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CASE REPORT

ROOT INVASION OF THE INCISIVE CANAL DURING ORTHODONTIC TREATMENT DUE TO EXCESSIVE PALATAL ROOT TORQUE. CASE REPORT

Invasión radicular del conducto incisivo durante el tratamiento de ortodoncia debido a un torque radicular palatino excesivo. Reporte de un caso

Shivani Singh.[1]

1. Department of Orthodontics and Dentofacial Orthopaedics, Manipal College of Dental Science Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India.

ABSTRACT

Aim: Patients presenting with bimaxillary proclination often have an accompanying maxillary alveolar procumbency.

Case Report: Posterior relocation of the anterior alveolus is an important mechanism to reduce this prominence. Torquing the maxillary incisor roots palatally allows the anterior alveolus (point A) to remodel distally. This technique is non-invasive and therefore has good patient acceptance.

Results: The following case report demonstrates the involvement of the incisive canal due to increased palatal root torque of the maxillary left central incisor root

Conclusions: The use of 3D imaging in the diagnosis, its clinical complications as well as their remedial measures is also discussed.

Keywords: *Incisive canal; Root resorption; Torque; Orthodontics; Maxilla; Cone-beam computed tomography.*

RESUMEN

Introducción: Los pacientes que presentan proinclinación bimaxilar a menudo tienen una procumbencia alveolar maxilar acompañante.

Reporte de Caso: La reubicación posterior del alvéolo anterior es un mecanismo importante para reducir esta prominencia. Apretar las raíces de los incisivos superiores hacia palatino permite que el alvéolo anterior (punto A) se remodele distalmente.Esta técnica no es invasiva y por tanto tiene buena aceptación por parte de los pacientes.

Resultado: El siguiente informe de caso demuestra la afectación del canal incisivo debido al aumento del torque de la raíz palatina de la raíz del incisivo central izquierdo superior.

Conclusiones: También se analiza el uso de imágenes 3D en el diagnóstico, sus complicaciones clínicas y sus medidas correctivas.

Palabras Clave: *Canal incisivo; Resorción Radicular; Torque; Ortodoncia; Maxilar; Tomografía Computarizada de Haz Cónico.*

CORRESPONDING AUTHOR: Shivani Singh. Department of Orthodontics and Dentofacial Orthopaedics, Manipal College of Dental Science Mangalore, Manipal Academy of Higher Education, Karnataka, Manipal, 576104, India. **Phone:** 0824-2428716-5659. **E-mail:** shivani.singh@manipal.edu; shivaniortho@gmail.com

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INTRODUCTION

The incisive canal lies at the median plane of the palatal process of the maxilla, between the two maxillary central incisor roots.[1] It is surrounded by thick cortical bone, which fuses with the palatal cortical plate around the roots of the maxillary central incisors at the level of the middle and cervical thirds.[2] Due to its oval shape it is particularly closer to the mesiopalatal surface of the central incisor roots.[1-4]

With the advent of the orthodontic mini-implants, it has become common to retract the maxillary incisors to up to 8 mm or more, in patients exhibiting severe maxillary dental proclination.[1,5,6] Absolute retraction of the maxillary incisors, places its roots in close proximity to the incisive canal (IC) and may result in its approximation, contact, or actual communication with the canal contents.[4]

The incisive canal involvement following excessive palatal root torque, and only moderate incisal edge retraction has not been reported in the literature. There is a paucity of information regarding the potential complications that may arise due to the same as well as their resolution.

This present report briefly illustrates one such scenario, in an adult patient undergoing orthodontic treatment.

CASE REPORT

A 21-year-old female patient with a chief complaint of forwardly placed upper front teeth and lip protrusion was referred for an orthodontic consultation.

The intraoral photographs revealed proclined maxillary and mandibular incisors, with minor crowding in each arch (Figure 1). The arches were symmetric and narrow "U" shaped. The molar, as well as the canine relationship, was Class I bilaterally.

A panoramic radiograph showed a normal complement of teeth with developing third molars in all four quadrants (Figure 2A). The cephalometric radiograph (Figure 2B) and its analysis (Table) indicated moderately proclined and forwardly placed maxillary as well as mandibular incisors.

In addition, due to the forwardly placed maxillary skeletal base (SNA, 86°), there was a protrusion of the maxillary anterior alveolus. The facial skeletal pattern was Class II (ANB, 4°) and the lips were moderately protrusive. The treatment objectives were to attain normal bimaxillary inclinations, reduce the maxillary alveolar procumbency, and attain normal overbite, and normal lip positions while controlling the vertical facial dimensions.

Two treatment options were presented to the patient. The first option was the extraction of four first premolars, followed by retraction in the mandibular arch, and anterior subapical osteotomy of the maxilla with slight clockwise rotation to gain a normal overbite. The second option was to extract a similar set of teeth followed by retraction with moderate anchorage. The retraction of the maxillary incisors was to be performed with increased palatal root torque to reduce the maxillary alveolar procumbency. Both treatment options were discussed with the patient.

The patient chose the second option, mainly due to the risks as well as postoperative complications, namely necrosis of the anterior teeth, root cutting, ankylosis of canine, and wound dehiscence at the osteotomy site, involved with the surgical procedure.

After obtaining informed consent from the patient, orthodontic treatment was initiated using a 0.022-in slot Roth prescription (Master series, American Orthodontics, Sheboygan, WI) conventional bracket system. Post-extraction, 0.14-in, 0.16-in, and 0.18-in NiTi archwires were used sequentially to align the teeth. Thereafter, following a two-step retraction method, the canines were retracted independently on a 0.018-in premium Australian wire, whereas the consolidated incisors were retracted using a "T-loop" 0.019 × 0.025-in SS archwire.

Palatal root torque of 30° was incorporated into the maxillary T-loop retraction archwire to enable cycles of root torque followed by root tip with each archwire activation. Prescription or customized maxillary anterior brackets to affect palatal root torque were not placed from the beginning of treatment to avoid greater anchorage loss than planned. The maxillary retraction archwire provided the desirable torque at demand.

At 30 months, after completion of anterior retraction, the arches were consolidated from the second molar on each side. Additional palatal root torque was placed again in the maxillary anterior region to affect increased posterior alveolar remodeling, as judged by the facial profile at the chair side.

This step was planned to continue for 3-4 months. Two visits later, the patient reported a dull pain in the anterior palatal aspect near the gingival margins.

No changes could be detected clinically in the aforementioned region. The pain was thought to be due to the pressure on the palatal cortical plate or perhaps due to plaque accumulation. Oral prophylaxis was performed for the patient. Next visit, the patient reported that the pain had remained the same. At this appointment, the root torquing archwire was removed and a 0.019 × 0.025-in finishing NiTi archwire was placed. This was done to release the force on the maxillary anterior region.

The following visit, the patient reported the pain had ceased. The case was debonded after 34 months of active treatment. At the debond appointment the patient was free of pain. No abnormality was detected upon clinical examination. Upper and lower Hawley retainers were placed for 1 year of full-time wear and another 6 months for nighttime wear.

RESULTS

Posttreatment photographs revealed a washboard appearance and a substantial reduction in the anterior alveolar procumbency (Figure 3). A panoramic radiograph revealed optimum root paralleling with no signs of root resorption (Figure 4A).

The cephalometric radiograph and its analysis revealed posterior remodeling of point A by 2 mm, (A-NP distance from 2 mm to 0 mm; SNA from 86° to 84°) leading to a normalization of the ANB angle (Figure 4B and Table). The

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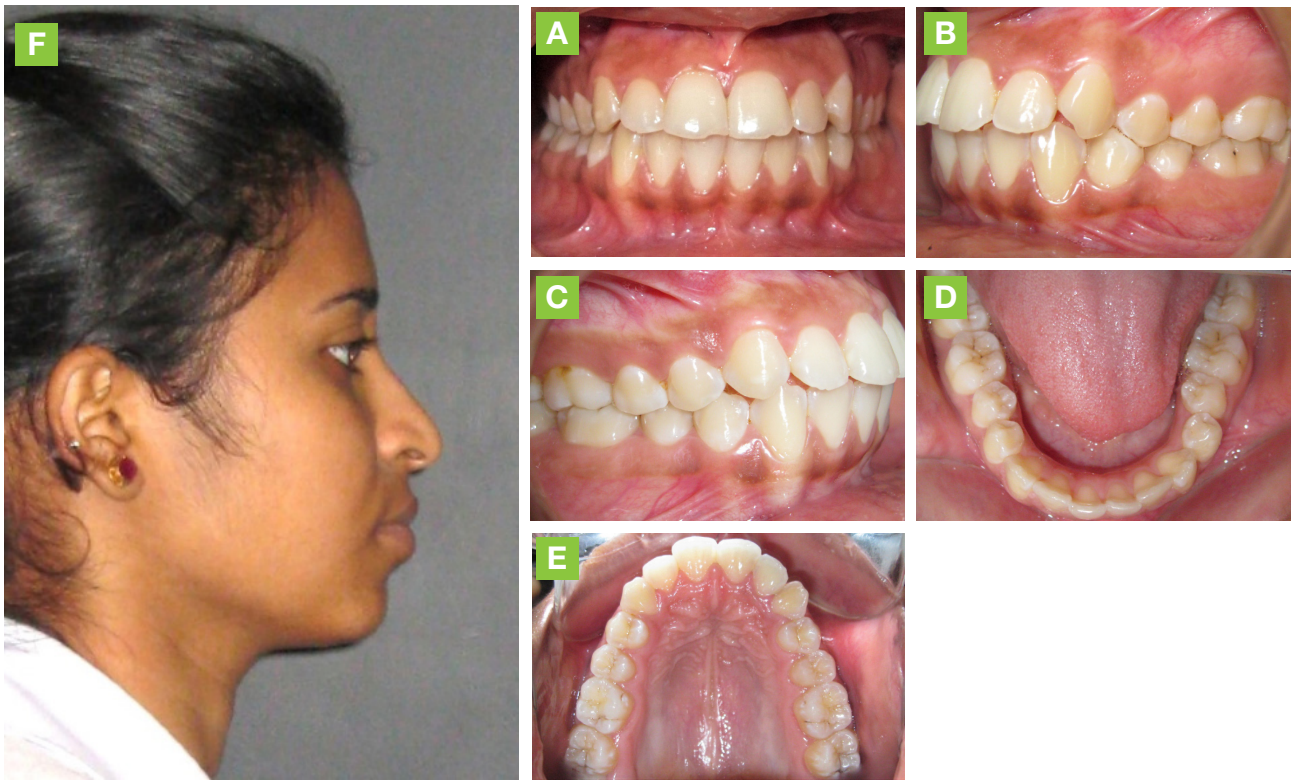
Table. Cephalometric Analysis.

	Measurement	Normal value	Pretreatment	Posttreatment
Skeletal Analysis	Angle SNA (°)	82	86	84
	Angle SNB (°)	80	82	81
	ANB (°)	2	4	3
	A-NP distance (mm)	1	2	0
	SN-MP-abo (°)	32	32	33
	FMA-abo (°)	25	24	26
Dental Analysis	+1i/NA (°)	22	36	34
	+1i/NA (mm)	4	8	5
	+1/SN (°)	103	119	118
	-1i/NB (mm)	4	9	6
	-1/MP-abo (°)	99	105	95
	Interincisal angle (°)	135.4	103	115
	Overjet (mm)	3.5	3	3
	Overbite (mm)	2	-1	1
Facial Analysis	Ls'/E-line (mm)	-4	-2	-4
	Li'/E-line (mm)	-2	2	-1

Figure 1. Pretreatment clinical examination.



A. Frontal photograph. **B.** Left side photograph. **C** Right side photograph. **D.** Mandibular occlusal photograph. **E.** Maxillary occlusal photograph. **F.** Facial profile photograph.

maxillary and the mandibular incisal edges were retracted by 5 mm when adjustment for the posterior relocation of point A by 2 mm was made for. Normal lip positions were achieved.

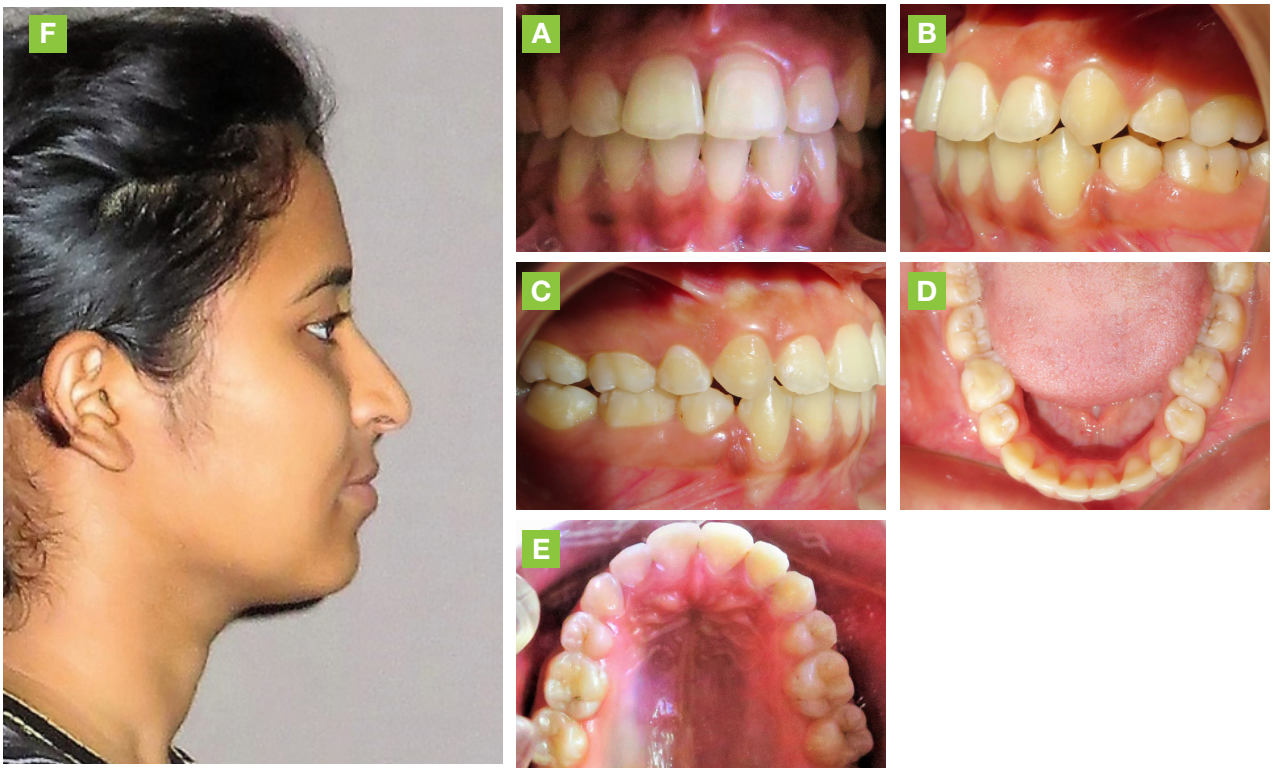
Superimposition of the pre and post-treatment cephalometric tracings revealed bodily retraction of the maxillary and mandibular incisors with increased palatal root torque of the maxillary incisors (Figure 4C).

Since the maxillary incisors were retracted with greater root movement than the incisal edges, their inclinations changed minimally (Table).

Figure 2. Pretreatment radiographs.

A. Panoramic radiograph. **B.** Lateral cephalogram.

Figure 3. Posttreatment clinical examination.



A. Frontal photograph. **B.** Left side photograph. **C** Right side photograph. **D.** Mandibular occlusal photograph. **E.** Maxillary occlusal photograph. **F.** Facial profile photograph.

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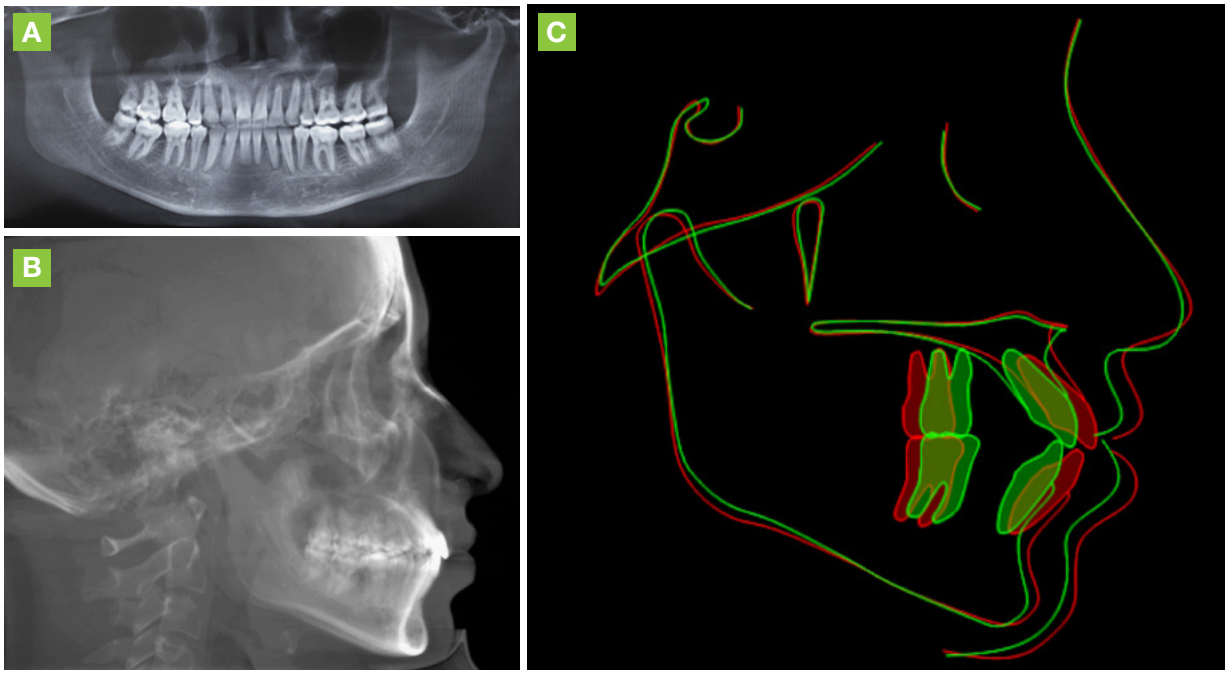
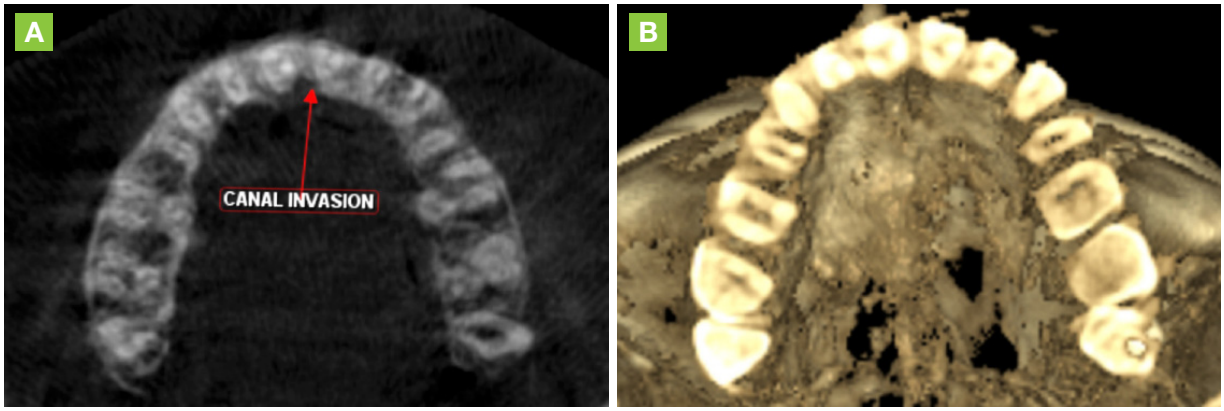
Figure 4. Posttreatment radiographs.



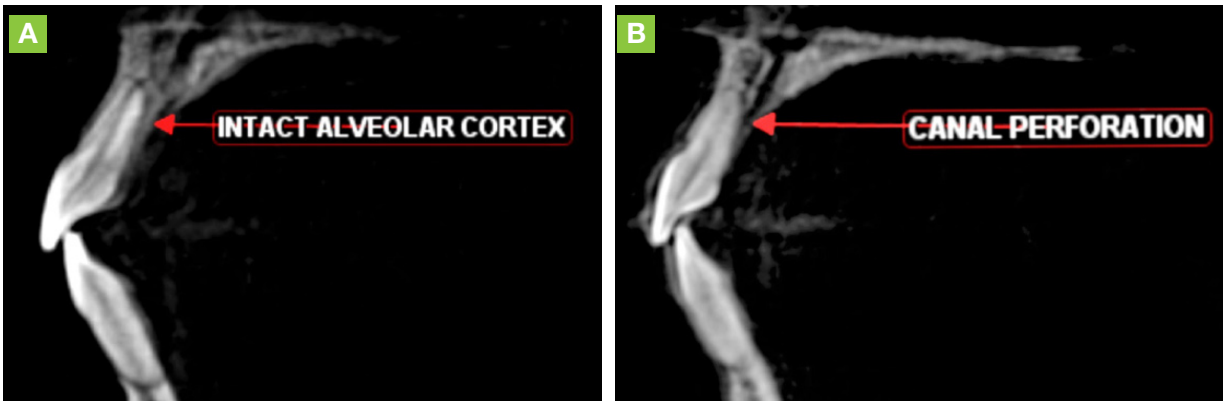
A. Panoramic radiograph. **B.** Lateral cephalogram. **C.** Pretreatment (red) and posttreatment (green) cephalometric superimposition.

Figure 5. Posttreatment axial CBCT sections.



A. Incisive canal invasion of the left maxillary central incisor root. **B.** 3D reconstruction of the axial CBCT section.

Figure 6. Posttreatment sagittal CBCT sections.



A. Incisive canal approximation of the right maxillary central incisor root. **B.** Incisive canal invasion of the left maxillary central incisor root.

In addition, there is a posterior positioning of point A as well as of the subnasale region, which reduces the maxillary alveolar procumbency.

A posttreatment cone-beam computed tomography (CBCT) scan (ProMax 3D; Planmeca, Roselle, IL; 0.4 mm voxel size) was taken to evaluate the anterior alveolar changes as well as any IC involvement. Overall, the cervical regions of the palatal surface of the maxillary anterior teeth as well as the lingual surfaces of the mandibular incisors were covered with bone. The axial sections of the CBCT scan revealed that a localized region of the mesiopalatal surface of the maxillary left central incisor root at the junction of the middle and apical third had invaded the IC space (Figure 5A and Figure 5B).

The sagittal sections of the CBCT scan revealed the involvement of the palatinal cortex of the IC whereas the palatal cortex was spared (Figure 6A and Figure 6B). Regressive changes in the form of complete disappearance of the palatinal cortex at the localized region were present. However, the radicular region was completely intact. There were no appreciable signs of apical, cervical, or surface root resorption.

Although the right maxillary central incisor was in proximity to the IC wall, frank encroachment or regressive changes in the IC cortex or the radicular tissues were not present. Since the invasion of the incisive canal was confined to a localized region with the cortical plates remaining intact at the cervical margin of the tooth, and the fact that the patient had remained free of symptoms, a follow-up CBCT scan was not prescribed.

DISCUSSION

While treating cases with bimaxillary proclination sometimes it is necessary to induce posterior remodeling of point A, which lies on the anterior surface of the maxillary alveolar process. This would reduce the maxillary alveolar procumbency that often accompanies the dental proclination. The Palatal root torque incorporated in the maxillary working archwire initiates coordinated apposition as well as resorption of the anterior alveolus thereby causing posterior positioning of point A and consequently reducing the midface procumbency.[8,9]

Incisive canal approximation or invasion has only been reported with regard to absolute maxillary incisor retraction aided by orthodontic mini-implants.[1,4,5] The average interroot distance between the central incisors is only about 3-4 mm.[1,5] Addition of palatal root torque during retraction may lead to root convergence, further decreasing the interroot distance and increasing the chances of IC contact.[10] Incidence of IC involvement due to excessive palatal root movement has not been reported in the literature. The present case report illustrates IC approximation and invasion due to excessive palatal root torque, as well as its complications and their resolution.

Variations in canal morphology including its deviation to one side, predominantly right, has been associated with a greater incidence of IC

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involvement on the right side as compared to the left.[1,4,5] In the present report although the IC did not show deviation, it was rather more rounded on the left side and hence closer to the root apex of the maxillary left central incisor. This might be the reason why the left side was involved although it is known to be less commonly affected.

IC contact has been routinely associated with orthodontically induced inflammatory root resorption of the maxillary central incisor roots.[1,4,5,11] A loss of root structure varying from mild blunting of the root apex to severe resorption extending up to the middle third of the root has been reported.[1,4,5]

Authors have attributed the large amounts of root movement, contact with the thick palatal cortex, as well as contact with the IC walls to be the main reasons for ensuing root resorption. According to some authors, it is the contact with the palatal cortical plate rather than the IC wall which is the main cause of root resorption.[12,13] Other authors, on the contrary, believe that the thicker walls of the IC are the primary reason for root resorption.[1,3,4]

They noted increased root resorption of the right central incisor which had moved across the IC wall as compared to the contralateral incisor which had only approximated the canal walls but was moved a similar distance. Although no regeneration of the root, as well as the IC wall, has been reported,[1-3] at least one report has mentioned regeneration due to cementum deposition, although to a minimal extent.[5] In the present report, no root resorption either apical, cervical, or in the region of IC invasion was noted. This might be because other factors apart from contact with thick cortical walls are also known to play an important role in root resorption.[13,14] In the present case the maxillary central incisors were slowly retracted and torqued palatally using conventional force levels which were moderate. Reduction of force levels upon reaching the cortical walls may be a strategy for preventing root resorption.[3,14] A pretreatment CBCT scan of the maxilla may prove useful to guide the extent of incisor retraction and avoid potential complications.[1,4,5]

No previous reports have elaborated upon the patient's response or clinical symptoms arising due to contact or invasion of the IC. In the present case although the patient complained of dull pain in the anterior palatal region when excessive palatal root torque was applied. No paresthesia was reported. The pain was reported for two months, amounting to two successive appointments, which subsided after the tooth movement was discontinued and the force on the central incisors was released.

Another potential complication is the regressive changes seen in the IC cortical plate. Extension of IC involvement up till the crestal region would result in a two-walled defect.[1] Although few reports mention that reconstitution of the palatal alveolar cortex takes place to a varying extent, the remodeling changes with regard to the IC have not been widely reported.[15,16] Only one study showed regeneration of the IC cortical plate although to a small extent.[5]

In accordance with the above information, it might be speculated that in the present case, the regressive changes that occurred in a localized region of the IC cortical plate will be reconstituted since the resorption was not extending to the cervical region which preserved the resultant soft tissue matrix. The osteogenic components of the soft tissue matrix may lead to bone deposition at the site.[16] In addition, it is anticipated that minor involvements of the IC are likely to remain free of any major consequences.

CONCLUSION

Root approximation, contact, or invasion of the incisive canal during orthodontic tooth movement may not result in root resorption. Incisive canal may exhibit modeling or regressive changes to preserve the radicular tissues. The remodeling of the incisive canal walls may be prolonged and might be discernible only at long-term follow-up.

A pretreatment limited field-of-view CBCT scan as well as close monitoring throughout treatment may be advised in cases requiring maximum incisor retraction, or in cases requiring excessive palatal root torque. Release of orthodontic force and discontinuation of tooth movement may prevent the complications of incisive canal involvement.

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CONFLICT OF INTERESTS

There are no conflicts of interest.

ETHICS APPROVAL

Approval from the Institution Ethics Committee as well as informed consent from the patient were obtained. (Manipal College of Dental Sciences Ethics Committee Protocol Reference Number 23013)

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AUTHORS' CONTRIBUTIONS

Shivani Singh: Patient care including diagnosis and treatment plan; conceptualization and manuscript writing (original draft, review and editing).

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ORCID

Shivani Singh

0000-0001-9717-4178

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