Case Report

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Application of Silver Diamine Fluoride in Dental Trauma: A Case Series Study

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ABSTRACT

Objective: Dental injury is a significant issue in children due to their immature physical, cognitive, and physiological development. These factors often result in heightened fear and behavioral challenges during their first visit following trauma, which can compromise the quality of treatment and lead to a poor prognosis for the affected tooth. Silver Diamine Fluoride (SDF), a colorless solution approved by the US FDA for treating dental hypersensitivity and caries, offers a simple, painless, and non-invasive treatment option. Its application involves a paint-on technique with a powerful fluoride formulation, making it an ideal choice for the initial management of enamel and dentin fractures in primary teeth, particularly in uncooperative young children.
Case Description: This case series described four cases in which SDF was successfully used as the primary treatment for Ellis Class IX anterior tooth trauma in very young children with negative behavior responses in the dental setting. The procedure required minimal armamentarium and was well-tolerated by all patients.
Conclusion: In each case, the use of SDF yielded successful and satisfactory outcomes, with a favorable prognosis for the affected teeth. Additionally, the treatment contributed to a positive shift in the children's attitudes toward dental care.

Keywords: Tooth fracture, Desensitizing agents, Children, Trauma management, Primary teeth.

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Introduction

Dental Injury is an emergency condition resulting from damage to primary or permanent teeth and their supporting tissues Young children are particularly prone to dental trauma due to their immature physical, cognitive, and physiological development [1, 2]. Nearly one-third of toddlers and preschool children experience dental trauma to their primary dentition [3]. Such injuries can lead to therapeutic, esthetic, psychological, and social challenges, significantly impacting the child's quality of life [4]. The management of these injuries often requires a multidisciplinary approach, which can be costly and impose a financial burden on parents and caregivers.

The prognosis of traumatized teeth largely depends on the quality of initial professional assessment

and treatment. The traumatic event itself is a source of psychological stress. Furthermore, very young children and those with special needs often exhibit heightened fear, anxiety, and behavioral challenges, which can complicate the management of dental injuries due to their limited physical and psychological coping abilities [5, 6]. Consequently, there is a growing interest in minimally invasive approaches that require little to no instrumentation for the emergency or initial treatment of traumatic dental injuries.

Silver diamine fluoride (SDF) is a colorless solution, approved by the US Food and Drug Administration (FDA) for treating dental hypersensitivity in 2014, and for preventing and arresting dental caries in 2016 [7]. The 38% SDF is presently used in a simple, painless, non-invasive, paint-on technique that delivers a high fluoride combination (44,800 ppm) with minimal or no instrumentation in both primary and permanent teeth. Due to its affordability, ease of use, and minimal patient cooperation requirements, SDF has a significant potential for managing dental conditions in pre-cooperative, uncooperative, and special needs children [6].

Though the existing literature extensively documented the applications of SDF in the prevention and treatment of dental caries, its use in dental traumatology remains unexplored. The minimally invasive nature of SDF, along with its ability to occlude dentin, prevent oral fluid seepage and inhibit future dental decay, makes it a promising material for the initial management of enamel and dentin fracture in primary teeth, particularly in uncooperative young children. The application of SDF during the first visit for Ellis Class IX dental trauma, involving enamel and dentin fracture without pulp exposure, can significantly improve the prognosis with the potential for the future [8]. Therefore, this case series aimed to introduce a new application of SDF in primary teeth by demonstrating its use in the initial emergency management of enamel and dentin fractures in very young children, including those with negative behavioral responses in dental settings.

Case Presentation

The present case series presented four cases of Ellis Class IX dental trauma in children with a mean age of 4.25 years (Table 1). The children, accompanied by their parents, visited the emergency of the Department of Pediatric and Preventive Dentistry with complaints of injury to the upper front teeth, resulting in chipping of the affected teeth. Due to their young age, behavioral challenges, and lack of cooperation, the children were thoroughly examined and treated with SDF after obtaining written informed consent from their parents. The entire treatment protocol adhered to the World Medical Association's Declaration of Helsinki (2008). As the intervention was an emergency response, ethical approval was not required.

All four patients were conscious, alert, and oriented to time and space. The parents or guardians reported no significant medical history and confirmed that the children's immunization records were up to date. There was no history of loss of consciousness, seizure, vomiting, or oro-nasal bleeding after the trauma. Skeletal injuries were ruled out before initiating dental treatment. The oral hygiene status of all patients at the time of the visit was satisfactory.

Each child's behavior in the dental clinic was assessed using Frankl's Behavior Rating Scale (FBRS). Three children showed negative behavior (FBRS score of 2), while one child showed definitely negative behavior (FBRS score of 1). Conventional behavior management techniques, such as communication, desensitization, modeling, and positive reinforcements, were used to improve cooperation before clinical examination and trauma management. However, due to the varying degrees of behavioral challenges, all cases were otherwise considered candidates for general anesthesia.

Case 1

A 5-year-old boy presented with sensitivity in the upper front teeth following blunt force trauma. Clinical examination revealed Ellis Class IX enamel and dentin fractures in teeth #63 and #62, respectively (Figure 1a). Radiovisiography confirmed the clinical findings, with no evidence of periodontal or pulp injury (Figure 1b). The child also had asymptomatic proximal caries in #51, and #61, which had previously gone untreated due to the child's uncooperative behavior in dental settings. Given the child's negative FBRS score, SDF treatment was planned in the initial visit for teeth #62, #63, #51, and #61.

Table 1. Demographic details and treatment plan of all cases

Case No.	Age (years)	Sex	Type of Dental Trauma	FBRS Score	Additional Clinical Finding	Treatment Plan
1	5	Male	Ellis Class IX enamel fracture #63; Dentin fracture #62	2	Proximal caries #51, #61	SDF wrt #63, #62, #51, #61
2	4	Female	Ellis Class IX enamel fracture #51	2	Early Childhood Caries #52,#61,#62	SDF wrt #51, #52, #61, #62
3	5	Female	Ellis Class IX enamel fracture #51, #61	2	Bruxism	SDF wrt #51, #61
4	3	Female	Ellis Class IX dentin fracture #61	1	----------	SDF wrt #61

FBRS: Frankl's Behavior Rating Scale; SDF: Silver Diamine Fluoride

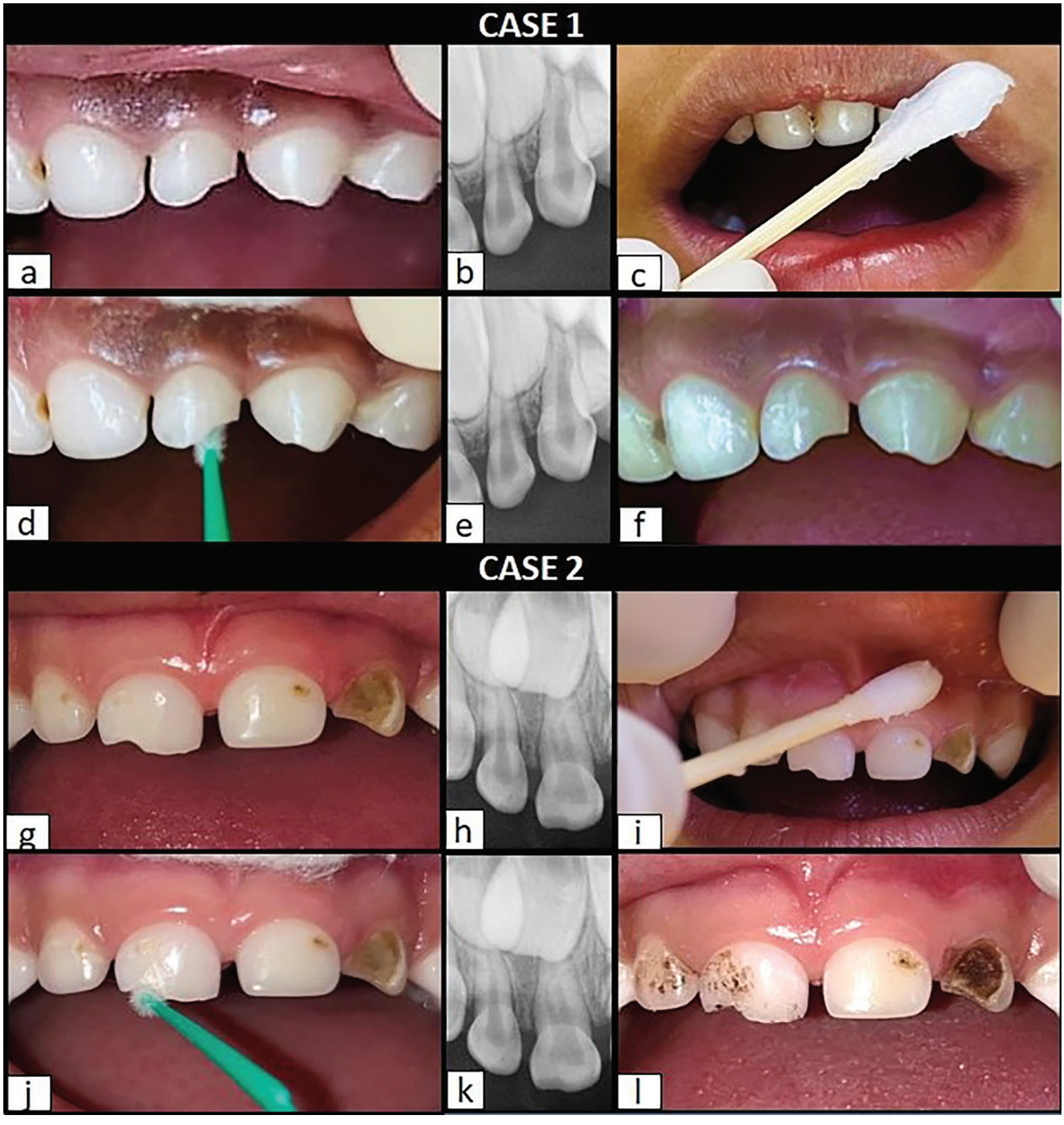

Fig. 1. Case 1 a) Pre-operative picture showing dentin fracture in #62 and enamel fracture in #63, b) Pre-operative radiograph showing no pulp involvement, c) Application of Vaseline on lip using cotton bud, d) Application of SDF on fracture area, e) Post-operative radiograph, f) Immediate post-operative picture showing staining of carious tissue #51, #61 and no staining of fracture #62, #63. Case 2 g) Pre-operative picture showing enamel fracture in #51 and dental caries in #51, #61,#63, h) Pre-operative radiograph showing enamel fracture #51, i) Application of Vaseline on gingival using cotton bud, j) Application of SDF on fracture area, k) Post-operative radiograph, l) Immediate post-operative picture showing staining of carious tissue and no staining of fracture #51

Case 2

A 4-year-old girl presented with an accidental enamel chip of a front tooth while playing. Clinical examination identified an Ellis Class IX enamel fracture in tooth #51, which was confirmed by radiographic imaging (Figures 1g and 1h) The child also showed signs of Early Childhood Caries (ECC), with dental caries in teeth #52, #51, #61, #62 (Figure 1g). Due to the high risk of dental caries and an FBR score of 2, SDF treatment was planned for all the affected teeth in a single visit.

Case 3

A 5-year-old girl presented with a fractured tip of the upper front teeth following a fall. Clinical evaluation revealed Ellis Class IX enamel fractures in teeth #51, and #61 (Figures 2a and 2b). The child also showed generalized attrition, and her parents reported a history of night grinding (bruxism) since 6-7 months. Additionally, the parents reported that the child was extremely fearful and easily distressed in unfamiliar situations. Hence, SDF was selected as the initial treatment for the fractured teeth.

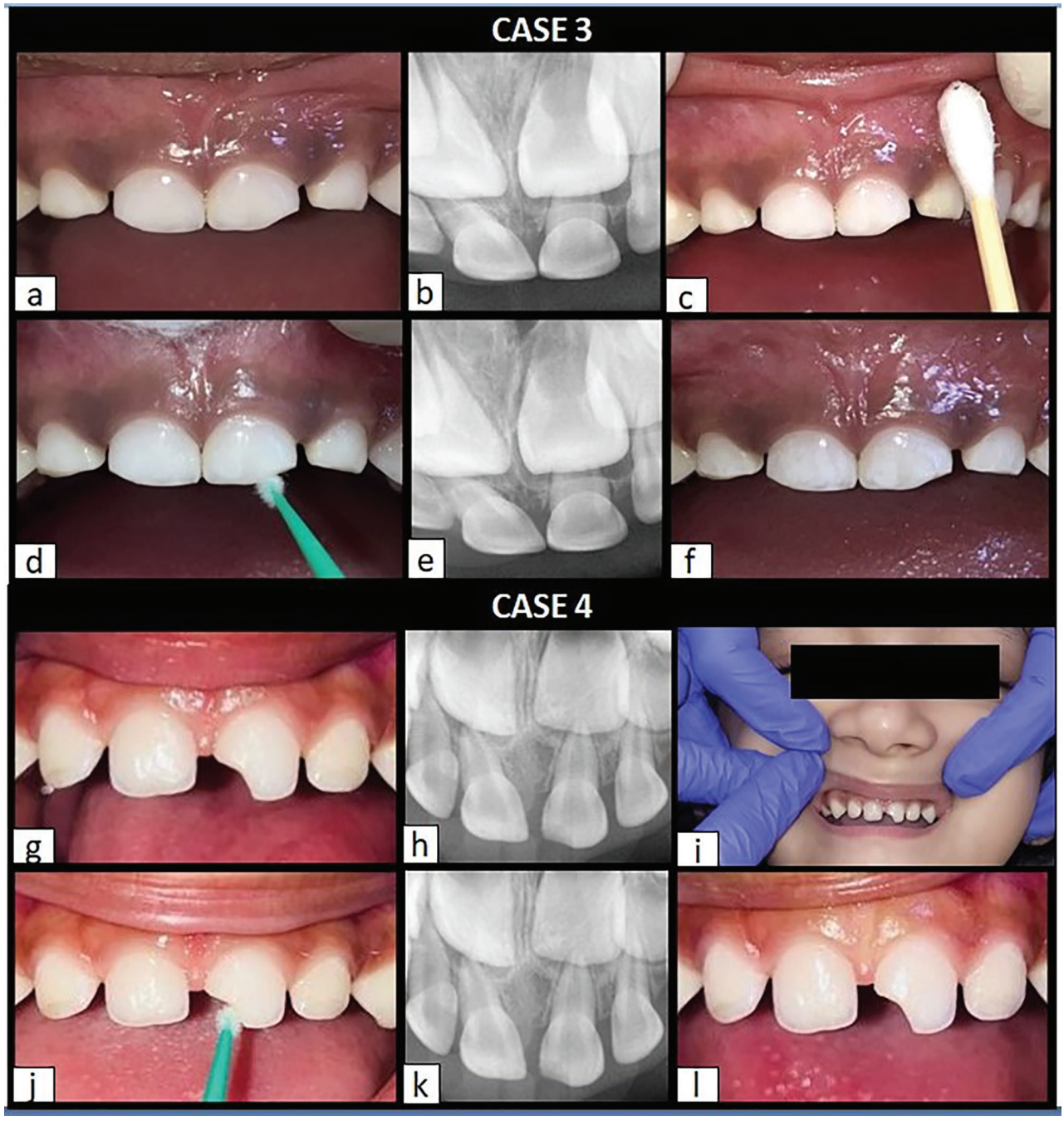

Fig. 2. Case 3 a) Pre-operative picture showing enamel fracture in #51, #61, b) Pre-operative radiograph showing enamel fracture, c) Application of Vaseline on gingiva using a cotton bud, d) Application of SDF on fracture area, e) Post-operative radio

Case 4

A 3-year-old girl presented with a fractured upper front tooth due to a self-inflicted fall. The child was extremely fearful and required extensive behavior management techniques before she agreed to sit on the dental chair in her mother's lap. Clinical assessment revealed an Ellis Class IX dentin fracture in tooth #61 (Figure 2g). Digital radiography confirmed no pulp involvement (Figure 2h). The child exhibited definitely negative behavior (FBRS score of 1) and refused to cooperate with any dental instrument. Therefore, a non-invasive treatment approach was planned using SDF for the affected tooth.

SDF was used in all cases to manage dental trauma. In addition, adjacent carious teeth were treated during the same visit to optimize the chairside time (Figures 1c-f, 1i-l, 2c-f, 2i-l). The American Academy of Pediatric Dentistry (AAPD) Clinical Practice Guideline was followed for SDF application, with modifications to address dental trauma [7]. The protocol included the following steps:

1. Removal of gross debris: A cotton pellet was used to clean the fracture site, ensuring better contact between SDF and the exposed hard tissue.
2. Protective coating: A protective layer (Vaseline or Cocoa butter) was applied to the lips and adjacent gingiva using cotton buds or a finger to prevent temporary staining from accidental SDF contact (Figures 1c, 1i, 2c, and 2i).
3. SDF preparation: One drop of SDF was dispensed

into a plastic dappen dish.

4. Tooth drying: The tooth surface was dried using a gentle flow of compressed air.

5. SDF application: A micro brush was dipped into SDF and dabbed on the side of the plastic dappen dish to remove excess liquid before application (Figures 1d, 1j, 2d, and 2j).

6. SDF placement: SDF was applied directly to the affected tooth surface for 1 minute. Excess SDF was removed with a cotton pellet to minimize systemic absorption, and the medicament was dried using a gentle flow of compressed air.

7. Isolation: Efforts were made to keep the isolated tooth for 3 minutes to maximize treatment efficacy. However, due to the child's lack of cooperation in Case 4, the isolation time was reduced to 1 minute.

Discussion

Traumatic dental injuries (TDIs) are highly prevalent in children and can have significant physical and psychological impacts, often leading to a poor quality of life. These injuries might cause physical discomfort, pain, and psychological distress, such as reluctance to laugh or smile, which could adversely affect social interactions [9]. Even minor dental trauma, such as enamel or dentin fracture, might compromise oral function, esthetics, and self-confidence, while also complicating long-term care for the patient. Therefore, prompt initial assessment and emergency management during the first visit are critical for achieving a favorable prognosis. However, this can be particularly challenging in very young children or those with special needs. In the present case series, all four young children exhibited negative or definitely negative behavior on their dental visits. The use of any armamentarium, such as high-speed air rotors or excavators for enameloplasty or restoration, was not feasible due to the children's lack of cooperation. Hence, conventional treatment methods for enamel or dentin fractures in primary teeth were impractical. De Young AC *et al.,* also reported that trauma in young children was often neglected due to their limited compliance and cooperation [10].

SDF has demonstrated remarkable benefits as a dentin-desensitizing agent and as a means of preventing and arresting dental caries [11]. Its benefits significantly outweigh its primary drawback, post-operative black staining of demineralized tissue [12]. The ease of application, minimal armamentarium requirements, and cost-effectiveness make SDF an ideal choice for managing dental trauma in uncooperative children. The positive outcomes observed in this case series underscored the potential of SDF in such scenarios. In this study, SDF was used as the primary treatment for Ellis Class IX fractures. In cases 1 and 2, children also presented with dental caries in adjacent teeth. SDF was employed to address both the traumatic injuries and caries in a single visit, significantly reducing the need for future treatment appointments. This approach not only saved time and costs but also improved the long-term oral health prospects for these children. In cases 3 and 4, SDF was selected due to its minimal cooperation requirements, making it suitable for highly anxious children. This approach also helped foster a positive attitude toward future dental visits. Othman MA *et al.*, in a systematic review, noted that parental acceptance of SDF increased greatly after improvements in post-treatment cooperation of pediatric patients [13]. This suggested that SDF could enhance the chances of cooperation during the definitive treatment of dental injuries.

The application of SDF in these cases adhered to the standard protocol for managing dental caries [6]. However, certain modifications were necessary to address dental trauma. For instance, gross debris removal was accomplished using a cotton pellet instead of an excavator. In Case 4, Vaseline was applied to the soft tissues using a finger due to the child's inability to cooperate. Notably, staining was not a concern in these cases, as no denatured tissue was present in the fractured enamel or dentin. This simplified the SDF treatment process, eliminating the need for an armamentarium and avoiding undesirable black staining of the enamel or dentin. The clinical advantages of SDF as an initial treatment for managing hard tissue injuries without pulp involvement in primary teeth are evident. However, further research is required to establish standardized clinical practice guidelines for the universal application of SDF in dental trauma management.

The present case series highlighted the successful use of SDF in the initial management of primary tooth trauma in behaviorally compromised pediatric patients, including those with special healthcare needs. It also emphasized the need to explore the broader application of SDF in dental trauma management and to develop clinical guidelines for its use.

To the best of our knowledge, this was the first exploration of SDF application in traumatic dental injuries.

SDF has demonstrated significant potential in the dental treatment of behaviorally challenged, uncooperative pediatric patients, including those with special healthcare needs.

Post-application discoloration by SDF has been accepted by parents due to its substantial benefits in re-mineralizing tooth hard tissue and preventing future disease.

The use of SDF for its desensitizing and caries-preventive properties in managing traumatic dental injuries involving enamel and dentin in young and uncooperative children represents a novel approach.

Declarations

Ethical approval and consent to participate: Manuscript is in compliance with the Helsinki

Declaration 2008. Written informed consent was taken from parents/guardians of the children undergoing treatment.

Consent for publication: Authors consent for publication in the journal.

Conflict of Interest: The authors declared no conflicts of interest.

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Authors Contribution: GM: conceived the idea, planned the diagnosis and treatment, supervised the treatment and follow ups, interpreted the result, prepared and edited the manuscript. NV: performed the treatment, collected the data, interpreted results, writing assistance in the manuscript. JB: performed the treatment, collected the data, interpreted results, writing assistance in the manuscript.

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