glass	10-20	Increase Strength, Provide Fluoride release
Calcium fluoro silicate glass	25-35	Releases basic ions (F−, Ca2+, OH−
Initiator [copper salt & thiocarbamide-Self Cure] [Ivocerin & Acyl Phosphine Oxide-Photo Initiator]	<1	Initiator
Pigment	<0.1	Pigment

Cention N lacks Bis-GMA, HEMA or TEGDMA. The liquid comprises dimethacrylates and initiators. The organic monomer part of Cention N is present in the liquid portion, consisting of four distinct dimethacrylates that account for 21.6% wt. of the final mixed material. The methacrylates contained in the liquid component and their roles are mentioned in Table 2.

1.3. Manipulation and application

Cention N involvesthe mixing of powder and liquid manually before use. A scoop of powder is mixed with one drop of liquid in a powder/liquid weight ratio o 4.6 to 1. Cention N has a mixing time (on the pad) of 45 to 60 seconds approximately, a working time (including the mixing time) that involves the restoration of the cavity and occlusal modelling of 2.5 minutes and a total setting time

Table 2: Composition of Liquid[21]

Composition	Weight %	Function
Urethane dimethacrylate (UDMA):	95-97%	The main component provides the basic mechanical properties of the material
Tricyclodecandimethanol dimethacrylate (DCP):		Allows for the handling of the material and mixing of the two components and improves the mechanical properties of the material
Tetramethyl-xylylene-diurethane dimethacrylate (aromatic-aliphatic UDMA):		Diminishes the colour variation of the material over time and increases elasticity
Polyethylene glycol 400 dimethacrylate (PEG-400 DMA) [The liquid monomer]		Increases the fluidity of the material and wettability of the surface on dentin and enamel.
Additives	1-2	
Initiator (hydroperoxide – self-cure)	2-3	
Stabilizer	<1	

(including the mixing and working time) of 4 minutes.While using Cention N in the self-cure option, the mixed material is placed in the cavity, condensed, sculpted, and allowed to set for 4 minutes. In the Light-cure (dual-cure) mechanism, the self-curing process begins following the mixing. Still, utilizing the optional light cure mode expedites and simplifies the restoration process.Cention N can be used either way: without or with an adhesive. Retentive undercuts are incorporated in the cavity, like amalgam fillings, and enamel margins need not be bevelled if Cention is used without adhesive. When used in conjunction with an adhesive, the cavity is prepared according to current concepts of minimally invasive dentistry, by retaining most of the tooth's natural structure, and similar guidelines are followed regarding tooth conditioning and restoration. Also, no etching with phosphoric acid is needed.[21] Regarding the type of adhesive system, the manufacturer of the Cention N product recommends both universal bonding agents like Tetric N-Bond Universal and etch and rinse adhesive systems such as Tetric N-Bond.[21]

During polymerization, the mixture of UDMA, DCP, an aromatic aliphatic-UDMA, and PEG-400 DMA interconnects (crosslinks), resulting in improved physical properties and longevity of the material.

1.4. Clinical Performance and Durability of Cention N Versus other restorative materials used in primary teeth

In its mixed state (powder + liquid), Cention N contains 78.4% wt. of inorganic filler. The alkaline glass accounts for 24.6% of the final product's weight, releasing plentiful fluoride (F-) ions equivalent to those released by traditional glass ionomers.[21] Instead, compared to conventional GICs, Cention-N demonstrates significantly higher long-term discharge of fluoride and calcium ions and alkalizing potential in acidic pH.[4,22] Also, Cention N, like any other fluoridated dental materials, exhibits two distinct stages of fluoride ion release, the initial 'burst release' stage followed by a sustained release.[23] This is because, during the initial acid dissolution of the surfaces of powder particles, many fluoride ions are absorbed into the product matrix. These fluoride ions are rapidly released from the matrix exposed on the surface of the material, causing the initial "burst effect." Over 24 hours, it is gradually replaced by fluoride ions from the matrix beneath the surface, which helps to maintain the release of fluoride ions.[24,25] Also, Cention N releases a considerable amount of fluoride 7.94 ppm in an acidic environment after seven days,[4,26,27] which is higher than traditional GIC (5.11 ppm after seven days postoperatively).[4]The increase in fluoride release on the seventh day can be attributed to unreacted calcium fluorosilicate glass and calcium barium aluminium fluorosilicate glass particles present in the self-cured polymerized material.[27] Further, studies assessing the fluoride release properties of Cention N have found that self-cured Cention-N, when compared with light-cured Cention-N and traditional GIC, had the maximal fluoride ion release and alkalizing capacity in acidic pH.[4] In an in-vitro clinical trial, Donly, and Liu 2018[28] evaluated the capability of Cention N in preventing demineralization of enamel and dentin and concluded that Cention N could clinically inhibit caries at restoration margins.[28]This could be attributed to the ability of a sustained release of fluoride, hydroxide, and calcium (OH- and Ca2+) ions. These ions create a favourable environment by reducing the survivability of bacteria in the deeper part of the carious lesions and enhancing the remineralization of the susceptible surfaces of the tooth, which helps in the prevention of dental caries.[27]

The fracture at the isthmus of the class II cavity is the most common form of restorative failure in molars owing to the accumulation of stress at the axio-pulpal line angle. Hence, while restoring class II cavities that are subjected to a significant amount of occlusal load, materials with high fracture resistance are chosen.[20] Researchers involved in comparing the mechanical properties of Cention N with other routinely used restorative materials such as GIC, amalgam, and composites have revealed promising results favouring Cention N as a better alternative for direct posterior restorations. Cention-N showed the maximal flexural

strength, according to Chole et al.'s[29] study, followed by bulk-fill composites, light-cure nanocomposites, and resin-modified glass ionomer cement.[29] Chowdhury et al.[20] in their study showed that when compared to different restorative materials, the Cention-N offers the highest fracture resistance.[20] Self-cured Cention N has a flexural strength of around 110MPa and Compressive strength of 300MPa, and similar values have been reported with dual-cure Cention N,[21] fulfilling the minimum flexural strength of 80MPa of permanent filling material, endorsed by ISO 4049.[1] This mechanical property of Cention N has been credited to the presence of barium–aluminium–silicate and calcium–aluminium–silicate glass-based filler particles and cross-linked structure of the polymer, which lower elasticity and provides rigidity to the matrix.[20] It contains a shrinkage stress reliever as a filler (Isofiller), which is accountable for its reduced modulus of elasticity (10 GPa), facilitating it to serve as a spring in contrary to conventional glass fillers incorporated in composites, having a greater modulus of elasticity (71 GPa).[30,31] All these factors make it highly resistant to stresses generated in the oral cavity and a reliable basis for a long-standing restoration.[20]

Based on the research, any restorative material's clinical performance and lifespan also depend on how well it adheres to the dentinal surface and can withstand the numerous dislodging forces generated in the mouth.Restorations can withstand all kinds of displacing forces directed towards them because of the high bond strength of restorative materials. Some authors have observed Cention N has the highestdentin shear bond strength, followed by Zirconomer and GC Fuji II.[32,33] Similarly, Mazumdar et al.[19] reported Cention N displays a higher bond strength value when compared to composite resin.[19] Also, when etching was considered, etched specimens of Cention N or bonded Cention N demonstrated higher bond strength than non-etched samples or conventional Cention N.[19,22] Likewise, a study by François P et al.[34] Cention N displayed the highest Shear bond strength (SBS)values following universal adhesive application (33.8 MPa).[34] The presence of a stable self-cure initiator and a strongly cross-linked polymer structure could be responsible for the higher bond strength of Cention N.

Microleakage is a critical issue in restorative dentistry. Hypersensitivity, secondary caries, and pulpal pathologies are the three leading reasons for restoration failure and have been linked to microleakage.[21,30] In spite of the minimum literature available regarding polymerization shrinkage and marginal leakage of Cention N, many researchers have reported Cention N displayed significantly less marginal microleakage at occlusal as well as the gingival margins**,** compared to GIC and composite restorations, thereby having a better sealing ability.[30,32,35] The exclusive patented filler (Isofiller) reduces the shrinkage force, causing low volumetric shrinkage and resulting in an advantageous feature of minimal microleakage**.** Furthermore, the silanes bonded to filler particles improve the bond between the inorganic filler.[21,32] Also, a study conducted by Meshram et al.[36] reported Cention N with adhesive was associated with lower microleakage than Cention N without adhesive.[36]

Cention N has better or comparable resistance to fracture as a nanocomposite or nanohybrid composite. Cention N demonstrated encouraging outcomes related to fracture strength and marginal adaptation in conventional and extended MOD cavities in a study by Firouzmandi M et al.;[22] many of the fractures in the bonded Cention N group were clinically acceptable and repairable.[22] Bonded Cention N restorations are more expensive and tedious; hence their routine usage in paediatric dentistry cannot be advised unless additional benefits are proven through future research.[22]

Surface hardness is an additional feature of significance in restorative materials. Lower hardness values are generally associated with poor wear and scratch resistance, which can compromise fatigue strength and result in restoration failures. Cention N has been reported to have the highest microhardness values. In an in-vitro study, Mazumdar et al revealed that Cention N exhibited the highest Vickers microhardness (VHN) followed by silver amalgam, nanohybrid composite resin and type II glass ionomer cement in the decreasing order.[19] Cention N has a larger filler particle size of 0.1–35 μm as compared to composite (0.1–1.0 μm); still, it showed better results. It might be due to the highly cross-linked matrix material in Cention N, which has a high degree of polymerization, resulting in significant strength and wear resistance.[21]A smooth surface is an essential component to consider when creating a favourable restoration since the rough surface of a restorative material causes plaque accumulation and secondary caries. Glass fillers present in Cention N cause only slight wear and provide beneficial polishing properties such as reduced surface roughness and high gloss.[21] Arsath, N et al.[37]evaluated the surface roughness of Cention N before and after brushing with herbal and fluoridated toothpaste. There was no significant increase or decrease in surface roughness values after brushing simulation, which indicates that the Cention N material can withstand abrasive forces; the results can vary in the oral cavity environment.[37] Likewise, a study by Park C et al.[38] reported a significant decrease in the surface roughness following the finishing of Cention N specimens.[38] Still, more studies are needed to give a proper conclusion on the properties claimed by the manufacturer.

There is a paucity of literature on in-vivo studies assessing the clinical effectiveness of Cention N and contradictory findings have been reported regarding the post-operative sensitivity with Cention N. At a one-month follow-up, patients treated with Cention N complained of more sensitivity than alternative bioactive materials

like glass hybrid restorative material or reinforced resin-modified glass ionomer, in an in-vivo study by Hirani RT (2018).[39] This could be because cavities were restored by Cention N without adhesive**.** Further, low volumetric shrinkage caused by the organic monomer component in the Cention N liquid can also be responsible for the increased prevalence of postoperative hypersensitivity with Cention N restorations.[35] This feature can adversely affect clinical performance, particularly in young permanent teeth with larger pulp chambers and dentinal tubules.

2. Cention N as an Aesthetic Restorative Material

The issue of aesthetics in very young children has received significant attention in psychology literature.[40] The same, however, is not true for dentistry. For a long time, paediatric dentists, while providing curative therapy, have routinely chosen from a limited set of options for grossly carious teeth, namely bands on severely decayed teeth, stainless-steel crowns, and amalgam restorations.Their simplicity of manipulation, durability, low cost, reduced technique sensitivity, and complete crown coverage contributed to their better acceptance; the fact that they are highly unesthetic and limited to posterior teeth has been the most significant drawback.[41–43] Research has shown that dentists have decreased the use of amalgam and increased the utilization of tooth-coloured materials such as glass ionomers and resin-based materials in both primary and permanent teeth. The dental fraternity could not help but question if there was another driving force behind the change, even though it was first believed to be associated with the superior mechanical characteristics and conservative tooth preparations of glass ionomers and dental composites. As these trends continued, studies have investigated possible additional reasons for the change and found that aesthetics was a significant contributor in adults and children both. Several studies surveyed paediatric dentists for their preference for restorative material for children, and many demonstrated a tendency toward tooth-coloured dental materials.[44–46] In a study by Fishman et al (2006),[44] most children preferred composite and least amalgam, regardless of age or gender.[44] Similar results were observed by Peretz and Ram in 2002[47] while assessing the preferences of parents and children regarding amalgam and aesthetic restorative materials.[48] Over the last few years, parents have desired a better aesthetic option for treating dental caries in their children.[41] Paediatric dentists at the University of Minnesota, USA, found that parental concerns before agreeing to any restoration materialin decreasing order were: aesthetics, cost, toxicity, and durability, and the topmost consideration related to stainless steel crowns (SSCs) were aesthetics and expenses.[48]

Paediatric dentists should understand the aesthetic perception of their patients because even the paediatric population below three years now seems to be conscious about their appearance and want to look better. The children, like adults, are aware of their own and other children's dental aesthetic appearance.[40,49] Although the long-established Jean Piaget Theory state that a child's perception about their appearance does not form until the age of 8 years, there have been recent studies in the field of child psychology that have challenged this concept, presenting that due to excessive media exposure, children as young as 3–5 years old develop a sense of consciousness of oneself and can appreciate the aesthetics of their front teeth restorations.[40,50] In paediatric dentistry, Glass ionomer cement (GIC) has been invariably considered a gold standard for primary teeth restorations for its exclusive characteristics, like the release of anti-cariogenic fluoride into adjoining teeth and chemical bonding to enamel and dentin.[51] However, they are opaque, susceptible to fracture, and have low wear resistance. These drawbacks have limited their usage and made them unsuitable for high-stress areas.

The clinical performance of the alkasite restorative material has been evaluated through the FDI parameters in a 2016 trial, suggesting its use to restore primary teeth and reporting better performance over GIC. Clinically, the Alkasite-based restorative materials showed better technical, mechanical, and aesthetic properties during the follow-ups for one year and hence were suggested as an alternative to resin-modified glass ionomer cement (RMGIC).[15,52] Various in-vitro tests demonstrated Cention N released F^- and Ca^+ ions over an extended duration without undergoing any significant variation in dimension and retained its flexural strength for a longer time. No tooth fracture was seen, and wear was acceptable. When used in slightly different mixing proportions, the differences in flexural strength and shrinkage values were insignificant; hence the product proved forgiving and user-friendly. Cention N also noticeably reduces demineralization in adjacent enamel.[21]

Cention N is available in A2 tooth shade and has advantages of both Amalgam and GIC and provides better aesthetics and high flexural strength with the additional characteristic of optional light-curing. The product cures equally well in both self-cure and dual-cure mode, is radiopaque, blends well with the surrounding tooth structure and is more translucent than standard glass ionomer cement. The translucency of Cention N is 11% compared to Fuji II's 4% and merges more easily with the neighbouring teeth than GIC, and the "chameleon effect" further enhanced the shade matching.[21]

Although dental caries is a preventable and controllable oral disease, an extensive burden is put on curative care. Dental caries is not life-threatening, yet untreated caries in children adversely impact the dental health-associated quality of life, leading to systemic complications and adding to the disease burden.[53] Although amalgam has been the most economical material for posterior restorations,

other restorative materials are increasingly being used by dentists. Cention N restorations can be a practical way to deliver high-quality treatment in developing countries like India. Due to Cention N's cost-effectiveness, the Ministry of Health Malaysia (KKM) opted for it as the primary restorative material to substitute for amalgam. It is an anti-cariogenic material as it has the property of releasing fluoride, calcium, and hydroxyl ions. The only limitation is that it is available in a single A2 shade.[27]

Aesthetics and cost of treatment are two main concerns of the parents related to the treatment of dental caries in children, and at times disagreement between dentists and parents can occur.[48] Thus, Paediatric dentists must prioritize materials and treatments that are aesthetic, efficient, and predictable. This alkasite Cention-N reappraises the principal restorative solutions, merging bulk placement and durability in a dual-curing, aesthetically pleasing material, hence fulfilling the demands of both dentists and patients.

3. Conclusion

Fulfilling parental and children's expectations have become one of the most important deciding parameters in selecting dental restoration**.** With characteristics of amalgam and GIC, Cention N delivers tooth-coloured aesthetics and high flexural strength. Cention N, the alkasite dental material can be considered a strong, user-friendly, basic filling material for primary teeth.

4. Source of Funding

None.

5. Conflict of Interest

None.

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