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Case Series

Dentistry Section

Silver Diamine Fluoride as Indirect Pulp Capping Agent in Primary Molars: A Case Series

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ABSTRACT

According to the current recommendations of the American Academy of Paediatric Dentistry (AAPD), Indirect Pulp Capping or Indirect Pulp Treatment (IPT) is defined as a procedure that preserves the deepest cavities adjacent to the pulp to prevent pulp exposure. Preserving and protecting the vital pulp through remineralisation of hypomineralised carious dentin poses a significant challenge in restorative dentistry. Traditionally, managing deep caries often led to pulp exposure and subsequent root canal treatment. Selective or stepwise caries removal is based on the concept of halting the progression of carious destruction, allowing for biological repair of the pulp-dentin complex by promoting the formation of tertiary dentin between temporary and definitive restorations. Silver Diamine Fluoride (SDF) has gained popularity due to its unique combination of silver and fluoride, which provides antimicrobial and remineralising properties. In this case series of three cases, three-year-old preschool boy, five year old girl and five year old girl, in whom, deep carious lesions in primary molars were treated using selective caries removal techniques with SDF as an IPT agent, resulting in successful minimally invasive restorative procedures. This case series underscores the importance of employing selective caries removal techniques and the potential use of SDF as an IPT agent in such scenarios to preserve tooth vitality in a less invasive therapeutic approach suitable for the paediatric population.

Keywords: Deep caries, Dental, Indirect pulp therapy, Vital pulp therapy

INTRODUCTION

Minimally Invasive Paediatric Dentistry (MIPD) has become the new standard in the post-pandemic decade because it reduces aerosol spray during dental treatments while still offering child-friendly and high-quality restorative dentistry. Despite the availability of contemporary restorative materials, traditional surgical excision of deep carious lesions contributes to the risk of pulp exposure or loss [1]. According to new caries management guidelines, there is a significant need to enhance the adoption of minimally invasive methods as a conventional choice rather than a compromise alternative for addressing deep carious primary teeth [2]. SDF had previously been used in dentistry as a desensitising agent and to prevent tooth cavities. Its well-known qualities might be applied in vital pulp treatment for primary and young permanent molars [3]. IPT, is a treatment used to protect the vitality of the pulp in deep carious lesions [4]. Selective or stepwise caries removal is based on the concept of interfering with the progression of carious destruction, which allows for biological healing of the pulp-dentine complex through the development of tertiary dentin in deep caries lesions [5]. A few clinical trials have recently advocated for the effective use of SDF as IPT in primary as well as permanent molars [6-8]. This case series encompasses three clinical scenarios in paediatric patients where deep carious lesions were minimally and successfully intervened with selective caries removal techniques and SDF as an IPT agent.

CASE REPORT

Case 1

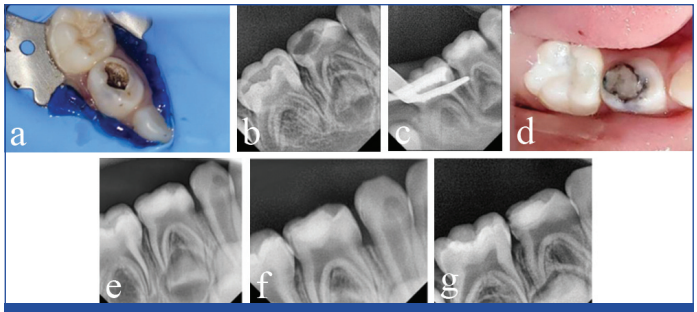
A three-year-old preschool boy presented to our department with occasional sensitivity during food consumption as the chief complaint. Upon anamnesis with the parents, there was no history of continuous pain or swelling. Additionally, there were no relevant medical issues, and it was his first dental visit. The behavior of the child was rated as positive based on Frankl's behavioral rating scale [9]. A deep carious lesion involving enamel and dentin was observed in tooth 84, classified as ICDAS code-6 according to the International Caries Detection and Assessment System (ICDAS) [10]. Provisionally, it was diagnosed as reversible pulpitis in tooth 84 along with deep pits and fissures in tooth 85 [Table/Fig-1a]. Radiographic examination revealed no pulp involvement, with the lesion affecting only the enamel and dentin [Table/Fig-1b], confirming the final diagnosis of reversible pulpitis. Therefore, IPT was performed on tooth 84 to preserve the vitality of the pulp.

Treatment

The parents were informed about the procedure, and informed consent was obtained. The authors decided to perform the therapeutic intervention with the child on the parent's lap to foster a positive dental attitude for future appointments. Under the TEDIE technique [11] and a flexible behavioral approach in the mother's lap, local anaesthesia was administered, and isolation with a rubber dam was achieved using the split dam technique and 13A winged retainers (Coltene®, USA) and liquid dam (Peroxidam®). After isolation, selective caries removal was conducted using a chemomechanical caries removal agent (Carie-Care®) and a sharp spoon excavator (Osung®). Soft carious dentin was selectively removed, while hard residual dentin was left behind according to guidelines [2]. Following the manufacturer's instructions, SDF (Kids-e-Dent, India) was applied over the remaining hard dentin using an applicator microbrush and restored with resin-modified glass ionomer (Fuji II, GC, Asia) [Table/Fig-1c]. The patient remained asymptomatic both clinically and radiographically during the 17-month follow-up [Table/Fig-1d-f]. The clinical image of the boy undergoing treatment is shown in [Table/Fig-2].

Case 2

A five-year-old girl presented at our outpatient clinic with occasional sensitivity in the lower right back tooth region as the main complaint. Upon clinical examination, enamel and dentin



[Table/Fig-1]: a) Tooth no. 84 pre-operative ICDAS code 6 isolated under rubber dam using split dam technique and liquid dam; b) Pre-operative radiograph of tooth no. 84 corresponding to ICDAS code; c) Postoperative radiograph after SDF application and GIC restoration in 84; d) Clinical intraoral photograph of the restoration after three month follow-up; e) Follow-up radiograph of 84 after three months; f) Radiograph after six months follow-up; g) Follow-up radiograph after 17 months.

[Table/Fig-2]: Flexible approach of behaviour management of a 3-year old boy by performing LA and rubber dam isolation in mother's lap.

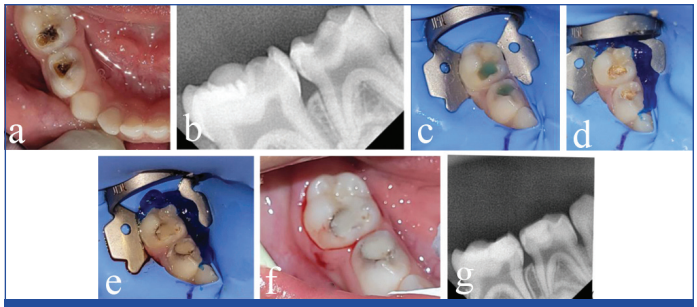
involvement corresponding to ICDAS code 6 was observed, and a provisional diagnosis of reversible pulpitis was made [Table/Fig-3a] [10]. Radiographic evaluation confirmed the absence of pulpal involvement, consistent with the clinical findings, and the final diagnosis of reversible pulpitis was established [Table/Fig-3b]. Therefore, IPT with SDF and restoration using resin-modified glass ionomer (Fuji II, GC, Asia) was planned for teeth 84 and 85.

Treatment

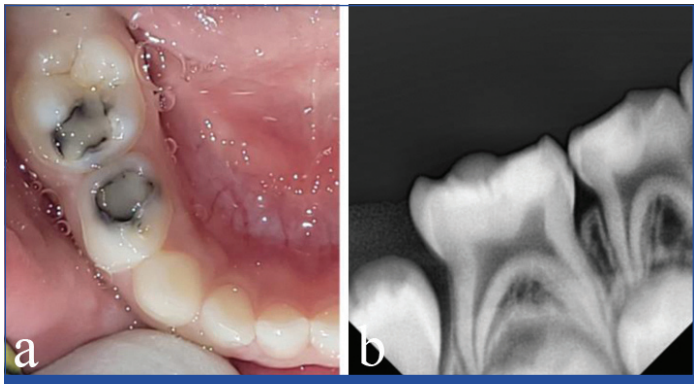
After obtaining informed consent from the parents, isolation of the teeth was achieved using a rubber dam and the split dam technique. Selective carious removal was performed using a chemo-mechanical caries removal agent (Carie Care®) and a sterile sharp spoon excavator (Osung®), with the remaining hard dentinal lesion left behind [Table/Fig-3c,d]. Subsequently, SDF was applied to teeth 84 and 85 using an applicator brush, followed by the placement of glass ionomer restorations in teeth 84 and 85 [Table/Fig-3e-g]. The patient remained asymptomatic during the six-month follow-up, with clinically and radiographically intact restorations [Table/Fig-4a,b].

Case 3

A five-year-old girl presented at our specialty clinic, complaining of short and intermittent episodes of pain and discomfort in the lower left back tooth region during the previous week. On Frankel's



[Table/Fig-3]: a) Pre-operative clinical images of tooth no. 84 and 85 corresponding to ICDAS code 6; b) Pre-operative radiograph of the same; c) Isolation of 84 and 85 and selective caries removal using carie-care; d) After selective caries removal; e) Silver Diamine Fluoride (SDF) and Resin-Modified Glass Ionomer Cement (RMGIC) placed in 84 and 85; f) Post Indirect Pulp Therapy (IPT) images of 84 and 85; g) Postoperative radiographs after IPT w.r.t. 84 and 85.



[Table/Fig-4]: Postoperative follow-up of six months of IPT done using SDF w.r.t. 84 and 85; a) Clinical picture of 84 and 85 with black marginal discoloration and intact restorations; b) Radiograph showing 84 and 85 with no periapical signs of inflammation.

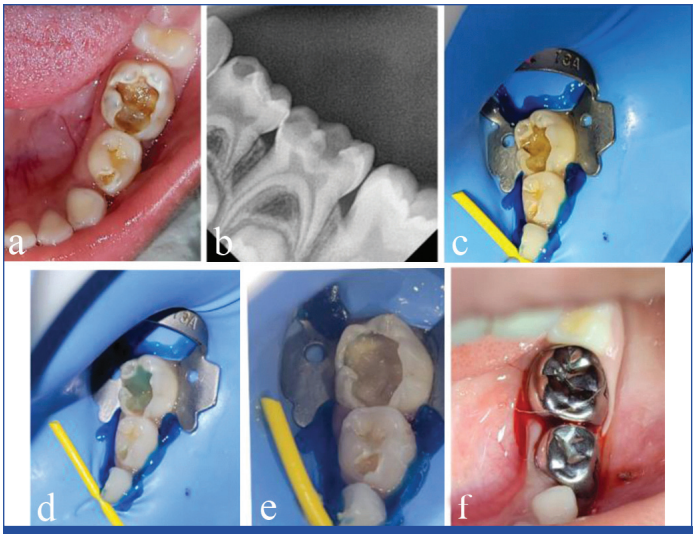
behavioral scale, she received a positive rating [9]. Clinical and radiographic evaluations revealed enamel and dentin involvement corresponding to ICDAS code 6, provisionally diagnosed as a deep carious lesion with proximal surface involvement. Radiographic examination confirmed the final diagnosis of reversible pulpitis [Table/Fig-5a,b] [10]. Selective carious removal and IPT were planned to be performed in the affected tooth (number 75), followed by SDF application as an IPT agent.

Treatment

After obtaining informed consent from the parents, local anaesthesia was administered, and the teeth were isolated using the split dam technique [Table/Fig-5c]. Selective caries removal was performed using a chemo-mechanical caries removal agent and an Osung® spoon excavator, leaving behind the hard dentin [Table/Fig-5d]. This was followed by the application of SDF using a microbrush. Since the affected tooth did not have sound cavosurface margins on the mesial wall, it was restored with a stainless steel crown (Kids Crowns®, South Korea) to provide a better peripheral seal, minimising microleakage of oral fluids [Table/Fig-5e,f] [2]. The patient was followed-up for a period of nine months, with no clinical or radiographic signs or symptoms [Table/Fig-6].

DISCUSSION

The World Health Organisation (WHO) identified SDF as one of the most effective, safe, and cost-effective medications for meeting critical health system requirements for adults and children in 2021 [12]. SDF is a colorless alkaline solution with a pH of 9 to 10. Although the makers have not revealed specific chemical information, their SDF products mostly contain silver, fluoride, and ammonia [13,14]. Studies have shown that SDF reduces biofilm development, promotes remineralisation, prevents collagen degradation, and blocks dentinal tubules [13,15,16]. These attractive qualities make SDF a good treatment option for tooth cavities and dentin hypersensitivity [3].



[Table/Fig-5]: a) Preoperative image of tooth no.75; b) Radiograph showing approximation to pulp corresponding to ICDAS code 6; c) Split dam isolation of 75; d).Selective carious removal of 75; e) Application of SDF on 75 indicating some black discoloration; f) Stainless steel crown cemented w.r.t. 74,75.

[Table/Fig-6]: Clinical and radiographs of 75 after nine months of follow-up.

Recent research has demonstrated that SDF inhibits Matrix Metalloproteinases (MMPs) involved in collagen breakdown in carious lesions [13]. The interaction of SDF with the dentin-pulp complex, which alters the physicochemical characteristics leading to tertiary dentin formation, is the mechanism of action for caries arrest and desensitisation [13]. This justifies the use of SDF as an IPT agent. Long-term studies have shown that IPT has a higher success rate than Direct Pulp Cap (DPC) and pulpotomy, according to the AAPD guidelines 2022 [4,17].

Baraka MMAL et al., assessed the clinical and radiographic production of tertiary dentin in young permanent teeth with Cone Beam Computed Tomography (CBCT) images after SDF treatment in deep carious lesions and found no difference between SDF and RMGIC as IPT agents [6]. Shafi N et al., determined that SDF had a 96 percent clinical and radiographic success rate as an IPT agent in primary molars when compared to calcium hydroxide and suggested that SDF could be used as a viable therapeutic agent for IPT in primary molars [7]. Patel MC et al., used a similar approach to examine the clinical and radiographic effectiveness of SDF as IPT and documented a predicted clinical success rate. Based on optimal case selection, they concluded that the removal of all infected dentin in deep carious lesions is not required for successful caries treatment, and Silver Modified Atraumatic Restorative Treatment (SMART) can be recommended as a potential biologic approach to manage asymptomatic deep dentinal lesions, which was followed in our protocol [8].

According to American Academy of Paediatric Dentistry (AAPD) recommendations, the choice of restorative material is also important in the effectiveness of IPT [4]. Therefore, the authors selected RMGIC as a restorative material in two instances, and a stainless steel crown in the final case of our series to establish a proper peripheral seal and reduce microleakage of oral fluids [1].

The efficacy of IPT in our case series may be attributed to the "zombie effect" of SDF, which occurs when dead silver-containing bacterial cells come into contact with active bacterial cells [18]. According to a systematic review, the moderate irritation of the pulp caused by SDF may also stimulate the pulp defense systems to develop reactionary or tertiary dentin, contributing to the success of IPT in our case series [19].

However, this case series has a few limitations in terms of follow-up and the type of restorative material used. The authors had successful follow-up for more than twelve months in one of the cases, and the authors believe that appropriate case selection based on ICDAS classification and the use of selective caries removal procedures in deep caries lesions may have resulted in minimally invasive and long-lasting restorations.

CONCLUSION(S)

Although many biomaterials are available in the market for IPT, SDF could be a viable and economically conducive alternative for developing countries in minimally invasive paediatric dentistry. This case series underscores the need for practitioners to follow such guidelines, resulting in minimally invasive treatments that preserve tooth vitality in primary and young permanent teeth, thereby avoiding the risk of pulp therapy. Additionally, this case series supports SDF as a therapeutic IPT agent in deep caries lesions, emphasising the importance of proper case selection based on ICDAS classification, the use of selective caries removal procedures, and adequate isolation in such lesions.

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