*Regeneration, Reconstruction & Restoration* **Case Report**

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# Forced Eruption of a Palatally Impacted Canine with a Temporary Skeletal Anchorage Device: A Case Report

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## Abstract

Maxillary canines are the second most commonly impacted teeth, with palatal impactions predominating. Forced eruption supported by temporary anchorage devices (TADs) can minimize adverse effects on adjacent teeth and shorten the preparatory phase. A 17-year-old male presented with maxillary left canine impaction (#23). Extraoral examination showed mild facial asymmetry; intraorally, there was absence of #23, anterior crowding, and a Class II subdivision molar relationship on the right. CBCT revealed a horizontally impacted palatal canine in close proximity to the left incisors. Cephalometrics indicated a Class I skeletal pattern with hypodivergent growth. A canine-first approach was used. Skeletal anchorage was obtained with a 1.6 × 8 mm palatal miniscrew between the left second premolar and first molar. The canine was surgically exposed, a palatal button bonded, and immediate traction applied with elastic thread, followed by a ballista spring. Fixed appliances (0.022-in slot) were used with sequential NiTi and stainless-steel archwires. To avoid lateral incisor root contact, initial retraction was directed posteriorly from the TAD before buccal movement. Space creation with open-coil springs and later interarch Class II elastics on the right were employed. Torque control of the canine was finalized with rectangular archwires. Total active treatment time was 34 months; retention included a braided fixed lingual retainer and a removeable retainer. Posttreatment records showed Class I canine and molar relationships bilaterally, normal overjet/overbite (2 mm/2 mm), improved midline coincidence, appropriate root parallelism, and no radiographic evidence of root or bone loss. Facial profile was harmonious on lateral cephalometry. CBCT-guided, TAD-assisted forced eruption using a canine-first protocol enabled safe, controlled disimpaction of a palatally impacted canine, preserving anchorage and protecting adjacent roots while achieving stable functional and esthetic results.

**Keywords:** Palatally impacted canine, Forced eruption, Temporary anchorage device (TAD), Ballista spring, Canine-first approach.

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## 1. Introduction

An impacted tooth refers to a permanent tooth with root development exceeding two-thirds, yet its natural eruption is delayed beyond a reasonable timeframe. Among impacted teeth, maxillary canines are notably the most frequently affected, ranking second only to the third molar (1). The occurrence rate ranges between 1.7% and 4.7%, depending on the surveyed population, and it tends to favor females (2). A canine with a maxillary impacted tooth may experience a number of issues, including pain, ankylosis, recurrent infections, short dental arches, and follicular cyst formation (3). Many circumstances, including hard tissue blockages, soft tissue lesions, disruption of normal incisor growth, inherited or genetic factors, and possible concomitant dental malformations, can result in maxillary permanent canine impaction (4).

About one-third of impacted maxillary canines are found labially, whereas the other two-thirds are found palatally. It is unknown what causes palatally displaced maxillary canines.

Palatally displaced maxillary canines are linked to two main theories: genetic theory and guidance theory (5).
A maxillary impacted canine may be treated by auto transplantation, interception, or prevention, surgical opening followed by autonomous eruption or orthodontic traction, or extraction and space closure, depending on the diagnosis and timing of intervention (6).
When it comes to impacted maxillary teeth, dentists have to choose between extracting the tooth and guiding it into occlusion. When the tooth is positioned poorly, they frequently choose to extract it, which can lead to increased risks of complications. Considering the essential role maxillary canines play in both function and aesthetics (influencing dental arch formation, occlusion, and facial support) this choice has far-reaching implications (7).
The two most popular surgical techniques for bringing palate-impacted canines into occlusion are: 1) leaving the teeth exposed and letting them erupt spontaneously in early or late mixed dentition; 2) leaving the teeth exposed and attaching a bonded attachment to the tooth, then using orthodontic forces to move the tooth (5).
When only the impacted teeth require movement before starting fixed-appliance orthodontic treatment, skeletal anchorage is necessary. Temporary anchorage devices (TADs) have gained popularity due to their easy placement and removal, requiring minimal patient cooperation, and relatively low cost (8). Additionally, they make challenging orthodontic tooth movements easier (9).
Regarding the failure rate of treatment for canine impaction, it was stated that the primary causes of failure were insufficient anchorage (48.6%), incorrect placement and directional traction (40.5%), and ankylosis (32.4%) (10). In any event, effective canine movement and the minimization of undesired changes to the posterior teeth depend heavily on appropriate anchoring preparation and management. To improve the stability of anchorage unity, skeletal anchorage has been proposed (11). Miniscrews may be positioned either between the roots of the teeth or in the paramedian region of the palate, where high success rates and treatment effectiveness have been reported (12).

## 2. Case report

A 17-year-old male patient came to the department of orthodontics of the Azad University of Medical Sciences, Tehran with the chief complaint of delayed eruption of his maxillary left canine. He was in good dental health and had no history of dental trauma.
He had a straight facial profile with a hypodivergent skeletal pattern, an average nasolabial angle, and an average mentolabial sulcus. In frontal extraoral examination the chin was deviated to right presenting facial asymmetry. His smile also appeared asymmetrical. The upper dental midline was 1.5mm to left from the facial midline and 0 mm of gingival show upon smiling.
Intraoral clinical examination showed asymmetric maxillary arches, crowding in the anterior region (By substitution of the impacted tooth) absence left upper canines and Angle's Class II subdivision molar relationship on the right side (Figure 1).

**Figure 1.** Pretreatment intraoral photographs. According to the pictures, in this patient, a canine impaction on the left side of the maxilla was seen. In the dental arch of the maxilla, the asymmetry was evident in the sagittal and transverse dimensions. As is clear, there was no crowding in the upper jaw, and there was mild crowding in the lower jaw.

There was also an overjet of about 3mm and overbite of about 3mm (Figure 2). Mandibular dental midline coincides with maxillary dental midline.
Visual inspection revealed presence of canine bulge between the lateral incisor and first premolar on the left side.

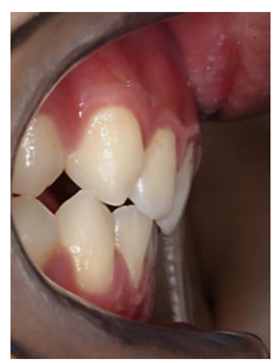

**Figure 2.** Pretreatment intraoral profile photograph.

### 2.1. Investigations

Extraoral and intraoral photographs, study models, intra-oral periapical radiographs, maxillary occlusal radiographs, lateral cephalometric radiograph, panoramic radiograph, functional examination and cone-beam computed tomography (CBCT) of the maxillofacial region were conducted. Study model analysis confirmed the clinical findings, showing the maxillary midline shifted 1.5 mm towards the patient's left side.

## 2.2. Radiographic analysis

### *2.2.1. Panoramic radiograph*

Revealed symmetrical condyles and normal ramus, the body of the mandible, and maxillary sinuses. All teeth were present, except for the impacted #23. (Figure 3).

**Figure 3**. Revealed symmetrical condyles and normal ramus, the body of the mandible, and maxillary sinuses. All teeth were present, impacted #23.

### *2.2.2. Cone-beam computed tomography (CBCT)*

As seen in these scans (Figure 4), #23 was horizontally impacted. The crown was positioned palatally, and the root was also palatally located. The canine was close to #21 and #22.

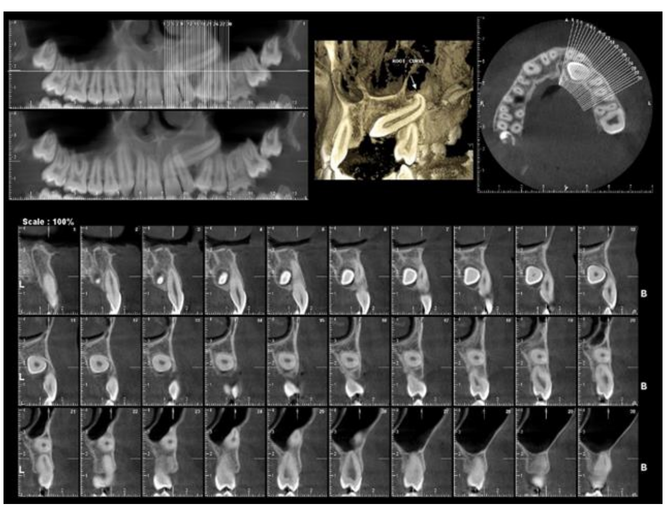


**Figure 4.** Cone beam computed tomography. As seen in these scans, #23 was horizontally impacted. The crown positioned on the palatal side and the root positioned palatally. The canine was close to #21 and #22.

### *2.2.3. Cephalometric radiograph*

Cephalometric radiograph (Figure 5) revealed a Class I skeletal relationship, (ANB = 2.5°, AO was ahead of BO by 1.5 mm), horizontal growth pattern (FH-MP = 13°) orthognathic maxilla (SNA = 85˚, Nperp A = 2.47 mm) and prognathic mandible (SNB = 82.5˚, Nperp-pog = 6.5 mm) in relation to anterior cranial base. Maxillary incisors presented a minimal decrease in axial inclination (U1 to NA = 17° and U1to NA = 0.1 mm), while mandibular incisors were retruded and retroclined (L1 to NB = 15° and L1 to NB = 0.7mm) (Table 1).

**Figure 5.** Pretreatment lateral cephalogram.

## 2.3. Prognostic evaluation

Different aspects of canine position were assessed by radiographs. The prognostic factors investigated by McSherry (13), Pitt, Hamdan, and Rock (14), and Counihan, Al-Awadhi, and Butler were used as references (15).

1) The amount the canine crown that horizontally overlaps the adjacent incisor. In our patient, the left canine was closer to the midline, and complete overlap of adjacent central and lateral incisor occurred (Figure 6, part A), which suggested a poor prognosis.

2) Vertical height of the canine crown. In this case report, the crown of the left canine was located more than halfway up the root of the central incisor but less than the full length of the root of this tooth (Figure 6, part B), indicating an average prognosis.

3) Canine angulation to the midline. In this patient, the canines were angulated above 30° to the midline on the left side (Figure 6, part C), which suggested a poor prognosis.

4) The position of the canine root apex in the horizontal plane. Cone beam computed tomography revealed that the left canine root apex was positioned above 1st premolar (Figure 4), indicating an average prognosis.

Autotransplantation of the left affected canine was not explored since the method had a low success rate. Finally, we decided to try forced eruption and alignment of the impacted teeth with the consent of the patient and his parents.

**Table 1.** Cephalometric measurements.

| Measurement | Norm | Pretreatment | Posttreatment |
|---|---|---|---|
| SNA (°) | 82.0 | 85 | 85.5 |
| SNB (°) | 79.9 | 82.5 | 83.5 |
| ANB (°) | 2.1 | 2.5 | 2 |
| Wits (mm) | 1.1 | 1.5 | 0 |
| FH-MP (°) | 28.2 | 13.5 | 12 |
| U1-SN (°) | 104.0 | 102 | 106 |
| U1-NA (°) | 22.0 | 17 | 21 |
| IMPA (°) | 90.0 | 91 | 93 |
| L1-NB (°) | 25.0 | 15 | 18 |
| U1/L1 (°) | 124.0 | 145.5 | 143 |
| Upper lip (mm) | 1.2 | -4.5 | -4 |
| Lower lip (mm) | 2.0 | -7.5 | -7 |

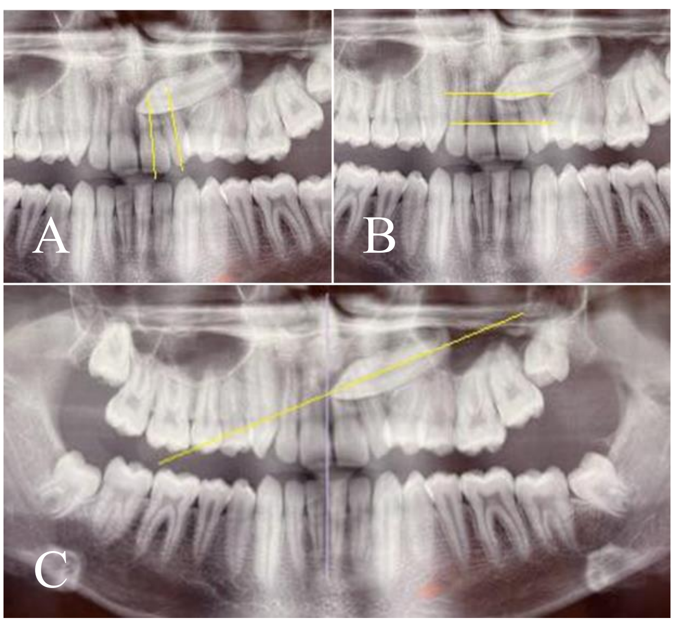


**Figure 6.** Radiographic assessment of the left maxillary canine. (A) Horizontal, (B) vertical, and (C) angular assessments revealed that the tooth was in an unfavorable position for orthodontic treatment.

## 2.4. Treatment method

A combined forced eruption therapy method was used at various stages.

### *2.4.1. Anchorage preparation*

The forced eruption procedure involved the precise placement of TADs and the application of controlled forces to guide the impacted canine. A miniscrew (Dual Top Anchor System - G2 Screw, diameter:1.6 mm; length: 8 mm) placed in the palatal area between the left second premolar and first molar. Once the angulation of the canine improved, the vertically directed force was applied on the canine from TAD. The approach to solve the impaction was "canine first".

### *2.4.2 Surgical exposure of the impacted teeth*

An open surgical technique was used.

### *2.4.3. Methods for attachment and traction*

MBT brackets were bonded, and initial alignment was achieved with the sequence of nickel titanium archwires 0.014, 0.016, 0.018, 0.019x0.025-in.

### *2.4.4. Alignment of impacted teeth using orthodontic mechanics*

The study used 0.022 stainless steel metal brackets (American Orthodontics, Sheboygan, WI, USA) for this treatment. Also, the study utilized Nickel-Titanium (NiTi®) and Stainless Steel (SS) archwire from American Orthodontics Corporate HQ (American Orthodontics, Sheboygan, WI, USA).

It should be considered that teeth #22 and #24 were not initially bonded. The impacted canine was surgically exposed under local anesthesia, and a button was bonded on the palatal surface for forced eruption. Direct buccal traction of the canine would apply pressure on the root of the lateral incisor distobuccally, so the transposed canine was initially retracted posteriorly using a microimplant inserted in the palatal area, and the incisors were not ligated until a sufficient distance was created to prevent root interference, and then the canine was moved buccally into its ideal position. The study utilized 1.6

× 8 mm Jeil® orthodontic miniscrews (Jeil Medical Corporation, Seoul, South Korea).
Traction of the impacted canine was started on the day of surgery with elastic thread that was changed every 2 weeks. After 6 months, we used a ballista spring to move the tooth in the occlusal direction. (Figure 7). The springs were fabricated from 0.016-in SS wire (G&H Orthodontics®, Franklin, IN, USA).

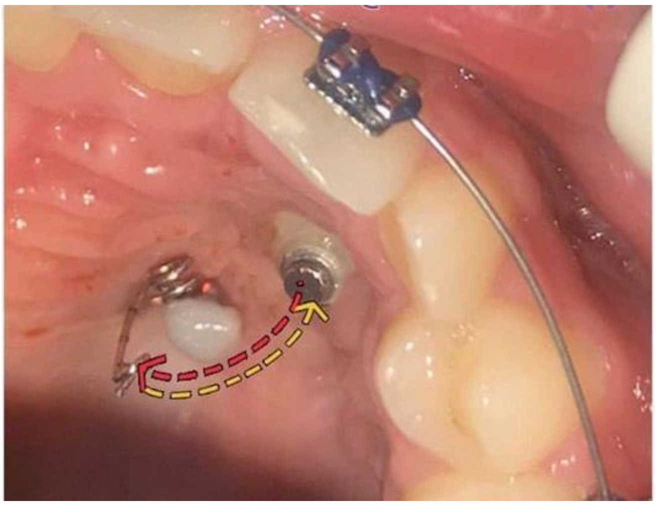

**Figure 7.** Ballista Spring and direct anchorage (yellow: activation, red: forced direction).

After 9 months of treatment, teeth #22 and #24 were bonded and again a 0.018-in nickel titanium archwires was inserted. The spaces in the upper left canine region were made with an open coil between the lateral incisor and first premolars. After 12 months of treatment, appliance was placed in the mandibular arch, and alignment began with a 0.012-in nickel titanium archwires. During the same visit, a 0.019x0.025-in nickel titanium archwire was placed in the upper jaw.
Alignment in the lower arch was achieved with the sequence of nickel titanium archwires 0.014 ,0.016, 0.018, 0.019x0.025-in in the next visits. In the upper jaw 0.019x0.025-in stainless steel archwire was inserted and the traction continued with a thread for the upper left canine.
To solve the class II problem on the right side, after placing 0.019x0.025-in stainless steel archwires in the upper and lower jaw, class II elastics were used for the patient on the right side. (3/16, medium-force (4.5 oz) elastics (G&H Orthodontics®, Franklin, IN, USA).
After 21 months of treatment, a bracket was bonded on the labial surface of the canine, and a 0.012-in nickel titanium archwires was positioned.
To achieve a good lingual crown torque in the canine, a sequence of rectangular wires was placed in the canine to finally obtain a favorable and balanced torque.
After 34 months of treatment, the torque control of the canine was completed, and debonding was done after detailing. A fixed lingual retainer (0.0175" braided fixed retainer wire (American Orthodontics, USA)) and circumferential clear retainer were used for retention.

At the end of the treatment period, a functional occlusion was observed. The clinical results included normal overjet and overbite (2mm and 2mm respectively), adequate intercuspation, nearly coincident midlines with class I molar relation and class I canine relation bilaterally (Figure 8).

**Figure 8**. Post treatment intraoral photographs. At the end of the treatment of this case, molar and canine class I relationships were obtained. Also, the asymmetry of the dental arch was corrected.

The patient was satisfied, and the case was finalized. Posttreatment panoramic showed the optimal positioning of the maxillary left canine with proper root parallelism and no significant signs of bone or root resorption. (Figure 9)
A posttreatment lateral cephalometric radiograph showed a well-balanced and harmonious facial profile (Figure 10).

## 4. Discussion

Maxillary canines undergo their development adjacent to the piriform fossa. These teeth follow a challenging path during eruption, have the lengthiest developmental timeline, and undergo development in the deepest region. Coulter and Richardson observed that maxillary canines move approximately 22 mm within the three dimensions of space between the ages of 5 and 15 years (16).
It's important to acknowledge that tooth eruption is a complex and coordinated developmental process. It involves a series of signaling interactions between the dental follicle and specialized bone cells like osteoblasts and osteoclasts located in the alveolar bone (17). Because of this intricate process and their lengthy and convoluted journey, maxillary canines rank

**Figure 9.** Post-treatment panoramic.

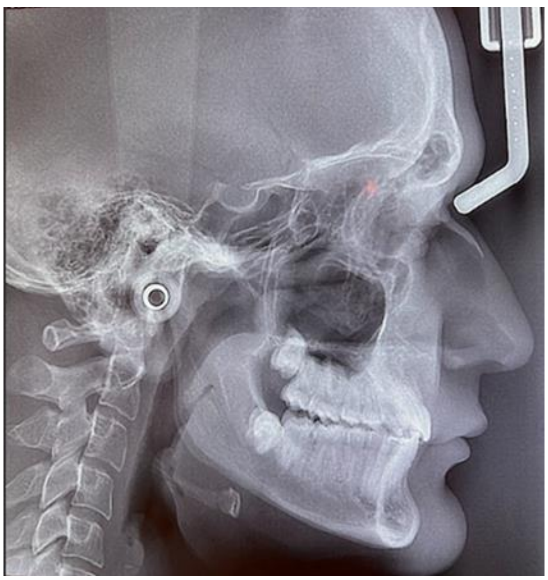

**Figure 10.** Posttreatment lateral cephalogram. Improvement of U1 to NA and L1 to NB is evident. It can also be mentioned to improve the prominence of the lips.

as the second most commonly impacted teeth after the third molars, with an estimated prevalence of around 2% (18).

Many circumstances, including as hard tissue blockages, soft tissue lesions, disruption of normal incisor growth, inherited or genetic factors, and possible concomitant dental malformations, can result in maxillary permanent canine impaction (4).

A canine with a maxillary impacted tooth may experience a number of issues, including pain, ankylosis, recurrent infections, short dental arches, and follicular cyst formation (3).

The conventional method involves the initial alignment and positioning of substantial rectangular base arch wires to counteract reaction forces. In practical application, the optimal approach involves relocating impacted canines away from the neighboring teeth's roots prior to finalizing the orthodontic setup of the arch. Achieving the canine's disimpaction without reliance on neighboring teeth necessitates bone anchorage (19). On the other hand, employing Temporary Anchorage Device (TAD) connected to a TMA cantilever spring proves beneficial in providing anchorage for canine eruption prior to commencing alignment (20).

The conventional method has certain drawbacks. Bonding and engaging the lateral incisor in orthodontic arch wires at the beginning of treatment can lead to displacement of the tooth's apex, bringing it closer to the dental follicle of the canine tooth. This proximity can cause the root of the lateral incisor to come into contact with the crown of the impacted canine, which may trigger or worsen root resorption. Therefore, moving the impacted canine away from the adjacent roots before starting fixed orthodontic treatment can reduce the risk of further root resorption in the lateral incisor (11, 19).

In the conventional method, orthodontic brackets and wires are placed in the mouth from the beginning of treatment. As a result, braces remain in the oral cavity for a relatively long period. This extended duration increases the risk of treatment complications, such as decalcification and root resorption (21).

In Heravi et al.'s study, it was found that dis-impacting palatally impacted canines prior to aligning the teeth might lead to a reduction in root resorption. Furthermore, the employment of Temporary Anchorage Devices (TADs) facilitates a more controlled movement of the impacted tooth (11).

Another potential drawback is the root resorption of adjacent teeth. The upper lateral incisors exhibited the highest degree of impact, with the upper central incisors following closely behind (22, 23). In all adjacent teeth examined, RR presented most often in the apical and middle thirds of the root. Identified root resorption typically remains stable before orthodontic treatment, yet it significantly influences the treatment strategy, particularly in determining the orthodontic traction direction (22).

A canine with a maxillary impacted tooth may experience a number of issues, including ankylosis. On the other hand, ankylosis of an impacted canine tooth cannot be definitely determined based on radiographs (24).

If the treatment plan involves aligning impacted canines and requires premolar extraction for space, the extraction should be delayed until the impacted teeth are successfully moved into the oral cavity. Orthodontic mini-implants are very effective in facilitating the mesial movement of posterior teeth. Replacing canines with premolars is a viable option if the impacted canines are ankylosed (25).

A significant factor contributing to the failure of impacted canine treatment is inadequate anchorage (26-28).

The "Canine First Approach" was introduced to mitigate the adverse effects associated with improper canine traction, such as root resorption and inadequate tooth movements. Migliorati et al.'s study indicated that both direct and mTPA anchorage demonstrated similar movement speeds for both cusp and root measurements, with slightly faster movement observed in the direct anchorage group. The direct approach required less preparation, enabling placement of miniscrews on the same day as exposure intervention and traction initiation. Clinically, both methods successfully exposed impacted canines and facilitated subsequent orthodontic treatment completion. The single-screw approach offered simpler movement management and less patient discomfort (29).

In our case report, the utilization of TADs and cantilever spring combination enabled us to implement the "Canine First Technique," thereby preventing excessive stress on neighboring teeth. The strategy adopted shared similarities with the clinical intervention executed in the study referenced as Capuozzo et al.'s research (30). Then, the therapy involved the use of fixed appliance to finalize the aesthetic and functional treatment.

# 5. Conclusion

Treatment of impacted canines while preserving anchorage and preventing undesirable movement of other teeth remains a challenge in orthodontics. A precise assessment of tooth position with CBCT, coupled with the application of appropriate treatment mechanics, reduces the risk of undesirable complications (root resorption and inadequate anchorage). In this case, both esthetic and functional treatment outcomes were attained through the precise application of orthodontic force, facilitated by the utilization of CBCT and a micro implant.

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## Ethics

This study was conducted in accordance with the ethical standards. Written informed consent was obtained from the patient for the use of clinical data, photographs, and treatment procedures in this publication.

## Using artificial intelligence (AI)

No artificial intelligence (AI) tools were used in the preparation, drafting, or editing of this manuscript.

## Author contributions

Faeze Shams: Conceptualization, Writing - Original draft, Writing – Review & editing
Nima Baniasad: Supervision, Writing - Review & editing
Ali Tashakor: Data Curation, Investigation, Writing - Review & editing

## Conflict of interest

The authors declare no conflicts of interest.

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