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Transmigration of Mandibular Canine: Review of Treatment Options and Report of 13 Cases

Abstract: Intra-osseous migration of a non-erupted mandibular canine is a rare phenomenon. The purpose of this article is to report 13 such cases of transmigration. The article reviews various aetiological hypotheses involved in transmigration, outlines diagnostic pathways for a patient presenting with missing permanent canines with or without over-retained deciduous teeth and discusses various treatment options for transmigration.
Clinical Relevance: The article proposes a difficulty assessing for the orthodontic traction of a transmigrated canine which may help the clinician in treatment planning.
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Intra-osseous migration of non-erupting teeth is a rare natural condition of horizontal tooth movement within the bone and is termed as transmigration if the tooth crosses the midline.[1,2] Management of such impacted and transmigrated teeth includes extraction or orthodontic alignment into the arch. We report 13 cases of transmigrated canines and also discuss a diagnostic sequence, as well as treatment considerations.

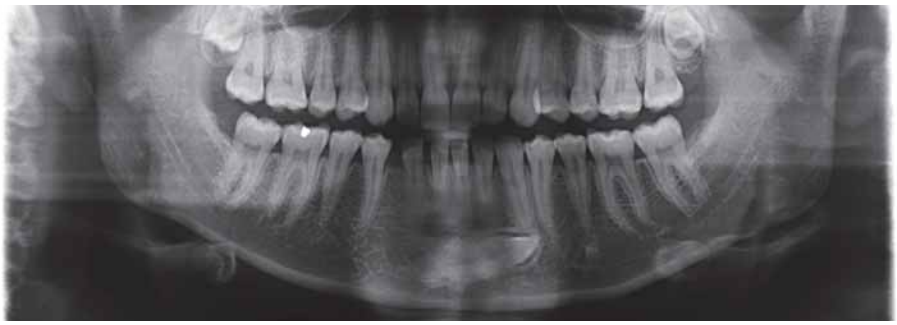

Figure 1. Panoramic radiograph showing right mandibular canine transmigrated below the apices of the left incisors and canine.

Case Reports

Case 1

A 13-year-old female patient reported with a complaint of irregularly-placed upper front teeth. Clinical presentation was an increased overjet. A panoramic radiograph revealed transmigrated LR3 below the apices of LL1, 2, 3 (Figure 1).

Case 2

An 18-year-old female patient reported with a complaint of proclined upper anterior teeth. Clinical presentation was an increased overjet. A panoramic radiograph revealed transmigrated LL3 below the apices of LR3, 2, 1; retained LLC and missing LL2 were noticed (Figure 2).

Case 3

A 27-year-old male patient reported complaining of pain and swelling in the lower jaw. Panoramic radiographs revealed a large radiolucency extending from lower LL8 to LR7. Biopsy confirmed it as unicystic ameloblastoma. LL3 had pathologically transmigrated to the right side with only the root crossing the midline (Figure 3).

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Figure 2. Panoramic radiograph showing the left mandibular canine transmigrated below the apices of the right incisors and canine.

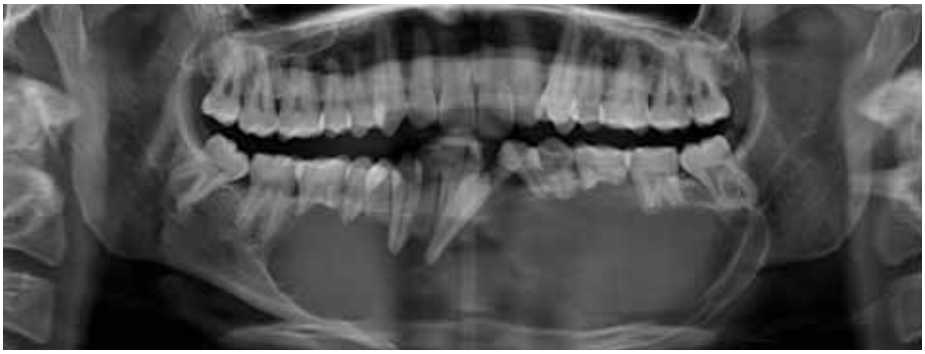

Figure 3. Panoramic radiographs showing the pathologically transmigrated lower left canine, to right side, with only the root crossing the midline.

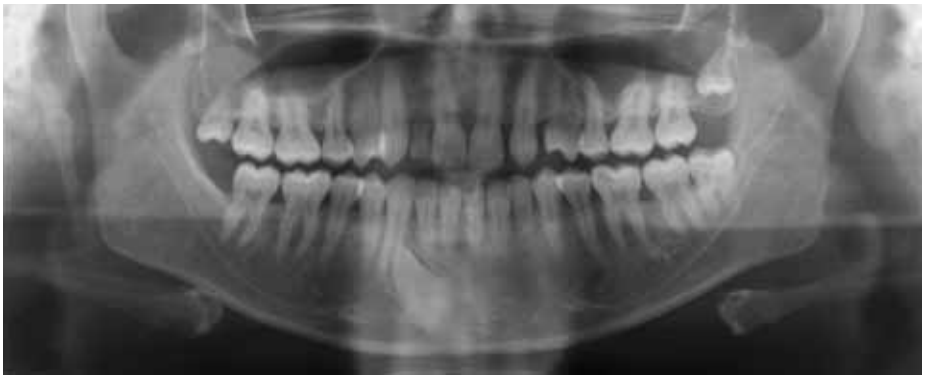

Figure 4. Panoramic radiograph showing the transmigrated left mandibular canine erupting mesial to the right canine.

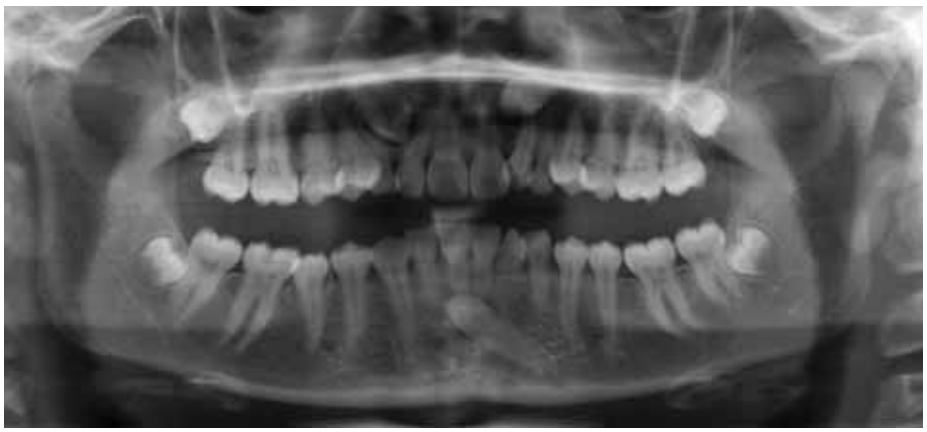

Figure 5. Panoramic radiograph showing the left mandibular canine transmigrated below the apices of the right incisors.

Case 4

A 30-year-old male patient reported complaining of space between the upper front teeth. Panoramic radiograph revealed transmigrated LL3 below the apices of LR3, 2, 1, retained LLC and missing UL2 (Figure 4).

Case 5

A 15-year-old female patient reported complaining of proclined upper front teeth. Panoramic radiographs revealed transmigrated LL3 below the apices of LR2, 1; retained LLC and impacted UR3 and UL3 were observed (Figure 5).

Case 6

A 25-year-old female patient reported complaining of proclined upper anterior teeth. Panoramic radiographs revealed transmigrated LL3 below the apices of LR3, 2, 1, retained LLC and impacted UL3 (Figure 6).

Case 7

A 29-year-old male patient reported for the prosthodontic replacement of missing upper and lower front teeth. Panoramic radiographs revealed transmigrated LL3 in the edentulous area of LR2 and 1 (Figure 7).

Case 8

A 15-year-old male patient reported for the prosthodontic replacement of upper front teeth. Panoramic radiographs revealed transmigrated LL3 oriented vertically below the apices of LR2, 1; over-retained LLC and LRC, and impacted LR3 UR3 and UL3 were observed (Figure 8).

Case 9

A 13-year-old female patient reported with the complaint of forward-placed upper front teeth. Panoramic radiographs revealed transmigrated LL3 below the apices of LR2, 1 and retained LLC (Figure 9).

Case 10

A 29-year-old male patient reported with the complaint of space between the lower front teeth. Panoramic radiographs revealed transmigrated LR3 below the apices of LL1, 2, 3 and missing LL2 (Figure 10).

Case 11

A 23-year-old female patient reported complaining of irregularly placed upper and lower front teeth. Panoramic radiographs revealed transmigrated LR3 below the apices of

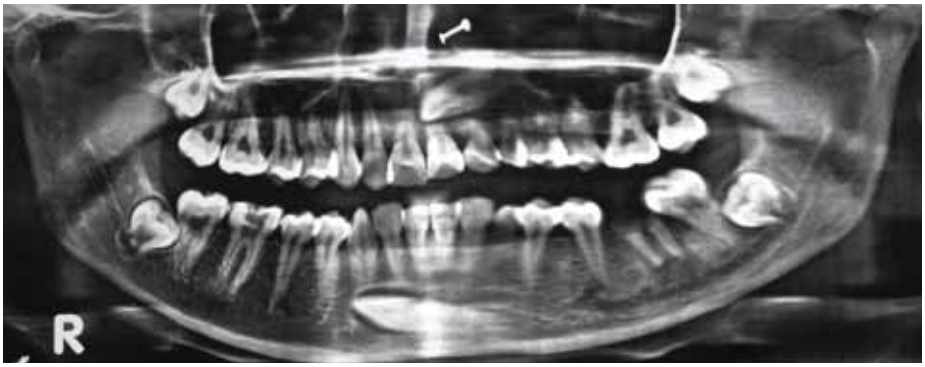

Figure 6. Panoramic radiograph showing the left mandibular canine transmigrated below the apices of the right incisors and canine.

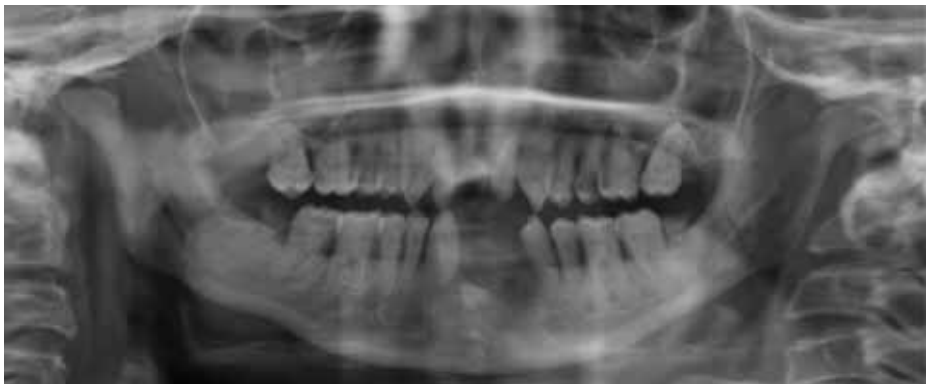

Figure 7. Panoramic radiograph showing the left mandibular canine transmigrated into the edentulous area of the right incisors.

Figure 8. Panoramic radiograph showing the transmigrated left mandibular canine oriented vertically below the apices of the right central incisor.

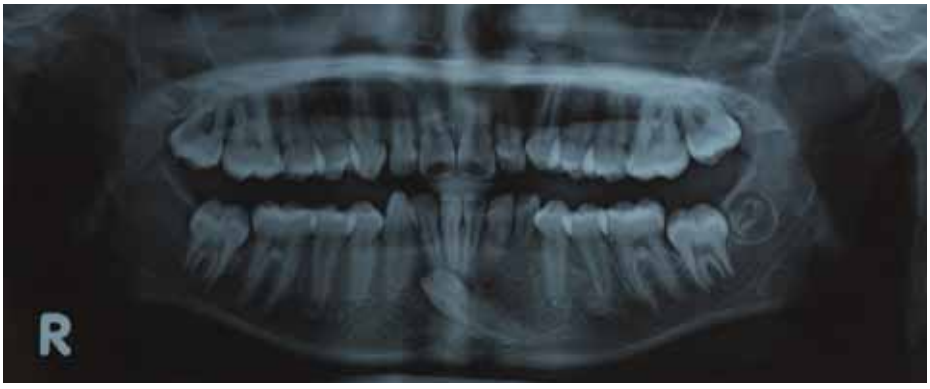

Figure 9. Panoramic radiograph showing the left mandibular canine transmigrated below the apices of the right incisors.

LL1, 2, 3, retained LRC and impacted UR3 and UL3 (Figure 11).

Case 12

A 24-year-old male patient reported complaining of irregularly placed upper front teeth. Panoramic radiographs revealed transmigrated LR3 below the apices of LL1 and 2 (Figure 12).

Case 13

A 20-year-old female patient reported with the complaint of crowding in the upper front teeth. A panoramic radiograph revealed bilateral transmigrated canines situated horizontally below the LR2 and 1; LL1, 2 and retained LRC and LLC were observed (Figure 13).

Discussion

Transmigration of mandibular canines is a rare phenomenon with as few as 200 reported cases to date.[3,4] According to various authors, the incidence of transmigration of canine ranges from 0.075% to 0.34%.[5,6,7] Transmigration of other teeth, like mandibular lateral incisors and second premolars, have also been reported with extremely low incidence rates (0.0017% for lateral incisor and 0.0026% for second premolar[5]). Though these two teeth are most commonly affected, developmentally the reason for the difference in the incidence of transmigration is as yet unknown.

The aetiology of transmigration is unknown; many authors have suggested various phenomenona[8-25] (Table 1). Eight of the 13 cases reported here had retained deciduous canines; these could be retained because of the absence of the resorptive forces from the succeeding tooth (ie the impacted and transmigrated permanent canine). In two cases, missing incisor teeth were observed. In only one case, the transmigration was pathological in nature and was associated with a cyst.

Intra-osseous tooth movement is regulated by the dental follicle, enamel organ and surrounding alveolar tissues; various putative molecules implicated in the tooth eruption signalling cascade, for example BMP-2, EGF, CSF-1, IL-1α, NFκB, Runx-2, etc have been identified. Formation of the tooth eruption pathway is a localized, genetically programmed event. Suggested eruption genes and their products are localized primarily in either the dental follicle or stellate reticulum.[26,27] Any disturbance in this signalling cascade might lead to a deflected path of migration, indicating a strong genetic role in transmigration.

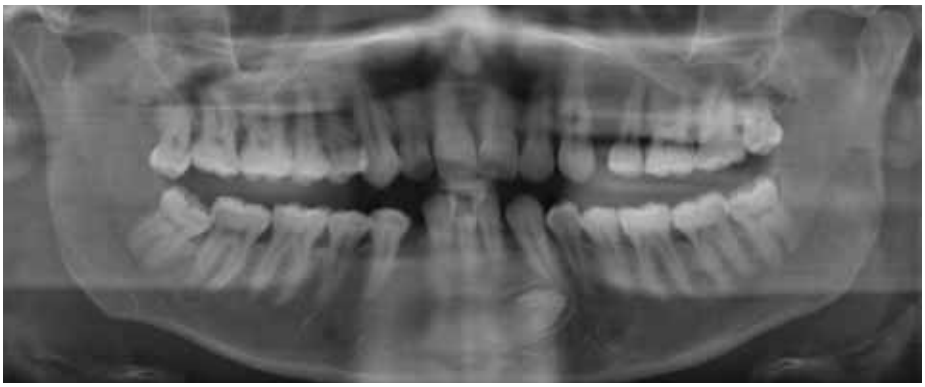

Figure 10. Panoramic radiograph showing the right mandibular canine transmigrated below the apices of the left incisors and canine.

Figure 11. Panoramic radiograph showing the right mandibular canine transmigrated below the apices of the left incisors and canine.

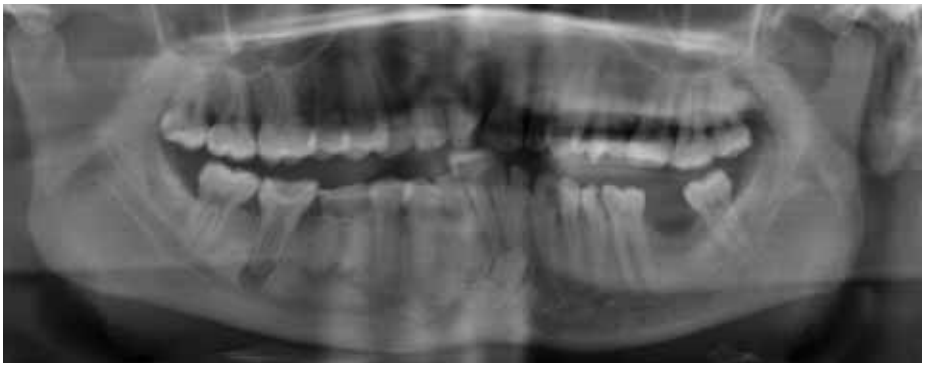

Figure 12 Panoramic radiograph showing the right mandibular canine transmigrated below the apices of the left incisors.

Figure 13. Panoramic radiograph showing the bilateral transmigrated canines situated horizontally below the apices of the lower incisors.

Transmigration of mandibular canines is generally a unilateral phenomenon, although bilateral cases have been reported.[28] In 2002, Mupparapu proposed a classification for transmigrated mandibular canines according to their migratory pattern and position in the jaw and classified these teeth into five groups.[3] Type 1 is the most common type among the cases reported in the literature (47.5%).[3] Cases 1, 2, 5-7 and 9-12 of our reported cases are of this category. (Case 4 is of Type 3 category and Case 8 is of Type 5). The current classification does not accommodate cases with only root transmigration, as seen in Case 3. Hence, it necessitates further modification in the existing classification to include such cases (Table 2).

Unilateral transmigration is commonly associated with left side canines.[29]In cases 2-9, left-side canines are transmigrated, and in cases 1, 10-12, right-side canines are involved. Our case series also confirms such a pattern of involvement.

The distance travelled by the canine ranges from the midline to the third molar on the opposite side. Type 4 of Mupparapu's classification is the farthest distance migrated, accounting for 9.9% of all transmigrations.[3] Howard expected older patients would show greater distance of travel because of longer time available for migration.[8] However, a review of Type 4 reported cases shows that the majority of them are detected at an early age between 6 and 31years;[3,10,23] Alba *et al* also reported higher prevalence in the age group 0-20 years.[29] Hence the distance of migration may not be age dependent but it may be due to abnormal displacement of the dental lamina, as proposed by Nodine,[15] or could be of genetic aetiology.

Bilateral transmigration occurs in only 9% of all transmigrations.[7] In 2007, Mupparapu *et al* proposed a new classification for bilaterally transmigrated mandibular canines into five groups with sub-types.[28] A total of 19 cases of bilateral transmigration have been reported in the literature[28] and a new case of Type 2 sub-type A has been added with this report (Case 13).

The majority of transmigrated canines are not associated with any pathology. However, cystic pathologies (17.2%), odontomas (3.3%), supernumerary teeth (1.9%),[3,10,29] enostosis,[30] Gardner's syndrome,[25] mural ameloblastoma[20] and bilateral agenesis of lower incisors[31] have been reported in association with mandibular canine transmigration. In four

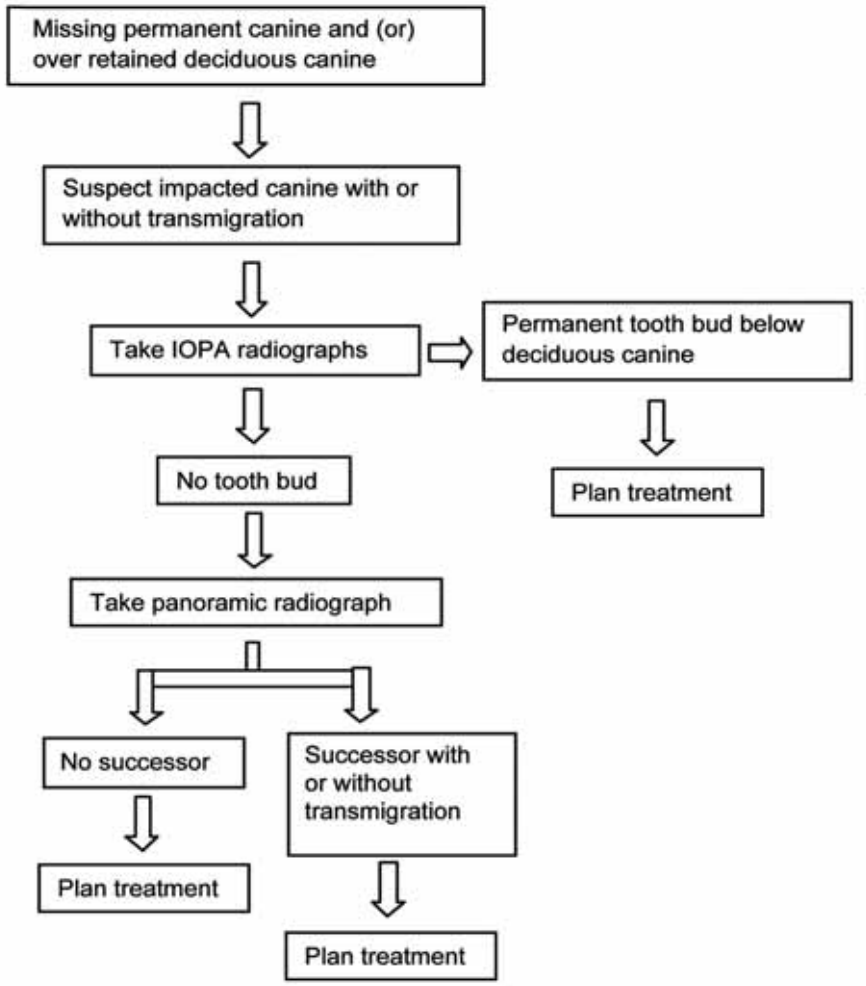

Figure 14. Diagnostic outline for cases presenting with a missing permanent canine and (or) over-retained deciduous canine.

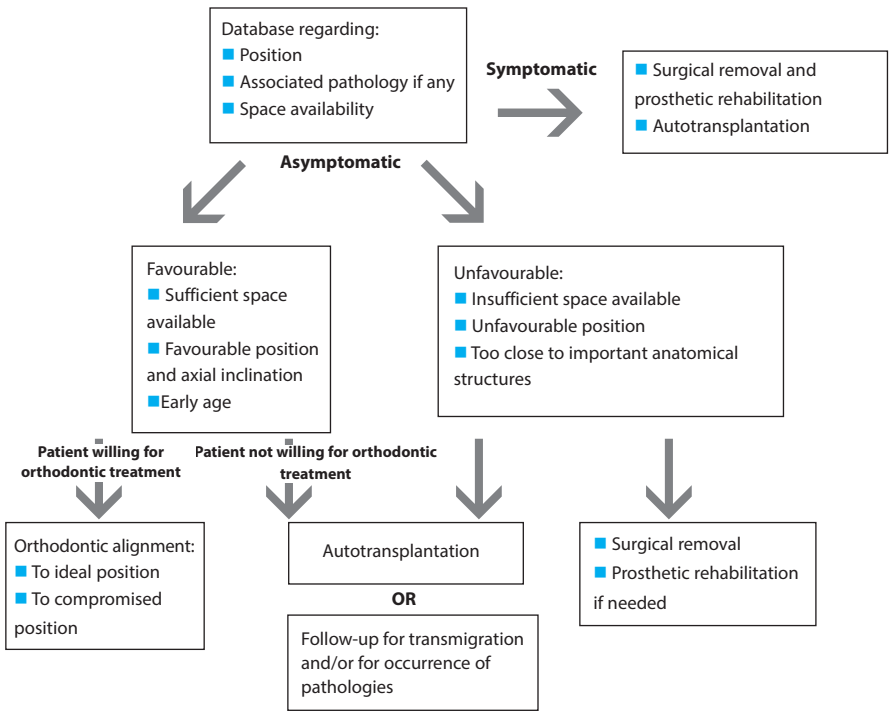

Figure 15. Treatment options for a transmigrated canine.

of our cases (Cases 5, 6, 8 and 10) other canines are impacted. Several treatment options are available for transmigrated canines, which include orthodontic intervention, autotransplantation, surgical removal and periodic observation.[6,9,17,18,23,32] From the data published regarding management of transmigrated canines, it is possible to outline pathways of care (Figures 14 and 15).

When the mandibular arch is crowded and requires therapeutic tooth extraction to correct incisor crowding, the surgical removal of transmigrated teeth can be considered. However, the symptomless unerupted teeth can be left in place.[33] Transmigrated teeth associated with pathologies, like cysts, tumours and fractures, are often surgically removed, along with associated pathologies.[7] Autotransplantation can also be considered if the tooth can be removed intact, even if associated with pathology. Improvement in the position of the canine after surgical removal of associated odontoma has been reported.[29]

Orthodontic treatment appears to be the ideal treatment option for transmigrated teeth. The majority of the successfully treated cases mentioned in the literature are of Type 1 variety.[17,33,34] Orthodontic alignment of a labially impacted transmigrated canine can be undertaken to its original position if the crown of the transmigrated canine has not migrated past the opposite lateral incisor, or if the apex has not migrated past the adjacent lateral incisor apex[17] (Figure 16). Trakyalı reported the alignment of a transmigrated canine to a compromised position.[34]

Autotransplantation of a transmigrated canine may be indicated

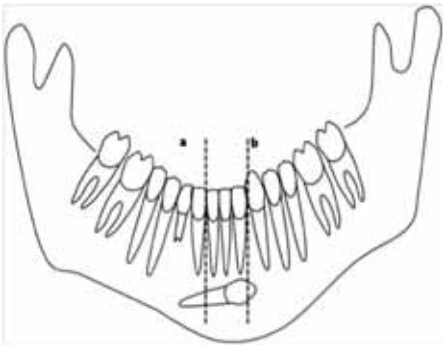

Figure 16. Favourability assessment of a transmigrated canine. Lines **a** and **b** are drawn parallel to the long axis of the incisors. The root apex should not cross line **a** and (or) the crown should not cross line **b**.

Etiologic factor		Hypothesis from literature
Developmental		1. Angulation of canine to midsagittal plane between 30 and 45° (Howard)[8] 2. Abnormally strong eruptive force (Javid)[9] 3. Conical shape of crown and root (Joshi)[10] 4. Agenesis of adjacent teeth (lateral incisor) (Vichi and Franchi)[11] 5. Canine tooth germ located farther from normal site (Alaejos-Algarra *et al*)[12] 6. Regional disturbance in the dental follicle leading to local defective osteoclastic function with an abnormal eruption pathway (Marks and Schroeder)[13] 7.Canine germ located in front of the lower incisor and facial growth pushes it towards the contralateral side (Bruszt)[14] 8. Abnormal displacement of the dental lamina in the embryonic life (Nodine)[15] Obstructive
	Pathological	1. Tooth within the cyst migrates owing to cystic pressure (Thoma, Wertz)[16,17] 2. Odontomas (Shapira *et al*, Taguchi *et al*)[18,19] 3. Ameloblastoma (Murthy *et al*)[20] 4. Fracture through developing crypt (Mitchel, Nixon and Lowey)[21,22] 5. Small obstacles like root fragments (Nodine)[15] 6. Supernumerary teeth (González-Sánchez *et al*)[23]
	Anatomical	1. Retention of deciduous canine 2. Premature loss of deciduous canine 3. Space deficiency (Shapira *et al*)[18]
Genetics		1. Clinical signs that suggest the presence of genetic control like bilateral occurrence, hypodontia and palatally displaced canines are associated with transmigration (Peck)[24] 2. Gardner's syndrome (Baykul *et al*)[25]

Table 1. Various phenomenona suggested by many authors for the aetiology of transmigration, which is unknown.

Type 1	Canine positioned mesio-angularly across the midline within the jaw bone, labia or lingual to anterior teeth, and the crown portion of the tooth crossing the midline.
Type 2	Canine horizontally impacted near the inferior border of the mandible below the apices of the incisors.
Type 3	Canine erupting either mesial or distal to the opposite canine.
Type 4	Canine horizontally impacted near the inferior border of the mandible below the apices of either premolars or molars on the opposite side.
Type 5	Canine positioned vertically in the midline (the long axis of the tooth crossing the midline) irrespective of eruption status.
Type 6	Canine with only root crossing the midline.

Table 2. Modified Mupparapu's classification for unilateral transmigration of the canine.

in selected circumstances where incisors are well aligned and sufficient space is available for the canine in those patients who are unwilling to undergo orthodontic treatment.[8,32,35] However, the procedure is technique sensitive and success rate depends on apex development and is higher in teeth with an open apex. The patient must be informed regarding failure and risk associated with such procedure. Average survival rate of autotransplantation reported is about 14.5 years (1.4–27.8).[36]

Asymptomatic transmigrated canines can be left in place; however, a series of successive radiographs should be taken periodically to check on any progressive worsening in position, pathologic changes, neurologic symptoms and pressure resorption tendencies to adjacent teeth. Surgical intervention is suggested if any such changes are noticed.[37]

Conclusion

In conclusion, clinical observation of a retained deciduous canine or a missing permanent canine warrants further radiographic investigation to rule out possible transmigration of an impacted permanent canine. Early detection of transmigration may help in a better prognosis for orthodontic alignment. The current system of classification does not include teeth with root migration. We are suggesting a modification of Mupparapu's classification for unilateral transmigration by including transmigration of only root as Type 6.

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